Lean Strategy

A study and lean application report in OMET s.r.l.

Tesi d'anno a.a. 2011-2012

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【Abstract】 This paper centers on a study in Lean strategy concerned about the application cases in OMET s.r.l.(abbreviation as OMET). This thesis deeply discusses about the concepts of Lean thinking and the essence in application. A comparison between conventional production ideas with Lean strategy will be told. Furthermore, this thesis will concentrate on the methods to solve the inventory problem of OMET with the aim of lean tools, like value stream map, KANBAN and so on. New relationship between OMET and its suppliers will be introduced and zero-defect of quality management will be presented as some side impacts on the inventory controlling. Also the details on the way to combine the theoretical principles with OMET's real production situation and stock management will be studied and true cases in OMET for this will be analyzed. In the end a prospect of the continuous development of lean ideas and efforts for JIT in the company will be demonstrated and also some of the achievements from the lean application obtained during this thesis period will be analyzed.

【Key Word】 lean Strategy; OMET; inventory; muda ; supplier ; KANBAN ; practical

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1 Preface

1.1 Introductions of OMET

When the company was first established in 1963 by Angelo Bartesaghi, OMET S.r.l. began by producing machinery for special tasks and assembling mechanical components. Towards the end of the 1970s, the company began to specialize in the design and construction of the first machines to produce paper napkins and presses for printing labels. Thus began a process that has marked the way to OMET's present position. The company continued to grow in the area of mechanical engineering centered on Lecco, where, today, it has its headquarters on two different complexes with a combined overall surface of approximately 8000 square meters. With customers in over 70 countries worldwide, the OMET Group also includes two foreign subsidiary companies: OMET IBERICA SL in Barcelona, OMET (Suzhou) Mechanical Technology Co., Ltd in China and OMET americas.

OMET company now is mainly divided into 2 parts: Printing Presses & Paper Converting Machines and Special Ball Bearings & Sliding Systems.

Figure 1.1 Printing Presses & Paper Converting Machines

For OMET Machines, it includes two divisions. Printing Presses, offering a complete range of printing machines for all packaging materials, where the different offset, flexo, rotogravure technologies are available and can be integrated into one another in a unique modular system. Tissue Converting, including a complete range of plants for in-line production, from a roll to the finished product, of disposable items: napkins, table sets and towels made of paper, tissue or synthetic materials.

Figure 1.2 Printing Presses & Paper Converting Machines

For OMET Motion systems, since 1963 OMET has been working in the motion field, designing and manufacturing components and integrated systems that find application in the widest industrial sector ranges. Almost 50 years experiences in the sector are a guarantee that few companies can offer in terms of liability and wealth soundness. A guarantee that finds a further confirmation in OMET's choice to remain faithful to its origins of a family capital company is with a strong entrepreneurial involvement and the presence of a young and reliable team of managers, technicians and employees. From the production of special "according to drawing" bearings and linear rails, OMET has widened the activity throughout last years, making its design skills available to customers, as well as the flexibility of its plants and the technical know-how of the operative staff, to offer complete sliding solutions.

OMET motion systems contains two factories, one in Italy and one in China. From the supplier in China, they buy raw materials and forming into semi-products in Wujiang factory which is located in Jiangsu province near to the harbor of Shanghai. This action reduces the cost of final products and also the labor cost. But this extends the lead time of the product and mainly increases the charges in transportation. For the transportation expenditure and capacity of quantities, most of the products are shipped by sea from China to Italy which means it needs six weeks more for the products to arrive in the warehouse of OMET Italy compared to getting semi-products or raw material from Italian supplier.

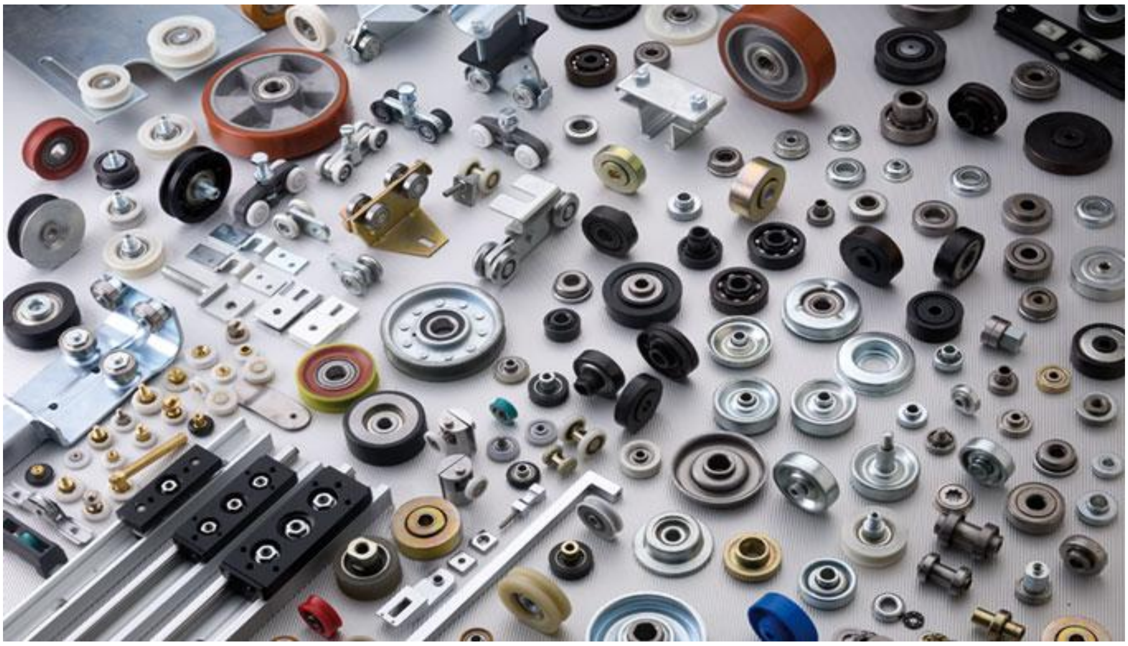


Figure 1.3 A show of different kinds of products

OMET Motion systems' main products contain: shower boxes, cable and component holders, sliding windows and doors frame, air chains, balconies, bed sofas, wardrobes and office's chairs, drawers and displays, vending, lift doors, doors, bellows doors, doors sliding into the wall, automatic doors, linear rails, wheels, sliding covers, roller conveyors and others. There are standardized pattern of products and also special products, which means customized. Therefore the field of species of the products that contained in OMET motion systems working field is very wide.

For this reason, the OMET technicians divide the products into different families according to different working processes. They use a code "A.BBBB.CCCC" to mark all different materials, semi-products and final products. Also with internal documents, the employees of the company can easily classify various materials to the definite location. This provides a compact way for the stock management and also the arrangement of working process. Different products also mean dozens of different set-ups of the turning machines, assembly machines and so on. Also to design a new product according to the customers' requirement, not only new moulds are needed, new drawings correlated to real working problems also will be tested again and again. For the distance from Chinese suppliers and Italian customers, the quality control and problem solving communication now are to put on the agenda of the focusing forces of the company. Now as a result of the mobility of the company's business and the fast changing of the European market, the funds blocked in the warehouse due to the inventory accumulation more and more gets the attention of the Lean production group from the company.

1.2 Introductions of OMET system in motion Valmadrera

The factory of OMET system in motion has been moved to Valmadrera from Lecco since May of 2012. With larger workshop and warehouse, they are intending to improve their business. All about 30 employees and managers from company concentrates on the quality of the old products and the development of the new products for customers all over the world. They have highly automatic lathes and assembly machines in the workshop. With controlled and efficiently producing, they want to extend their business to new fields. According to OMET's philosophy, which is based on a customized approach and starting from the customer's needs, OMET individuates the best solution under the profile of quality, performances, functionality and cost.

Design is the first step of such a path: using the most advanced 3D drawing systems, the technical office analyses the customer's requests and sets up an industrial development project for the product, choosing the most suitable materials and defining the most appropriate processing.

And in the factory of OMET, they can independently finish one product with high-precision to the customers' demand. Now they have three punching machines, one lathe machine, seven assembly machines and some other machines for classify the material automatically and packaging process. Also in the office of quality control, they have many types of equipment to test and inspect the quality of the final products. With the help of technical office and some suppliers, partners in Italy, the quality of the products can be guaranteed for the market competitiveness.

1.3 Introductions of OMET system in motion in Wujiang

The factory in Wujiang has been founded for more than 5 years since 2008. At the beginning its main task is to provide raw materials and also some first processing steps of the products which are mainly targeted to the customers in Europe. While from last several years, the employees of the company have risen up to 50 and several new machines have been introduced for a variety of production requirement. The work of the factory in Wujiang has extended further than just a "supplier" for factory in Italy. It gradually construct its only supply chain and market net also in China. The ability to work on plastic molding gives them some other opportunities to march into new areas. While now the major of the work is still supply most of the semi-products to OMET in Italy, the quality level has been raised up by the cooperation with the supplier in China and the technical support provided by Italian side.

1.4 Situation of the stock 2011-2012

From May of 2010 the company has introduced a system named SAP to manage their stock level, purchasing order, client order and so on. For all the data used in the thesis is from the SAP system and protected by law.

Following, the stock level from January 2011 to May 2012 will be analyzed. We check all the pieces in the warehouse at the beginning of the year 2011 and follow the locus of the upload and download of the products during the period, then we find some of the problems growing in the inventory.

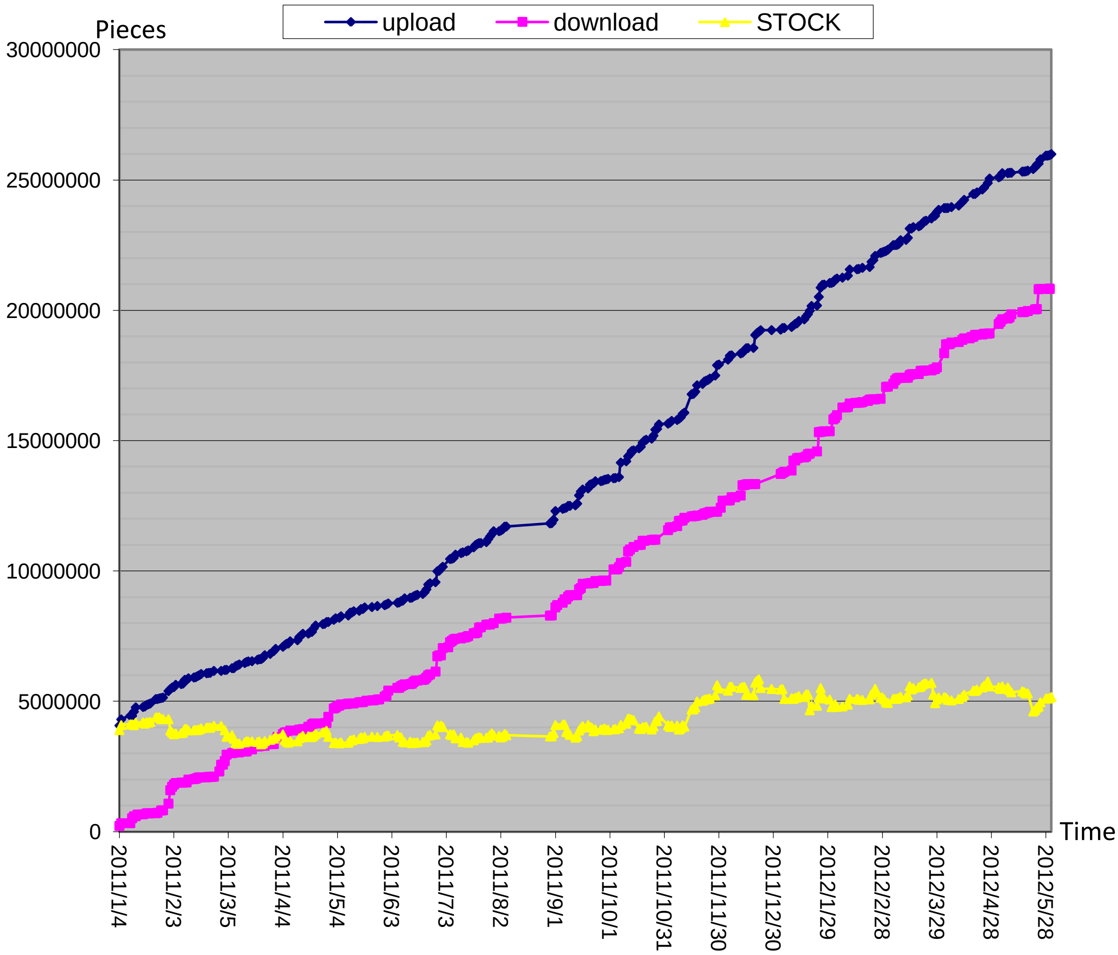


Figure 1.4 Stock level (pieces) from 2011.01 to 2012.05

From Figure 1.4, we could conclude that the quantity of all the pieces is about *4.800.000* at the beginning of 2011, while it increases quickly to almost *5.100.000* till May of 2012. That means we are importing more and more, but consumes less. But will it be that we are consuming faster so the safety stock has to be increased? So next the Lead Time of the pieces in stock will be provided. This time is calculated as to reach the same level of the upload at one date, how many days we need according to the download level.

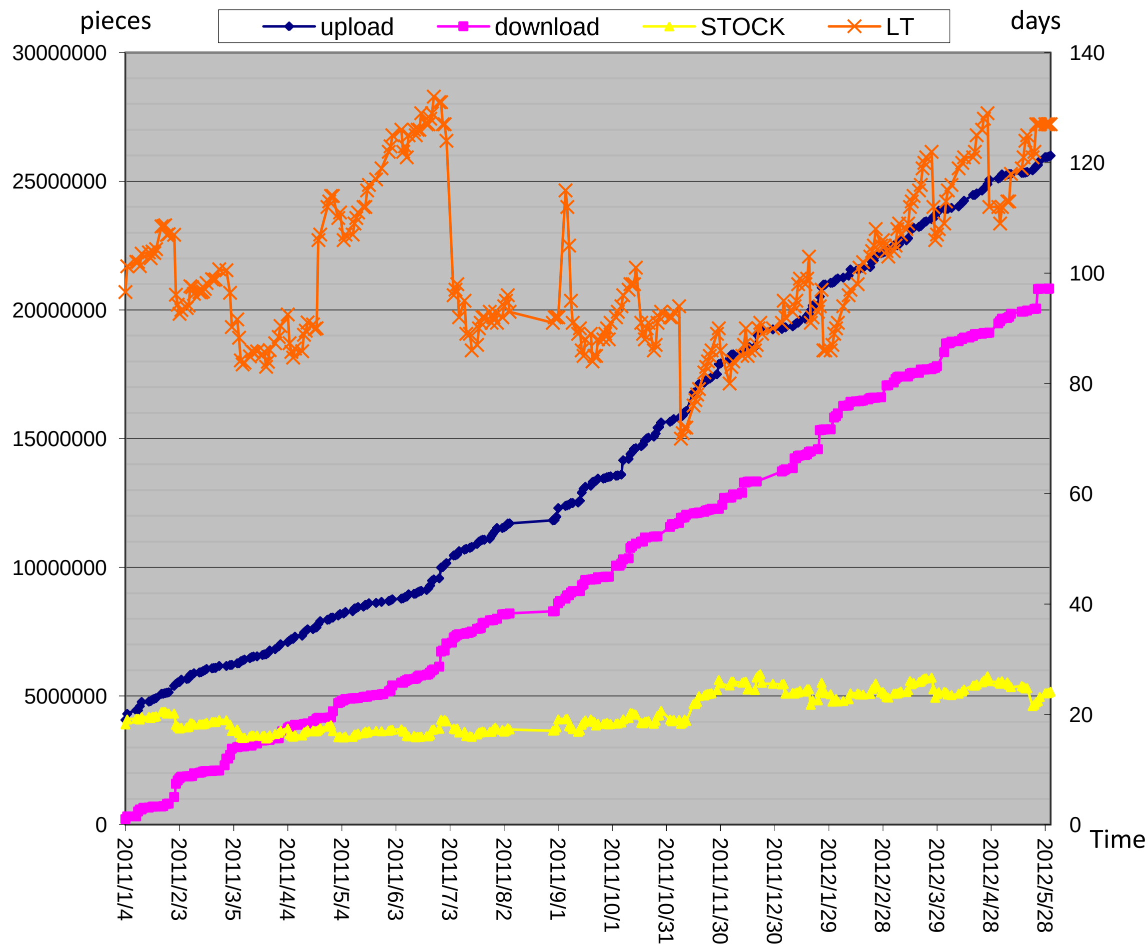


Figure 1.5 Lead Time level (pieces) from 2011.01 to 2012.05

So from figure 1.5, we can easily tell that average level of the lead time has increased from *95* days at the beginning of year 2011 to *120* days till May of 2012. That means even considering about the consuming speed, the time that the products stay in the inventory gets longer. But this can also be caused by the mounting types of material and clients or by products remaining in the warehouse with no consuming any more. These are possible factors we have to concern about and more details will be discussed later in the following chapters. However the matters caused by the increasing numbers of pieces have to be discussed now. That is the value blocked in the warehouse.

There is a cost for each of the pieces we make, and we can take the cost back when the pieces have been sold. The time that the pieces we made stay in the inventory can be seen as blocked. We can't do anything with that money we invested in the stock.

From a research in OMET, there is an astonishing result which shows the company blocked almost 2 times of the assets in the stock in a little more than one year, but not using this money to invest more on the production improving or extending the market.

Therefore it provides a possibility to improve immediately the company's situation by managing the stock level and set those "blocked" value free for other more meaningful research and development. And reducing the stock for sure will bring some changes or storms to the company construction. The stock level actually depends on a lot of factors, for example, lead time of the production, safety stock for emergency situation, capacity of working load and so on. To reduce the stock level can cause influence to most operation activities of the company. So we need a complete model of thinking way, here we introduce the lean strategy to see what is the relationship and solution we can find for lean and inventory management.

2 Lean Thinking

2.1 Concepts of Lean

What is Lean? Easy way to explain is to make it thinner. So when it applies to the company management, we can consider it as eliminating the "adipose" that causes the company to get "fat". In manufacturing field, the concept of lean is usually referred to as World Class Manufacturing and The Machine That Changed The World in which illustrates very well what is Lean's spirit.

The term of lean is popularized in the 1980's and 1990's to encompass a number of approaches to managing manufacturing companies that included an emphasis on systems producing exactly what the customer wants at the lowest cost and with no waste. Lean thinking is a highly evolved method of managing an organization to improve the productivity, efficiency and quality of its products or services. Most ideas in lean were developed by Toyota, a successful Japanese automobile manufacturer. Because Toyota developed so many ideas of lean, so the term "Toyota Production System"(TPS) is almost a symbol for Lean production. The focus of Toyota was "the absolute elimination of waste", where waste is anything that prevents the value-added flow of material from raw material to finished goods.

Customers' requirements to the company are the final judges as to whether the company has created value or not. For those materials or those processes that don't create values, Japanese call them "*muda*", which means waste. All the lean main idea is concentrated on eliminating any and all waste.

For most of the waste, we can classify them in to eight types:
I. Over-delivering-volume
II. Waiting for the work to be ready for the next process
III. Conveyance or transportation
IV. Over processing - because of poor design (i.e. not what the customer values)
V. Inventory level too high
VI. Human motion
VII. Correction of defects.
VIII. Defective Design

It's definitely wrong to tackle these wastes in isolation, for instance, trying to reduce the stock levels alone. This will surely lead to an imbalance, disruption of flow and a worse situation. Because some wastes can be the causes for some others, and also if one factor related to more than one kind of waste and we treat it only in one case, this may cause troubles in another waste. Let's see figure 2.1 to make things more clear.

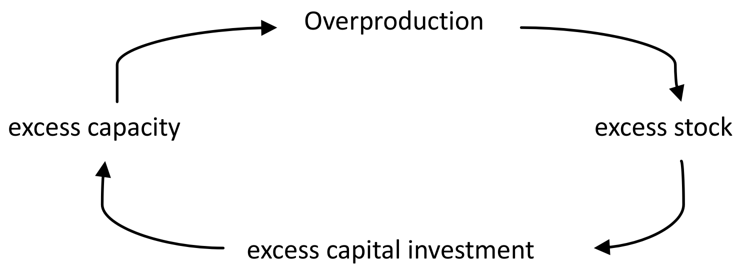


Figure 2.1 one example of the relationship between different wastes

In this figure, we can see that excess capacity to produce means that we do produce even if it is not needed. This overproduction is seen in delivering of services that are not wanted at all or delivering services at the wrong time and the extra output will be put into excessive stocks. We may also over-produce if we are simply not in a position to deliver services that are required. For example having too many staff available so that some are free and without work load.

Overproduction is the result of pushing the flow of work through our system, rather than allowing the customer to pull the work through the system by their demand. Excess stock will lead to capital being "blocked" in a "dead place" and the final depreciation, maintenance and other overheads.

Therefore it's easy to see now that such wastes correlate with each other very firmly. Even if we just change one small factor with the willing to improve one field, the "butterfly flaps its wings" and a "tornado" will be followed influencing the whole system.

2.2 Lean against batch-and-queue

What is batch-and-queue? It describes a production process by which all the units in a given lot complete a particular stage of production before moving to the next stage. The process creates a "batch" of units, which then must wait in a "queue" at each production stage as each unit is processed in turn. According to its feature, it is also called as "batch-and-push".

The following figure 2.2 will show the batch-and-queue process.

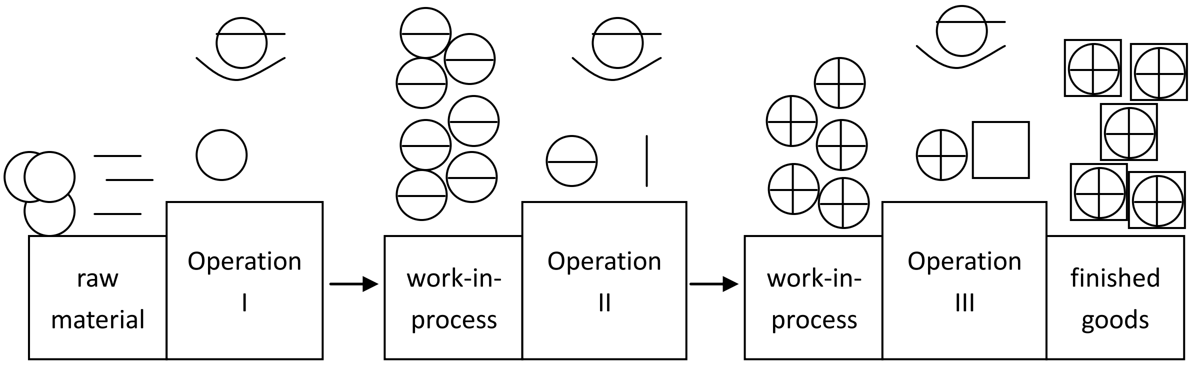


Figure 2.2 batch-and-queue working process

In the batch-and-queue, we don't consider about how much quantity that we really need, but how many batches need to be processed. It's just like pushing the materials from left to right. And between two operations, many pieces will stay there and wait in the queue. This operation method keeps worker and machine busy and sounds logical. But wastes will appear when the production is not needed yet by the external and internal customer, like overproduction, excess stock and so on.

But even though, human is born with a batch-and-queue brain. Take bicycle as an example. At the beginning, when we first invented bicycles, we worked one by one for the customer's need. The working process was slow because we needed to work by hand for different parts of the bicycle, and when we assembled them together, we also needed to adjust some parts' dimensions to fit them into other parts. And this long time-cycle working process didn't matter a lot, because the demand was low and bicycle was purchased as luxury. But the situation later changed.

As the worker becoming more skillful and some parts could be replaced by standard parts, the time necessary for a bicycle reduced a lot. This also led to the falling down of the price, so clearly the demand of the product increased rapidly. Then the production firm started to think about this problem. Reducing the cycle time of the production process is a vital competition for the market. An idea grew up among the manufacturers: why not we arrange one worker for one certain part, and in the final we just get all parts together. For one worker continuing for one certain job, the skill for him increased a lot and the cycle-time for each piece reduced a lot. Also for the worker only needed to know the technology for his own job, compared to one worker handling the whole production flow of the bicycle, the labor cost will be much lower for the less skill needed. The only problem is the harmonization between different parts. The dimensions and the connection style must be determined and calculated carefully, otherwise the assembly process will have a lot of problems. So after every part finished, we needed to add a quality control for the parts in order to make sure the assembly process went smoothly. Further later, we invented automatic machines to replace human workers to ensure the quality and reduce the cycle-time for each part.

Everything went well, from the original working way to highly automatic working line, as they should be in our mind like this way. Batch-and-queue was born naturally. The basic but important idea for batch-and-queue is efficiency and cost. So if we want to continue to improve the work process, based on the property and idea of batch-and-queue, we need to enhance the technology of the operation machines and the level of automation or we can enlarge the business to mass-production to reduce the cost of the raw material. Also as the different types of the bicycle being required more and more, the set-up time and change-over cost for the operation machines must be cut, otherwise new machines will be needed. But all of these need very large investment and some technology leap, which is indeed not easy and overproduction, excess stock and so on may occur quickly as a result.

In fact, the batch-and-queue idea is rooted into human's heart. When we need to complete a certain amount of repetitive tasks, we always try to solve one part of the task once for all the pieces, then go on with another part. The reason is one simple work at one time increases the work efficiency a lot and we do all agreed on this. Until 1980's, some people began to consider the situation in a new way: LEAN.

"LEAN IS… A mindset, or way of thinking, with a commitment to achieve a totally waste-free operation that's focused on your customer's success….It is achieved by simplifying and continuously improving all processes and relationships in an environment of trust, respect and full employee involvement….It is about people, simplicity, flow, visibility, partnerships and true value as perceived by the customer." Ref: David Hogg, High Performance Solutions.

Actually the basic idea of lean is attractively simple. It is that the organization should be obsessively focused on the most effective means of producing value for their customers. So to achieve the lean enterprise, it requires a departure from traditional thinking by applying 5 basic principles which are focused on understanding waste and value in the working process and training staff who do and manage the work to act as improvement teams to bring about change. Here are the 5 principles:

I. *Define what customers value*: Value is what the perspective of the end customer, in terms of a specific product, with specific capabilities, offered at a specific price and time. This is what the customer wants and only what the customer wants, which requires a precise understanding of the specific needs of the customer. But in batch-and-queue process, most of the process activities are non-value adding, for example, time blocked in the inventory and time spent in the queue.

II. *Understand the Value Stream*: We can't identify correctly for a single activity in the whole production process. Each activity should be put into the entire value stream, that is those activities, when done correctly and in the right order, produce the product or service that the customer values. A lean organization traces and manages all the activities in the organization that deliver value wherever they are and whichever department they are in. Also some activities could be totally or partly unnecessary and wasteful, which should be reconsidered and eliminated. Others may be used just for supporting the value-adding activities. These should be reduced and improved as far as possible. In the final, what we need to continuously improved are those activities add value entirely to the customer requirement.

III. *Improve the flow*: to achieve lean, working steps should flow steadily and without interruption from one value adding or supporting activity to the next, which means working on each design, order, and product continuously from beginning to end so that there is no waiting, downtime, or waste, within or between the steps. This usually requires introducing new types of organizations or technologies and getting rid of “monuments" (obstructions whose large scale or complex technology necessitates operating in a batch mode). This is contrasted with the "batching" of work where, for instance a week's expenses claims are collected for a manager to authorize in one go. Where it is suitable, flow significantly speeds the processing and every effort should be made to eliminate obstacles and bottlenecks that prevent flow.

IV. *Pull*: The system should react to customer demand, in other words, letting the customer pull the product/service from the value stream eliminates the following types of waste: designs that are obsolete before the product is completed, finished goods, inventories, elaborate inventory/information tracking systems, and those surplus goods no one wants. For we have discussed above, thinking of mass production, batch-and-queue work is pushed through the system at the convenience of the operators and so it's normal to produce outputs that are not required. The first thing we need to change is that we need to react but not push.

V. *Perfection*: As the above 4 principles are implemented we could get to understand the system ever better and from this understanding we should generate ideas for more improvement. A lean system should set sights on perfection, which means they need continue to become leaner and faster and waste is ever easier to identify and eliminate. The idea of total quality management is to systematically and continuously remove the root causes of poor quality-with the ultimate goal of achieving zero defects, which we will discuss in the later chapters. For those perfect processes, we need to deliver just the right amount of value to the customer and every step is valuable-adding, capable (produces a good result every time), available (produces the desired output, not just the desired quality, every time), adequate (does not cause delay), flexible (easy to make the change-over), and linked by continuous flow (value does not block in one step, but flow to the next step without obstacle). If one of these factors fails, then there will be some waste produced.

For many services, different to the manufacturing, they react only when there comes a need of the customer. For this reason, they are somehow closer to LEAN principles. The problem is that in service, customers concerns more about the lead-time and the quality. But according to the lean principles, we may check every step in the service and eliminate the waste existed and potential to improve the service.

Batch-and-queue concentrates on the working time we need to produce the total business, so we batch things to do it more fluently. But lean sets the focus on the time that the desired quantity of desired quality goods needs for delivering to the customer. This reflects more on the market's demand, which is taking a customer eyed-view. These five principles mainly differ from the 4P that concerns a lot in batch-and-queue. For 4P, we discuss about product, price, promotion and place. But if the efforts of production don't make any interests in customers, it's totally useless for a lean thinker. As the way going, who wins the heart of the customer, who wins the market.

Another comparison is on the improvement efforts between lean and batch-and-queue:

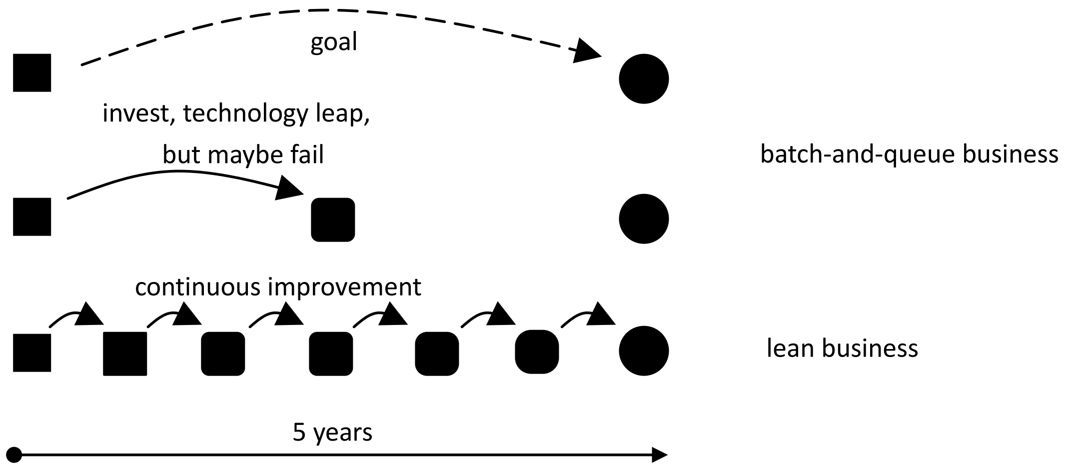


Figure 2.3 batch-and-queue and lean competitors' different development idea

From figure 2.3, we can tell that batch-and-queue producers rely on new initiatives every few years to regain lost competitiveness but often fall short of intended goals. Partial or total failure results in the distribution of blame, making stakeholders such as employees and suppliers, weary of participating in future initiatives.

Lean producers prefer to make steady progress in small increments, knowing that this increases stakeholder participation, learning, retention, and application to future business problems. As a result, lean producers can usually remain ahead of their batch-and-queue competitors.

So discussed about much of the advantages of lean strategy compared to batch-and-queue, but all of these are in a theoretical plane. What we exactly need to do to improve our business (in our case is to reduce the high level of inventory stock) according to lean ideas? Next chapter will show us what are the basic tools applied in lean enterprise.

2.3 Tools of Lean

There are many tools and methods to apply lean in our real business. Here presents only the 25 tools most known and useful. For some tools, the relationship with stock and opportunity to improve in OMET will be discussed.

(1) *5S*

Tool explanation: To organize the work area according to the following 5 ways.

I. Sort (eliminate that which is not needed)
II. Set In Order (organize remaining items)
III. Shine (clean and inspect work area)
IV. Standardize (write standards for above)
V. Sustain (regularly apply the standards)

From 5S, we can eliminate waste that results from a poorly organized work area. For inventory, if we do like this way, it reduces the time to find the product in the stock and reduces the total maintenance cost, keeping the product in a suitable ambient.

(2) *Andon*

Tool explanation: Visual feedback system for the plant floor that indicates production status, alerts when assistance is needed, and empowers operators to stop the production process.

This one acts as a real-time communication tool for the plant floor that brings immediate attention to problems as they occur, so they can be instantly addressed. For inventory management, it can control the upload and download of the stock more smoothly.

(3) *Bottleneck Analysis*

Tool explanation: Identify which part of the manufacturing process limits the overall throughput and improve the performance of that part of the process.

For those weakest links in the manufacturing process, when they are processing, other steps can just wait in the stock or buff between two steps. If such lead time of some step is, like OMET, much longer than others, this may also cause stock time getting longer.

(4) *Continuous Flow*

Tool explanation: Manufacturing where work-in-process smoothly flows through production with minimal (or no) buffers between steps of the manufacturing process

To make the flow continuously working, this eliminates many forms of waste, like inventory, waiting time, and transport).

⑸ *Gemba*

Tool explanation: A philosophy that reminds us to get out of our offices and spend time on the plant floor, where real action occurs. So this is also called as *The Real Place*.

Promotes a deep and thorough understanding of real-world manufacturing issues by first-hand observation and by talking with plant floor employees.

⑹ *Heijunka(Level Scheduling)*

Tool explanation: A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process.

This will reduce the lead times (since each product or variant is manufactured more frequently) and inventory (since batches are smaller) very obviously.

⑺ *Policy Deployment*

Tool explanation: Align the goals of the company (strategy), with the plans of middle management(tactics) and the work performed on plant floor (action).

Ensures that progress towards strategic goals is consistent and thorough-eliminating the waste that comes from poor communication and inconsistent direction.

⑻ *Autonomation*

Tool explanation: Design equipment to partially automate the manufacturing process (partial automation is typically less expensive than full automation) and to automatically stop when defects are detected.

After autonomation, workers can frequently monitor multiple stations (reducing labor costs) and many quality issues can be detected immediately (improving quality).

⑼ *JIT*

Tool explanation: Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. Relies on many lean tools, such as Continuous Flow, Level Scheduling, Kanban, Standardized Work and Takt Time.

To process JIT, it will have highly effective in reducing inventory levels. Cash flow will improve and also space requirements will reduce. This is mainly we will try to perform in our real case. To achieve just in time, it's not just as simple as to organize the production according to the customers' order, but it needs the foundation of all the other efforts. To explain it clearer, we could take a look at the figure 2.4. Without those premises below, we could tell that JIT is just a dream. That's why in the following chapters we need to discuss about lots of other operations first. When we have done others perfectly, naturally we could get to the time of JIT operation.

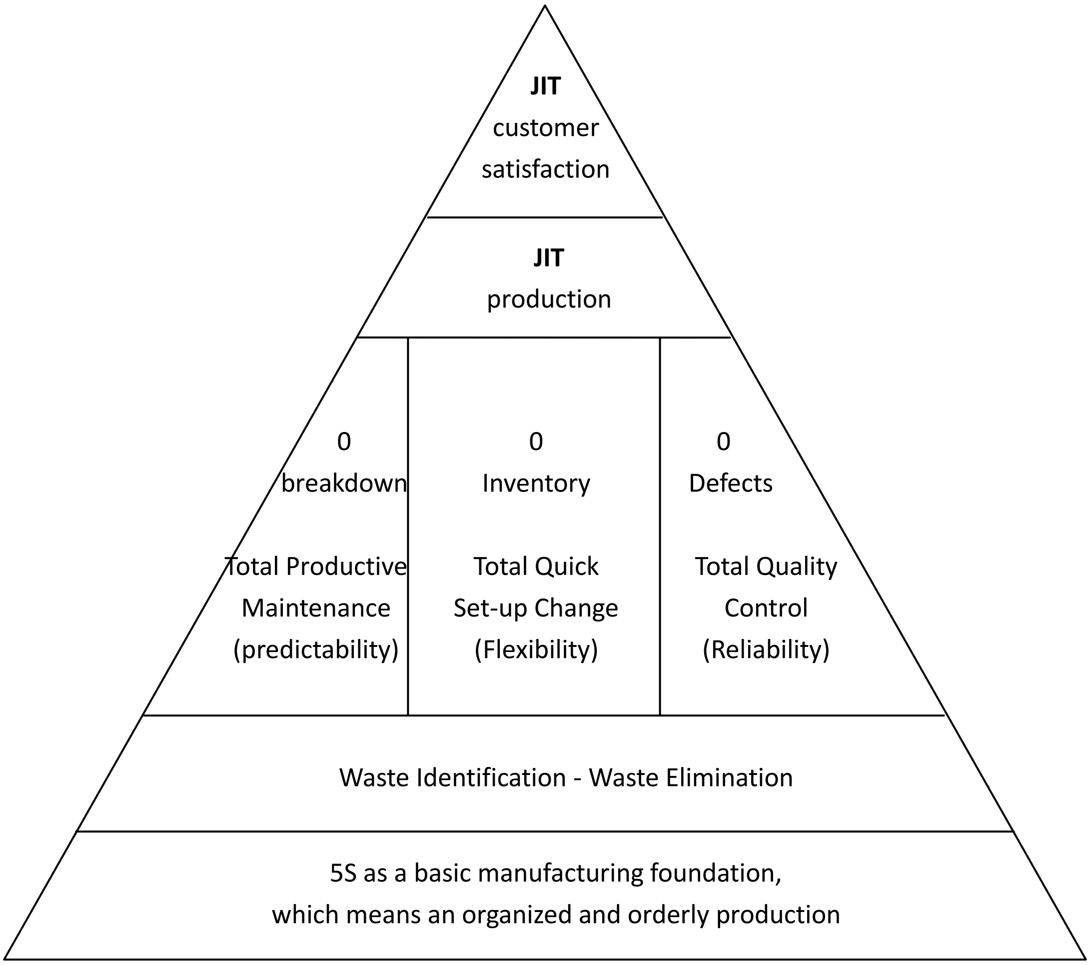


Figure 2.4 Pyramid of JIT enterprise

⑽ *Continuous improvement(Kaizen)*

Tool explanation: A strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process.

Combines the collective talents of a company to create an engine for continually eliminating waste from manufacturing processes.

⑾ *Kanban (pull system)*

Tool explanation: A method of regulating the flow of goods both within the factory and with outside supplier and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.

With kanban we can replenish the inventory only when it has been consumed. This can eliminate waste greatly from inventory and overproduction. Actually kanban can be seen as a virtual stock. It controls two kinds of information on the working line: one for taking the kanban and another for producing the product on the kanban. The main order transported by kanban is that "what to produce""when to produce""how much is the quantity""how to produce""how to transport". With this information, ideally the products don't need to stay there but just flow through the working steps to the customer. And it can eliminate the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered). So kanban mainly controls the information flow, and with this flow, we can reduce the wastes in the physical flow. It mostly benefits the inventory level.

⑿ *KPI*

Tool explanation: Metrics designed to track and encourage progress towards critical goals of the organization. Strongly promoted KPIs can be extremely powerful drivers of behavior - so it is important to carefully select KPIs that will drive desired behavior.

We need to select manufacturing KPIs aligned with top-level strategic goal (thus helping to achieve those goals). Also those effective at exposing and quantifying waste (OEE is a good example) are good manufacturing KPIs. And the KPIs readily influenced by plant floor employees (so they can drive results) are very important.

⒀ *MUDA*

Tool explanation: Anything in the manufacturing process that does not add value from the customer's perspective.

Eliminating muda is the primary focus of lean manufacturing.

⒁ *OEE(Overall Equipment Effectiveness)*

Tool explanation: Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked: Availability (i.e. downtime), Performance (i.e. slow cycles), Quality (i.e. rejects).

OEE provides a benchmark and a means to track progress in eliminating waste from a manufacturing process. 100% OEE means perfect production (manufacturing only good parts, as fast as possible, with no downtime).

⒂ *PDCA*

Tool explanation: Iterative methodology for implementing improvements: Plan (establish plan and expected results), Do (implement plan), Check (verify expected results achieved), Act (review and assess; do it again).

We could see some detail process in figure 2.5. For OMET, it has already taken on such method for the activities in the company. Every Monday, they will have a meeting with managers from all the departments and discuss about the situation of last week, collecting the problems, brainstorm for plans to solve the problems. Then they will practice the plan in the following week and check on the next week. If something goes wrong, they will act on the new situation. Or something goes fine, then they will discuss and improve it further for mass production.

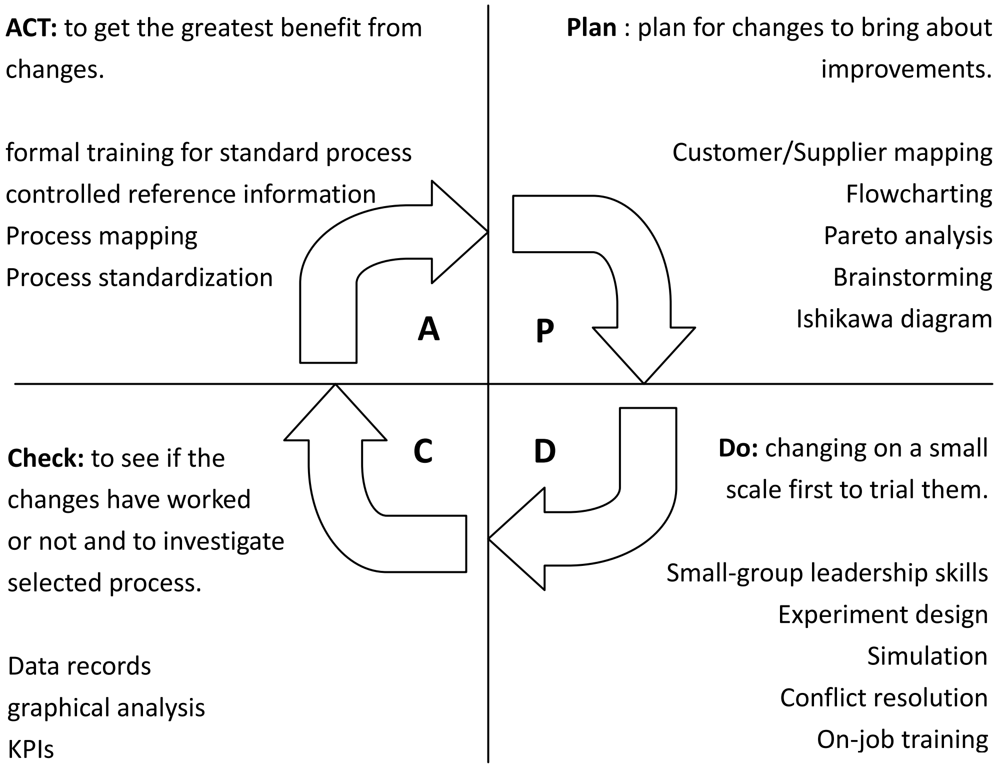


Figure 2.5 the circle of PDCA

⒃ *Error Proofing(Poka-Yoke)*

Tool explanation: Design error detection and prevention into production processes with the goal of achieving zero defects.

It is difficult (and expensive) to find all defects through inspection, and correcting defects typically gets significantly more expensive at each stage of production. So for quality control, what we need to do is nipping the error in the bud, but not checking at the end then modifies the piece. Of course, this is not an easy task, because every different product has different kinds of defects and where there will be defects also should be very practical that only through many periods of producing and reports from customers, we can know the reason of the defect and try to apply an easy error proof.

⒄ *Root Cause Analysis*

Tool explanation: A problem solving methodology that focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. A common approach is to ask why five times - each time moving a step closer to discovering the true underlying problem.

This helps to ensure that a problem is truly eliminated by applying corrective action to the "root cause" of the problem.

⒅ *SMED*

Tool explanation: Reduce setup (changeover) time to less than 10minutes.
This techniques include:
- Convert setup steps to be external (performed while running the process
- Simplify internal setup (i.e. replace bolts with knobs and levers)
- Eliminate non-essential operations
- Create standardized work instructions

Enables manufacturing in smaller lots, reduces inventory, and improves customer responsiveness.

⒆ *Six Big losses*

Tool explanation: Six categories of productivity loss that are almost universally experienced in manufacturing:
- breakdowns
- setup/adjustments
- small stops
- reduced speed
- startup rejects
- production rejects

Provides a framework for attacking the most common causes of waste in manufacturing.

⒇ *Smart Goals*

Tool explanation: Goals that are: specific, measurable, attainable, and time-specific.
Smart goals help to ensure that goals are effective.

(21) *Standardized Work*

Tool explanation: Documented procedures for manufacturing that capture best practices (including the time to complete each task). Must be "living" documentation that is easy to change.

It eliminated waste by consistently applying best practices, forming a baseline for future improvement activities.

(22) *Takt Time*

Tool explanation: The pace of production (i.e. manufacturing one piece every 1 week) that aligns production with customer demand. Calculated as Planned Production Time/ Customer Demand.

This provides a simple, consistent and intuitive method of pacing production. Also this is easily extended to provide an efficiency goal for the plant floor (Actual Pieces/ Target Pieces). But for OMET, the transportation time is too long compared with e real production time, so we need to change the production method. We need to consider if we need the takt time for the whole processing line or the takt time for ATO. We will discuss this in the later chapter.

(23) *TPM (Total Productive Maintenance)*

Tool explanation: A holistic approach to maintenance that focuses on proactive and preventative maintenance to maximize the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help maintain their equipment.

This creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity (increasing uptime, reducing cycle times, and eliminating defects).

(24) VSM

Tool explanation: A tool used to visually map the flow of production. Shows the current and future state of processes in a way that highlights opportunities for improvement.

With VSM, we can expose waste in the current processes and provide a roadmap for improvement through the future state. Womack and Jones visualize the value stream in "Lean Thinking" as this: raw material along with knowledge and information enter the system upstream (the suppliers); and, products or services of value flow out from the system downstream (the customers). The individual processes that take place in between are those that add value to the product or service as it flows through them. It is a simple but powerful model. If an activity or process does not add value, it shall be eliminated. Batch-and-queue thinking causes people to focus on optimizing pieces of the system instead of looking at the whole value stream. But with a VS vision, we can know why we need to improve, what we need to improve, by seeing the whole - a significant leap up from a simple process flow chart. Process maps or charts are not the same as VSM, because they do not show us the REASON of the problem.

(25) Visual Factory

Tool explanation: Visual indicators, displays and controls used throughout manufacturing plants to improve communication of information.

Visual control makes the state and condition of manufacturing processes easily accessible and very clear to everyone.

2.4 Stock meaning

To understand what the stock level means for a company, first we could to see an example, figure 2.6.

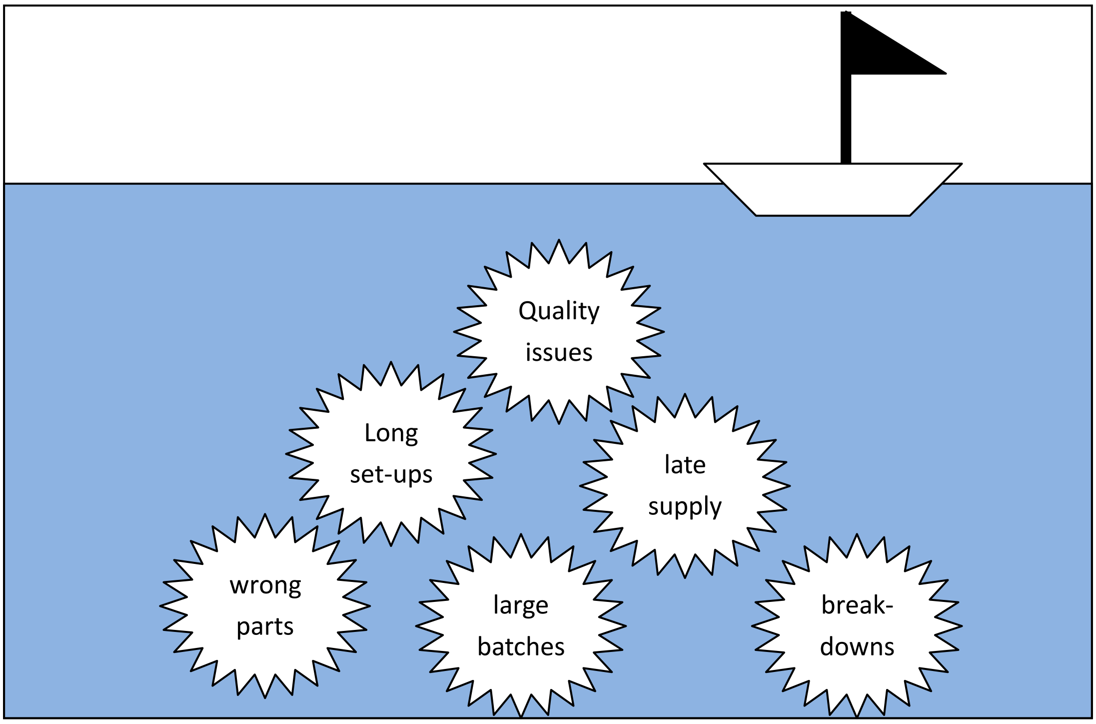


Figure 2.6 Inventory level and company's operation

If we think the company as a boat navigating on territorial waters, to ensure it can sail smoothly, we need a depth of the water, which means inventory. This water can give a solution to many problems, just like the rocks under the boat, which the company will meet. The stock can guarantee a safety stock for the company for cases in emergency such as delay of the supplier, some sudden breakdowns and so on, otherwise there will be a fail on the customers' demand. And for wrong parts and quality issues, if we can stock more goods than normal, we can pick out the proper quantity of goods from the excess stock for the customers. And also when we processing large batches or different steps in the work having quite large differences in time, some semi-products must stay in the inventory and wait for the next step.

It seems to increase the inventory level "solves" a lot of problems of the company, but it's not the truth. The truth is that the problems have been "hidden" under the inventory level. So when new problems come or the business getting larger leading to the old problem more serious, what we could do is only to enhance the level of the stock once more. As long as we didn't start to solve the problems, the level of the stock keeps increasing and maybe some vital affairs occur.

For example, with the increasing of the "water" level, it gets harder and harder for us to recognize where the real problem is hidden in the company. And more realistic, more and more money tied up in the inventory and can't be invested into other development issues which are more useful.

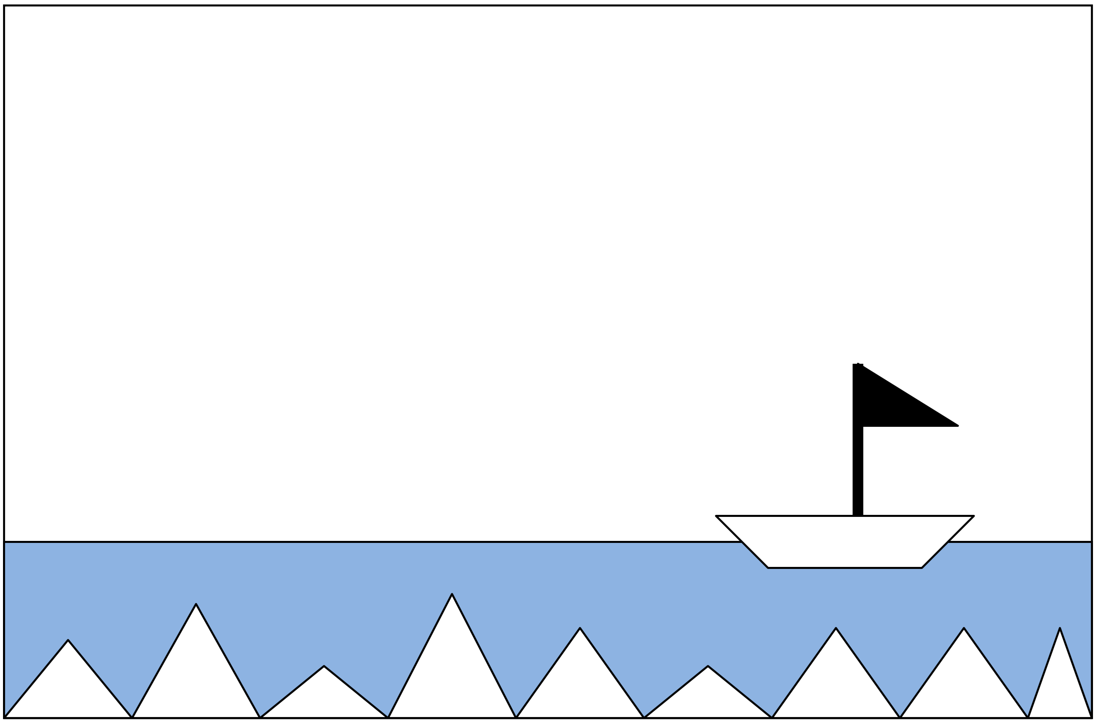


Figure 2.7 successful "sail" of the company with lower "sea" level

Instead of keeping increasing the stock level to guarantee the operation of the company, the correct solution we should take is to eliminate the "rocks", problems covering by the inventory. For a lean company, they choose to do such thing like this way: First we remove some stock, when some problems are exposed, then we stop and start to analyze the problem. After solving the problems, even small, we can continue to repeat these processes. This is the safe and convenient method. However two bad situations are waiting for us. One is that if we do not want to remove stock at the beginning, we may not get the right point which we have to solve, and this may cause trouble later when we really eliminate the stock. Another situation is that if we eliminate the stock too much in one time, we may not keep the company going on well with the right now business. As shown before, we have to go advance step by step, but keep going.

Also there is one method to add. When we apply KANBAN system, we don't really need to reduce the physical stock inside the inventory, to reduce the number of kanbans is also convenient to the result, but this need a just-in-time idea in the manager's mind and more information transfer control will be applied. However this is necessary to achieve the Promised Land: zero-inventory.

2.5 Stock management theoretically

Stock management is not only to control the goods flow in and out, but also we need to analyze the whole situation of the company, to control the delivery, to manage the production process and so on. And the final goal of the stock management is "zero-inventory". Since 1980s, the concept of zero inventory has been set up and open a new field to all the business players. And it's simple compared with other management dogmas. It asks people to pare the inventory to a minimum and boost the profit margins by eliminating the need for warehousing and other expenses that are associated.

This shocks the things rooted deep inside the mass-producers' mind. For batch-and-queue, the inventory is just compulsory and needs to grow larger with the business. But as a result of highly developed technology and more convenient and faster way for the communications between supplier and customer, nowadays when a customer places an order, suppliers can immediately see that the manufacturer needs additional raw materials or not. And also in another situation, if a customer cancels an order, suppliers can immediately stop their activity. This increased level of responsiveness and awareness leads to less fault stock in the inventory effectively. This seems we have taken one step much closer to the zero inventory, but actually even with more and more supply-chain communications and wider spread adoption of technologically advanced planning software, mass producers have found it is still difficult to achieve the inventory-management goals, not further to say about the door of zero inventory, just like an unreachable and purely theoretical idea.

In fact, it's better to speak of "lean" rather than "zero inventory”:

"Inventory is not the problem; it is a symptom. Inventory is the result of waste and variance. The way to reduce inventory is simple: You get rid of waste and you reduce variance." But many companies are not doing the same way.

"Instead, they jump around from program to program, trying to slash inventory here and there, like a dieter trying to lose weight. Just as a dieter can't realistically expect to stop eating for a day, jump on a scale, and magically hit his weight-loss goals, a company can't take a few superficial steps and significantly reduce inventory."

For certain we agree that most companies striving for zero inventory must fundamentally change the manufacturing and handling processes. This is surely different from improving some key software and getting a leap.

There are some tips to get started for slashing inventory:
I. *To check the customer base*. Ensure you understand who your critical customers are and what they value. Then communicate that data throughout the company so the producers can focus on creating value for key customers instead of trying to satisfy everyone which is an unfocused approach that can lead to unnecessary inventory.

II. *To check the processes and establish a baseline*. Before you can locate the problems, you have to recognize them. For example, in Omet sometimes you can find one single ball stays in the buff for more than 2 weeks and traveled hundreds of meters, touched by 5 workers and passed through 12 steps and only 2 steps among these all added value to the component. Then things get clearer.

III. *To check the critical processes*. Focus on critical processes to quickly identify which parts of your overall system most significantly affect inventory, then begin to make necessary changes. Critical processes include bottlenecks or constraints in your system, processes can be judged easily by the customer to determine the basis of the production, unique core competencies or skills, the process with the highest amount of variance, or the process that requires the most resources.

All those above are not one-day-work, which means we need to check them regularly and get improved continuously. Even the advance for each step is not as large as a leap, but when they are accumulated, they are. We need to keep doing the simple things right and it's true every company needs inventory, the right way is to ZEROING inventory.

Following are the tips for zeroing inventory management:
(1) *Develop a lean infrastructure*. Establish a program, place someone in charge of it and be sure senior managers support it.

(2) *Recognize and reward successes*. Publicize the successes and the people who helped achieve them to underscore their importance.

(3) *Share information*. If some parts of the company become more adept than others at minimizing inventories, they should spread best practices across the company.

(4) *Be patient*. Give the employees enough time to install, learn and become proficient with new inventory-management systems.

Zero inventory may be wishful thinking, but embracing new technology and processes to manage your inventory more efficiently could move you much closer to that ideal.

2.6 Stock management situation in reality of OMET

Theoretically there are many ways for us to "zeroing" the inventory. But these ways in practical need to be tested and to be carefully chosen. Here we present some present situation of Omet motion systems (below abbreviated as Omet) inventory management.

First we have to discuss with the supply chain of Omet. For Omet it has 2 factories, one in China and another in Italy. The factories in China we call it "FA" and that in Italy we call it "FB". For FA, it has its Chinese suppliers from Shanghai, Suzhou and Ningbo. The lead time for a normal lot of parts to arrive in FA from its suppliers is around 3 days. For this "3 days" we consider infinite capacity of production of the supply and no other work from other customers for the supply. Also before the production, we need to test some samples if the parts are special required by the customer not standardized. Different types of parts need different lead-time. Anyway for many practical reasons some parts arrive earlier and need to wait in the inventory. After all parts arrive in FA, workers begin to do the plastic molding or some else processing to achieve semi-products. In the mean time, they will send some samples to Italy customer for the quality check. After all is done maybe in one week, they will order a ship to transport all these pieces to FB for final assemble and packaging. Here considering about the long journey from China to Italy and also about the high cost, usually they don't send them immediately but wait for other batches ready, then send them together.

After almost 1 or 2 weeks waiting and then 6 weeks on the sea, the products arrive in port of Italy. The manager from FB will arrange trucks to fetch the goods and pick some samples to check the quality, because quality of samples may differ from the quality of mass production. When passed the test, they going on the work in FB and after almost 1 week, the products will be ready to send to the customer.

But situation here may be various differences. Some clients order for one batch , then the product will be sent directly after packaging. Some others order several batch but with small quantities for each batch, then usually in mass production, concerning about the cost of raw materials and transportation problem, FA will send all the quantity that the customer needs to FB. FB will assemble and package the batches once for all or just for one batch depends on the load of that time. And the excess parts will stay in the inventory waiting for the next order of the customer. As the number of customers grows up and more and more not-standardized parts are required, we can easily tell the inventory level will grow rapidly as shown in Chapter 1.

Under this pressure, Omet wants to manage the stock with help of MRP. By forecasting the demands of the customers, they could arrange the production more reasonably. But remember that we have considered infinite capacity of production of suppliers, also some clients, big or small, out of forecast may come and ask for business, all of these may cause delay or stock out, which is the biggest lost we can consider for reputation. So a certain safety stock for every product in fashion is surely in responsible.

And in real business, some big customers of Omet require a certain stock particularly for them, otherwise the order will be cancelled. Usually these parts will be standardized products, which means they could also serve other customers. But for this negotiation, the production sometimes is forced to be "push" but not "pull".

For the 6 weeks long transportation time, the takt time of product may not match. And also the commercial department's strategy of the marketing, usually they receive order for one or half year, but the production department wants to finish the order one by one, so again we are stepping away from zero inventory. Other reasons such as quality problem (not every time the product can pass the quality check, and if they don't, the raw material stay in inventory and wait), information not matching for FA and FB ,and so on, may also affect the inventory.

So the FB uses "KANBAN order" to control the production and delivery activities of FA. Every Monday, the manager of FB will contact of the manager of FA through video meeting and check every activity to see if they are finished on time or delayed. Then according to the result of the video meeting, the lean group of FB will try to study out a solution for the situation they are facing or changing the production arrangement to fit the situation most urgent. Of course all the efforts are used to reduce the stock but prevent the stock-out or delay.

For stock-out, a vividly example could be provided for understanding the dilemma. Once on the lesson of Prof.Sianesi, the class was divided into six groups. Each group represents one factory involved in one competition, or called "game".

The game was simple: each one of six factories has the same capacity of production. It is possible to arrange 2 shifts of workers in one week (which is the minimum time unit in the game), but there is a certain quantity of cost for workforce. Also arranging maximum one extra shift of worker in one week is allowed, but this shift costs much more than normal. There is also some cost for extra machine which you could buy to replace the human labor to get some higher efficiency but with higher cost at the beginning for purchasing. Cost for inventory holding needs to be taken into consideration and that is not a small quantity. Delay is allowed but no more than one month, which means if you delayed the goods for more than one month, all the products in that month will be waste and customer won't need that lot any more. And for delayed goods, the factory needs to take some penalties for reputation cost, which means you could only to sell the delayed goods in half price. For sure you could cancel the delayed order yourself, but this will turn to the situation of stock-out, and the cost of stock-out is much larger than others. Not only those already produced products will turn to wastes and also the factory will have to pay a certain penalty for it, which depends on the quantity of goods in stock-out. For forecasting and calculation, each group has one sales list for last year, figure 2.8, which is the same for all the groups of course and records the sales quantity for each month of last year. What we should do was that we needed to arrange the production quantity for each month in the following year. The winning target was very simple: to earn as much money as you could. At the first turn "the competitors" designed all the working quantity for the 12 months, and the customers' real need in the first month will be shown in the next turn. It keeps going on this way for a total 12 turns. And between 2 turns, we can decide to change the arrangement or keep it still.

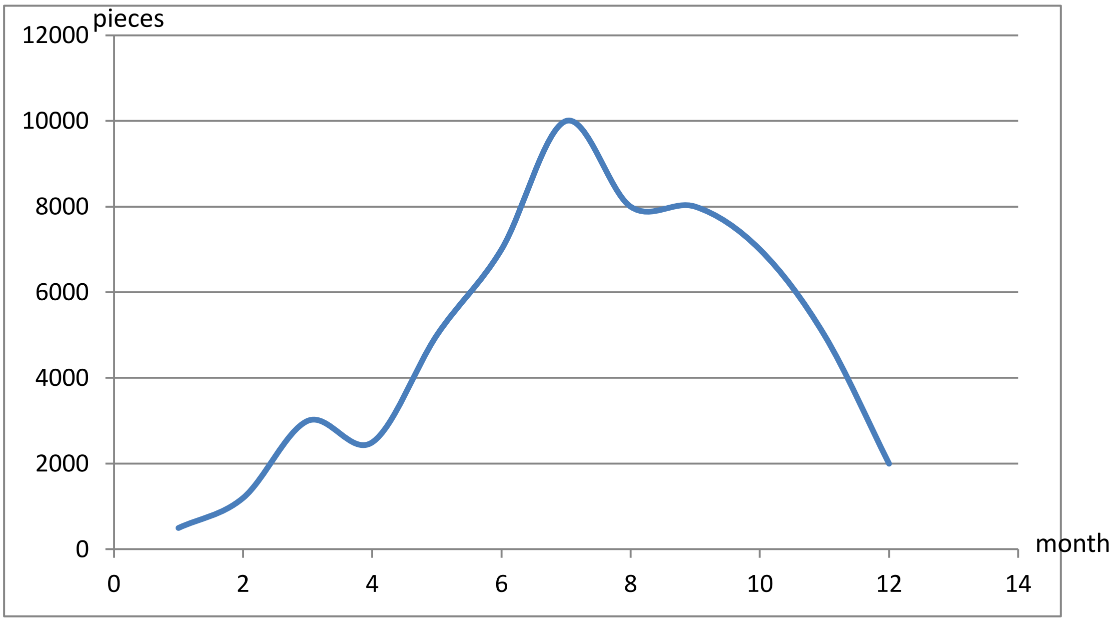


Figure 2.8 sales quantity trend of "last year"

There is no need to waste words on the process of the game. But one result astonishing is that at the end of game, 4 groups lost money and the other 2 groups only gained a little profit. And the only reason was that for "this year", the customers' demand increased a lot compared with the data from "last year". When the groups all tried their best to reduce the inventory cost and wanted to keep the production at the level just right fitted the customers' demands, they were all defeated by the stock-out.

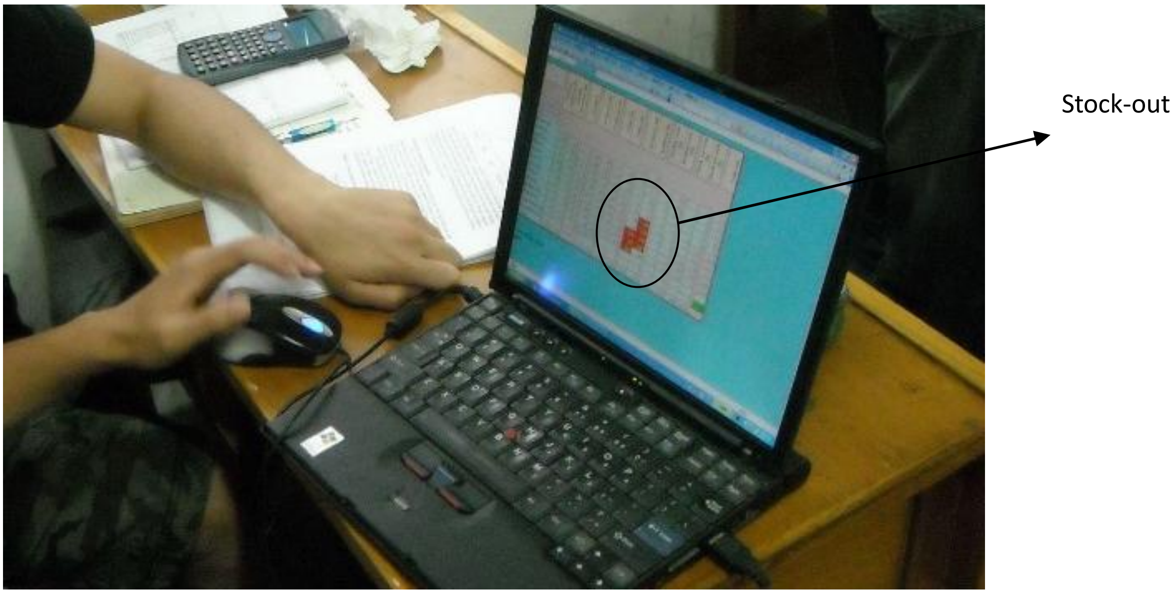


Figure 2.9 Stock-out in the business game

From that game, quite a lot of the idea about the real business and JIT idea could be reconsidered. For the work ability limits in the real world or some other reasons, when we want to achieve JIT to cut down the inventory holding cost, we need to think twice or at least, we have to think it in another way, maybe small batches or something more flexible for operating the business.

Then, we have to introduce the lean strategy in stock management in the real business, which is the way starting from the viewpoint of the whole business but not only the directly related activities like production, and is the method for zeroing inventory without stock-out.

3 Solving Methods with Lean Strategy

3.1 Lay out

First of all, we need to check the lay-out of the workshop. Because a good lay-out can help with the continuous flow production which will ensure that value is constantly being added to the product for the time the product is in the plant. The most ideal situation is one-piece-flow which means only one piece at and between processes. We can see the difference between traditional piece flow and one-piece-flow from figure 3.1 and figure 3.2:

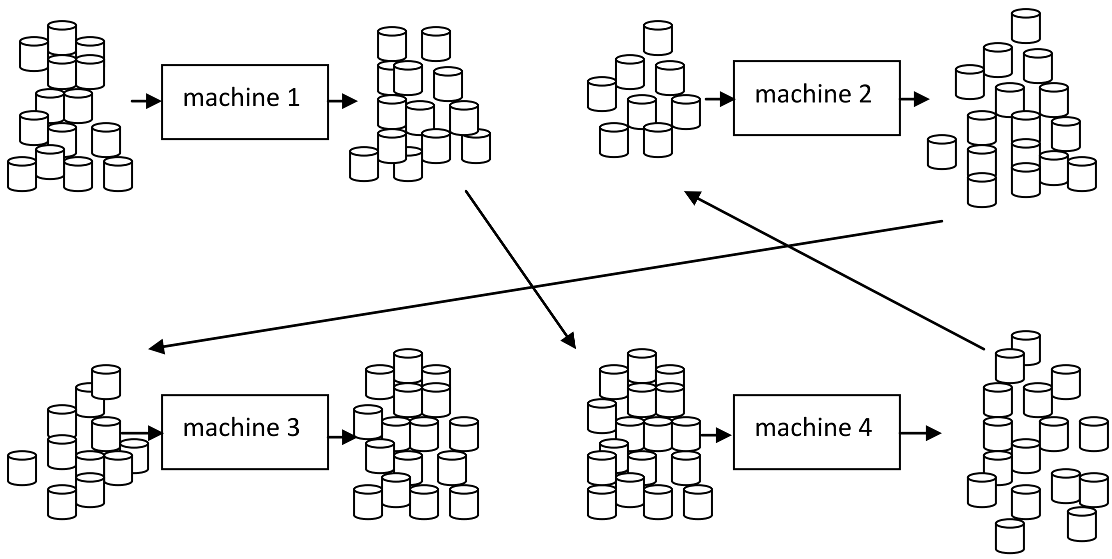


Figure 3.1 Traditional pieces flow

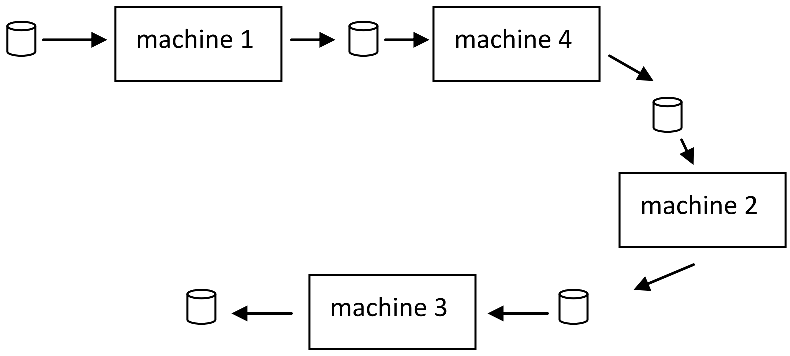


Figure 3.2 one-piece-flow

We can clearly see that to apply one-piece-flow reduces a lot of the inventory, or we can say WIP products. This inventory here costs some more than just the value blocked by the stocked material and space, for example, material handling equipment and labor, quality problem, time to detect errors, and causing long lead time which will also increase the need for forecasting.

So now let's back to the case of OMET, and we check first what is going on now in Omet's workshop. Figure 3.3 below is the lay-out of OMET now.

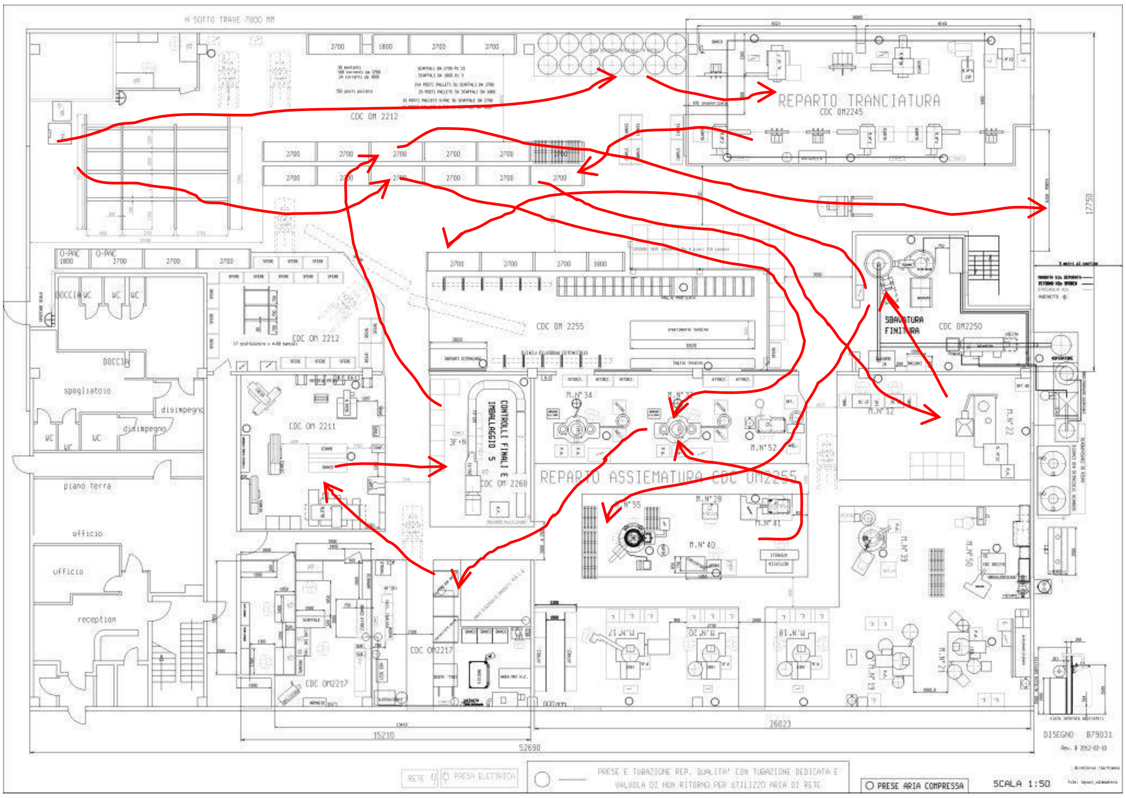


Figure 3.3 lay-out and piece flow of Omet

In figure 3.3, red lines are the pieces flow directions for one kind of product. When two parts (A and B) of the product come into the company, first we put them in the inventory and take A to operation I. During the operation of A, B waits in the inventory. After operation I is finished, A is delivered back into the inventory. When arrives the order, B is sent to a selection machine for picking the right dimension and A is sent to operation II. After selection, B waits beside the assembly machine. For A, operation III follows. Finally when A finishes all the operations, it will arrive at the assembly machine where B waits. After assembly, they will be sent for quality control by taking some samples for tests. If everything goes fine, they will be packaged and then sent back to the inventory until the order from the customer comes.

During these processes, the parts of product go forward and backward, go into the inventory and out of the inventory again and again. It wastes a lot of time and increases a lot of distance to move. When one part is under working, another part is blocked in the inventory and creating no value.

For one-piece-flow, usually we need a U-shape working space. For U-shape cell, less workers can control larger area and the moving distance will be decreased a lot. Also the working space will shrink. But for different family of product we need to choose different cell to work. And the working time of different pieces for one product should be balanced in order to reduce the idle time. For the A and B example, we have designed a future status, figure 3.4

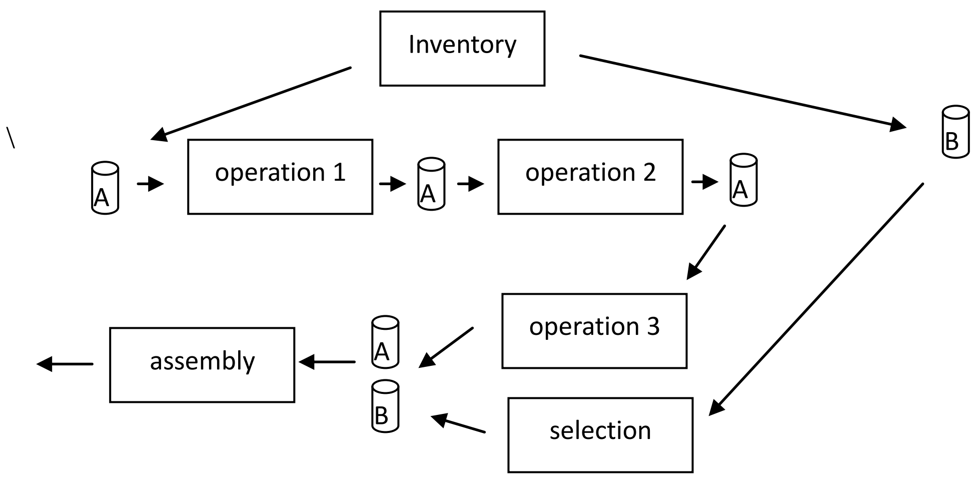


Figure 3.4 One simple cell in the future

For the status in figure 3.4, the semi-products and final products no longer wonder between the inventory and the workshop. The large batches are turned into small ones, so the products won't need to wait in a long "queue" between two operations. One piece of the product flows from the beginning to the end but not after one operation waits there for the others all finished then all together go to the next step. To improve the flow, we have to balance the cycle time of each operation. Especially for the bottleneck of the flow, we need to focus the efforts on it. However this future status is not that possible to achieve in a short time.

To design such cells for different families of products in the company surely will cause huge changes, for example we need to change the machines' position and rearrange the electric wires. Wall of the factory needs to be pushed down and Doors need to be widened or closed. But step by step, we keep the lay-out unchanged but modify the flow of the pieces a bit to eliminate useless routes, like figure 3.5. The main idea is to make the pieces flow but not be at a standstill. The distance may not change much, however we try our best to reduce the reliance on the inventory to decrease the buffing time.

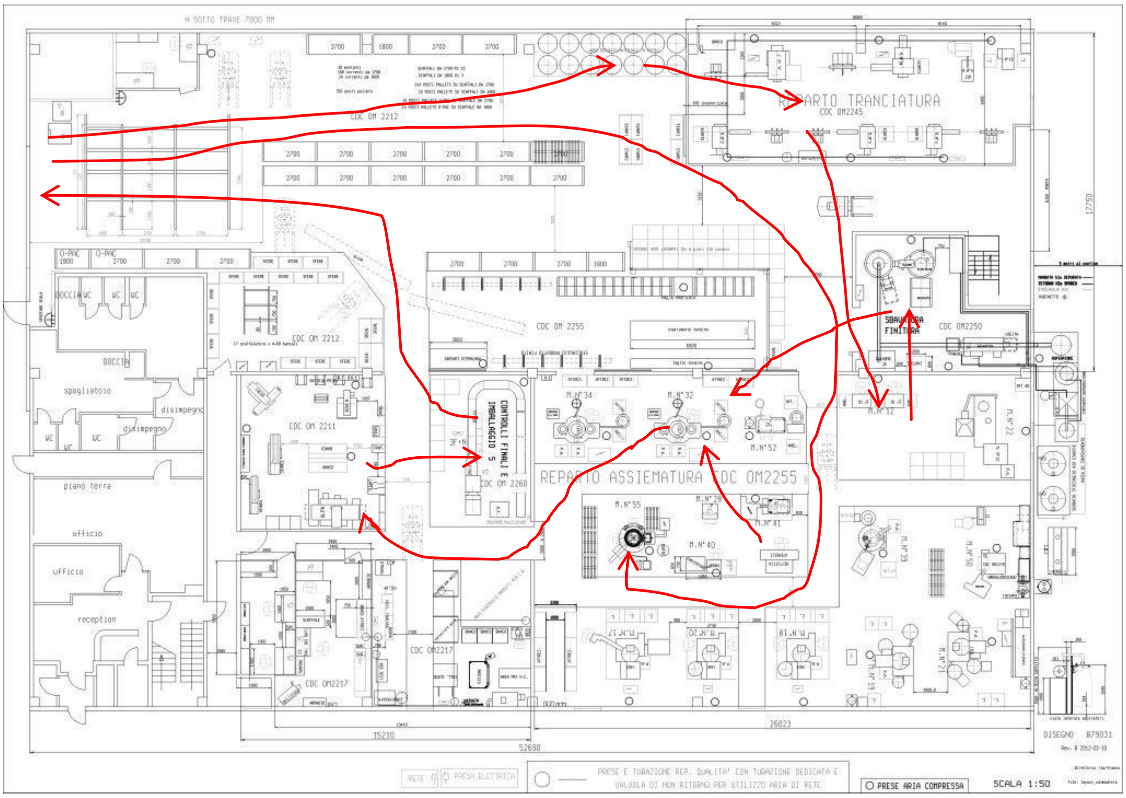


Figure 3.5 After the modification of the flow

3.2 Value Stream Map

A Value Stream is the process through which the raw material flows through from the time it is received from the supplier until it reaches the customer. It includes all the operations transforming the raw material into the product which the customer is really valuating. The Value Steam also includes all information flow to and from the supplier, within process and the customer.

But in Value Stream, there are not only the activities that add value to the transformation, but also some supporting or totally useless activities are included. These useless activities may be communication all along the supply chain, material transportation, production planning and scheduling, and the network of processes through which material and information flows in time and space as it is being transformed. To identify these activities non-value-added, we could visualize the whole value stream as map on the paper. Then through this kind of scientific approach, we could directly focus the lean improvement on the point that matters most. What customers need is that the lowest cost, the specific quantity, and the fastest lead time. While manufactures want highest profit margins, the lowest operating expenses, sales volumes increased and satisfying customers' demands. VSM could find the balanced point for the solution to both sides.

There are nine steps to approach the improvement by VSM.
(1) Identify the right VS
(2) Understand the lean tools and commit to it
(3) Map the current state of VS
(4) Focus on areas most effective by improving
(5) Map the future state Value steam
(6) Set the right performance metrics
(7) Validate the improvement and reward
(8) Document changes and audit for conformance
(9) Return to step 1.

Now we start to deal with the case of Omet with this guide. First, we should recognize that there are 3 big types of products in Omet. One is to buy the products and after quality check, packaging, and some simple processes, they are sold to others. Another one is that to buy the raw materials, then to form different parts of products, at last to assemble them together and after quality check and packaging, they will be sold. The final type is the factory in China will send the semi-product in Italy, then they are assembled in Italy and after quality check and packaging, they are sold. Here I present three main VSMs for the most important products in Omet. One (assumed as product A) will be discussed in detail for the future solution and the other two (products B and C) will be shown in the appendix B and C, and discussed briefly. (Legend in appendix A)

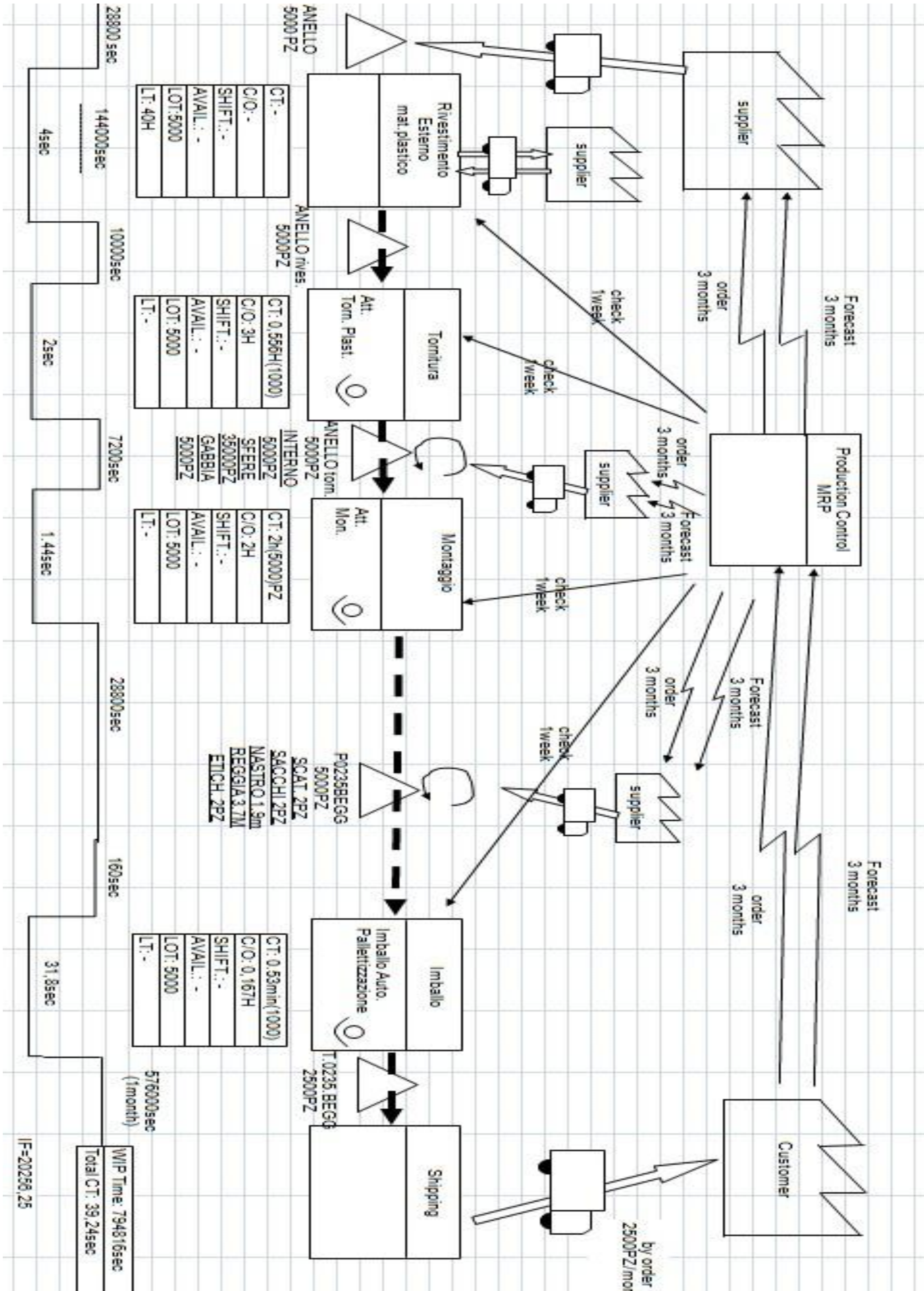


Figure 3.6 current VSM for product A

From figure 3.6, we may tell that the long lead-time takes in place where external plastic molding happens, waiting in the queue and staying in the inventory. The real value added time is only 39.24 seconds but it takes 794816 seconds for it really to arrive to the shipment, with a index of flow 20256.25((Total WIP time + Total cycle time) / Total cycle time). This sounds astonishing but it happens. So we try to reduce the batch to one piece to see what will happen.

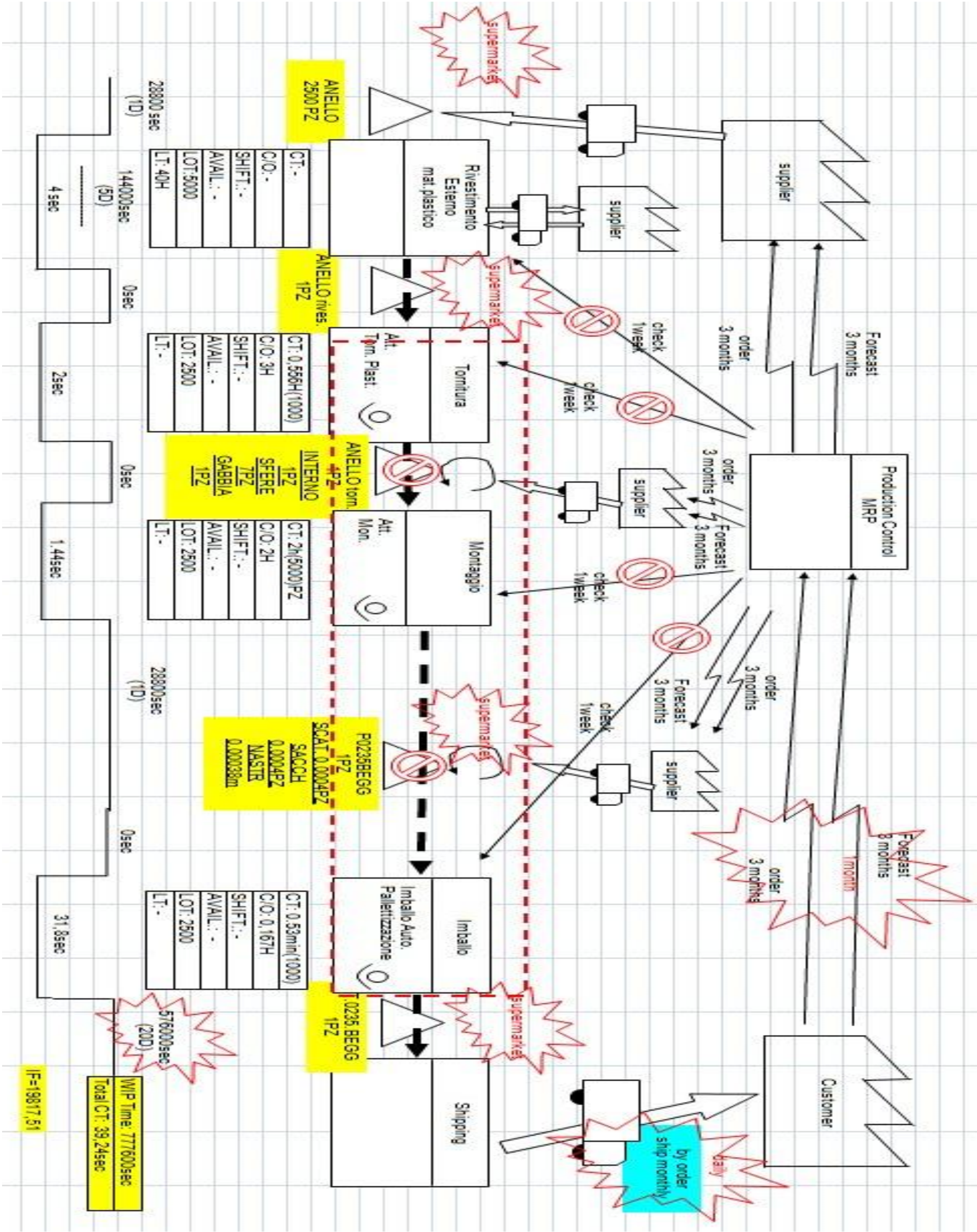


Figure 3.7 ideal one-piece-flow VSM for product A

From Figure 3.7, after we let only one piece of product flow in the system, the time wasting in the queue reduced and the index of flow decreased to 19817.51. Things become clearer and we have leaner ideas to apply. For those long lead-time terms, we may set some "supermarket" to help the steam flow. we should also improve the total forecast system and monthly delivery. Some wasteful inventory could be eliminated. Then it becomes Figure 3.8.

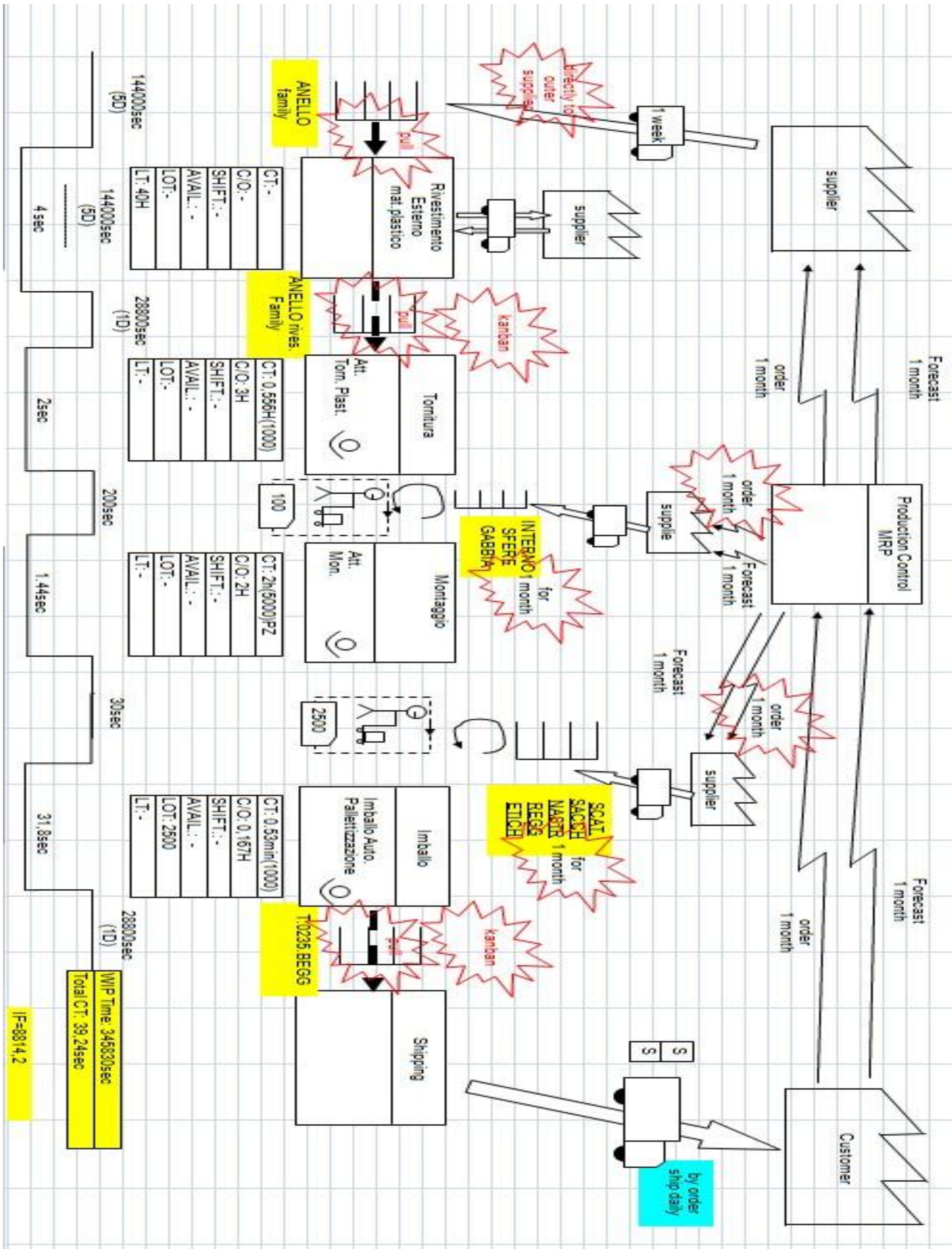


Figure 3.8 first approach to lean VSM for product A

In Figure 3.8, although situation has been improved a lot and index of flow decreases to 3814.2, system is still pushing the production and many problems have to be solved. To achieve JIT in time and zeroing-inventory, we need to apply a pull system with the help of KANBAN. So appears the second edition of the VSM.

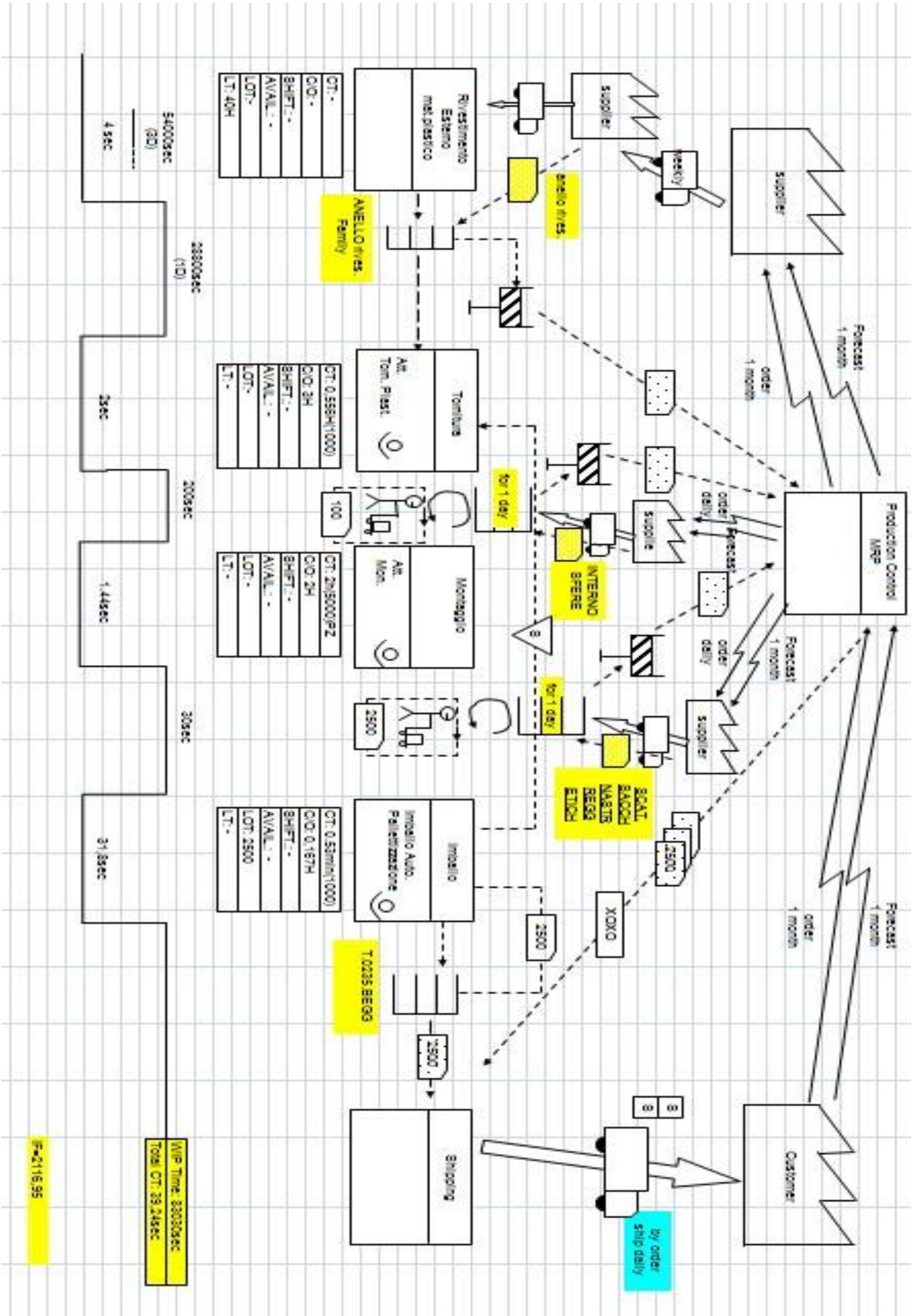


Figure 3.9 second approach to lean VSM for product A

From figure 3.9, we have seen that the pull strategy reduces the index of flow to 2116.95. The bottleneck now we can see is the external plastic molding supplier. Now for Omet, all of these outside working process suppliers ask for a minimum quantity of products and usually the lead-time, including the production schedule and transportation time, can't not be precisely decided but only can be told in one week. This blocks the continuous flow a lot. For now, it seems hard to solve this problem, but in the future, as Omet commits the lean supply chain which we will discuss in the next chapter, surely everything will be solved step by step, and at that time, other possibility for improvement will be discovered.

As soon as we do the VSM, we find 3 greatest weaknesses in our production, long lead-time for external supplier, long waiting-time in stock, long waiting-time in queue. Then we focus our forces and find solutions for the latter 2 and also a possible solution in the next chapter for the external supplier.

Now let's calculate the TAKT TIME for the production. The customer needs *2500* pieces each month. We have *20* days for work and *8* hours for one day. So the TAKT time should be *20*8*3600/2500 = 230.4* sec. That means in the future if we want to synchronize the working pace with the external supplier, the cycle-time for each step of the supplier should also be less than 230 seconds.

If we continuously apply improvements on the activities like this way, like lower change-over time, less downtime, and more convenient transportation route, the inventory level will surely decrease. That is why in the former chapters, we have said the factors are correlated with each other. And a right VSM shows their relationship and provides a possibility to find a way for changing.

For the other 2 types of production in Omet shown in Appendix B and Appendix C, we can also apply the same thinking strategy: find the weakest point, where inventory piled up and where the bottleneck appears. All these information should be collected by walking on the shop floor. To improve the situation of current, we also need to learn many of the lean tools, like SMED, error proofs, 5S, KANBAN, TPM, and so on. By the case of Omet, the supplier relation is also very important, because some production activities are committed in the factories of external suppliers and some suppliers are even from overseas. These suppliers' work causes long lead-time for Omet's production. Then next we will discuss about the lean supply chain.

3.3 Supply chain management

Now in Omet, we send the requirement to the suppliers and ask for prices. With the comparison of price and checking the quality, the supplier of raw material for the next product will be determined. Also there are some old suppliers who have been cooperated with Omet for a long time and are still taking a large share of the business correlated to Omet. And in another way, Omet, as the supplier, is seeking more share of the business not only in Italy but also abroad like in China. The main idea is to fit the customers' need by the lower cost than their competitors.

To keep on the business with some large customers, Omet, according to some of the contracts, is obligated to keep a certain quantity of stock in the inventory for them, beware of an emergency. And also Omet will ask some of his suppliers do so. All of these to some extent are caused by the long lead-time. And now Omet is seeking a new method to make the relationship with the customer, the lean way.

Lean principles need cooperative supplier relationship while balancing competition and cooperation. The supplier will be considered a partner and also a strategic alliance, which means, different from conventional modes of suppliers, and also lean model requires fewer suppliers and clustered. And also lean supply chain management needs consistent with strategy but not only cost-based outsourcing. For the conventional suppliers, they will try to hide their techniques to make the product in order not to let Omet cut more of his price, which means an adversarial relationship. To have lean supply chain, Omet needs to change the idea to cooperation and mutually beneficial, and the selection will be done by judging high performance but not lowest price. Also for the length of the contract should not be a "one-time-contract", but a long term one. Price may not grow upward but will decrease downward according to the techniques sharing and designed-in quality instead of "done-inspection-redone...". Having more communication and closer relationship, we can order smaller quantities each time from the supplier for JIT to reduce the level of the inventory, but not large batches and even excess stock what we are doing now. Information will flow two-way between the supplier and Omet. And not just task-related communication will be done, also some deep, multi-level, technological problem can be involved. Also Omet could do some investment to the supplier to help them improve the quality of the goods, which will benefit Omet in another way.

But at the first period of the revolution, we could face some problems. Partnerships and strategic alliances are ridiculous for conventional suppliers, especially for those large factories. Also synchronized production and delivery is hard to achieve, and if not this may lead to stock out. Actually this is still at the point of view from mass-producer. For the lean relationship, we could integrate suppliers' lead times and delivery schedules. The production flow of the supplier will be pulled directly by the customer, but not blocked in the middle of supplier and Omet like now. For the communication in technical layer, Omet could minimize the incoming goods inspection and both sides will march to the target of zero-defect. For this kind of supply chain, as the depth of the cooperation goes, greater efficiency and profitability will be achieve through this kind of supplier network. In spite of the long transportation lead-time, Omet could find a solution with the help of the suppliers, by sharing the schedule of production or by less quantity for each batch while with more times, to synchronize the production rhythm with the customers' requirement and to be more flexible with the wide variety of products in customers' demand, which will decrease the stock level for both sides and eliminate those awful "safety stock by contract". All these may also give the conventional suppliers more confidence to come into the revolution they are not willing to do before.

If Omet could have fewer first-tier suppliers, the suppliers will share greater of the product content. And also Omet could focus more into the innovative solutions to leverage supplier technology base. Continuous improvement will be done by cutting the whole cost and sharing the cost savings. For some specialized product required by the customer, Omet can find a solution in theoretical but supplier may have some problems to apply the raw material in practical. With the lean supplier relationship and basic ideas from both sides shared, the lead-time for the new product development will decrease a lot.

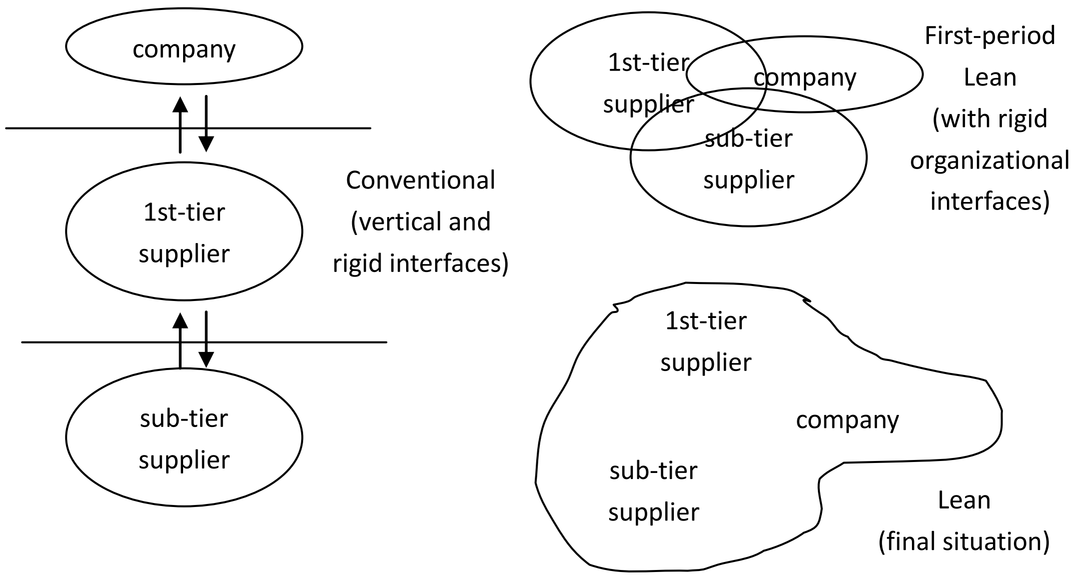


Figure 3.10 Different structures for conventional and lean supply chain

Figure 3.10 tells us the for the conventional supply approach, the interfaces are totally defined and controlled. And when we begin to approach the lean way, we may find we and the suppliers are collaborating but still constrained by prior work division. Finally if we can break the functional interfaces, we can not only have knowledge integration and architectural innovation, but also make the production flow but not piled up in each other's inventory.

For Omet, first step could be the electronic integration of supplier networks. This is for technical data exchange and also for synchronization of business processes. Some factors are very important to make this electronic integration successful: clear business vision and strategy, integration of specific functionality benefits of legacy systems into evolving new IT/IS infrastructure, great thought in scaling-up experimental IT/IS projects into fully-functional operational systems. Electronic integration of suppliers provides great mutual information exchange and builds increased trust, which also enables a closer collaborative relationship and long-term strategic partnership. Close communication links with overseas suppliers are very important but could also lead to security risk and complex policy challenge.

3.4 New products

For Omet, a quite large quantity of work is to produce the specialized products. Some are designed by the customers and Omet needs to find suitable working process to match the requirements requested by the drawings. Some others should be designed by Omet and the only requirement is that the products could pass the customers' tests on real working situation.

Nowadays, Omet will do this research and development totally by themselves especially for the second situation. The technicians of Omet will try to design the structure of the new product, with some theoretical calculations and also with some experience in using what kind of material. Then they draw the drawings for the product and send it to its supplier for the feasibility. Usually the supplier could only make some samples and give them to Omet for testing. Unfortunately, lacking of communications, when the samples don't pass the tests, Omet should find the reason by them alone. Maybe the supplier hasn't obeyed the tolerance of diameter designed by the technicians. Or it can be the wrong material. However it also could be some problems happening during the manufacturing process. Or the mechanical error appears directly in the idea of the design that has mistaken the customers' need. It's hard to identify which really causes the error, especially for that kind of suppliers' working process, which could be considered as a secret by the suppliers. And if unlucky, the test for the new product couldn't be passed in a short time, then the raw materials pile up in suppliers' inventory and Omet also has to pay for it.

Actually R&D, different from manufacturing, is a non-repetitive, non-sequential, unbounded activity that produces information. Adding value in research and development could be difficult if we are not doing the things in a correct way. There are many variability in R&D, some contains value while others not. So we should have a complex view of variability in a non-repetitive process. And manufacturing adds value to physical objects while R&D adds value to information which, different from physical objects, can appear in more than one place at one time. We need feedback to check the availability for all the information. Unbounded activity means emerging information. We must continuously assess whether the economic benefit of further improvement justifies its cost. This is totally different from manufacturing which requires a defined start and finish. Taking rational risks is also crucial in R&D. The inevitable result of investing in unproven technology is uncertainty, in performance, in cost and in timing.

In lean strategy, we need to "reduce batch sizes", which in R&D means by taking small steps into the unknown, we get fast feedback to react quickly to any changes. By advancing step by step to the unknown field, we could also meet the milestones by taking less risk. "Distinguish between variability" is necessary. For R&D we need to test different variability, which means we could try to lower its cost but couldn't try to eliminate it. "Focus on maintaining flow" but not perfect planning. Planning relies on the ability to forecast but forecast relies on the grasp of the data which is hidden in fog of R&D. We need to dynamically adjust capacity and demand according to the situation where technical problems arrive at random. If we put all our heart into one large batch, then this will inevitably lead to delays and inefficiencies. And we need "To pull the R&D" ,which means goals for current work and faster cycle time. No need to make forecast schedule for all the steps but just less queues and accelerating useful feedback. "Fast, powerful feedback loops" could be created by more collaborative relations with Omet's suppliers and customer. And we need a wide range of workers to work together with the research, like the manufacturing person should communicate with the designer about the feasibility of the drawings. Increasing technical breadth sometimes is more important than technical depth in designing the new product in Omet's case, and technical breadth increasing also makes the work more "flexible". Another important idea is to "achieve adequate failure rates". A certain failure rates create less waste than trying hard to do it right at the first time.

Above all, in Omet case, instead of producing large batches of products according to the design drawings, and testing for long time to find all the problems then modifying, we need to apply small batches of new invented products and modify them step by step to the final customers' need. This can efficiently reduce the waste in R&D process and decrease the possible inventory that will be needed in the conventional way.

3.5 Automation and Autonomation

To make the production process flow continuously without stops, the high automation of the machines is necessary. But the problem is what level of automation should reach. The lean strategy asks for the following requirements:

1. The machine or tool shall be able to operate without being permanently monitored by the operator.
2. The machine or tool shall be able to stop self-dependently in case of failure.

Then a new work appears: Autonomation. This word is composed of automatic and autonomous. In TPS (Toyota Production System), they also call this feature of machine design as JIDOKA or SHIGEO SHINGO pre-automantion. The autonomation implements some supervisory functions rather than production functions. That means if one abnormal situation arises, the machine stops and the whole production line could be stopped by the worker. And after the suspension of the production, the worker focuses his attention on understanding the problem by asking "five why", step by step moving forward to the real and basic cause of this problem. After fixing, they are sure such kind of problem won't recur.

This kind of strategy provides a possible way to prevent the error from this step to the next and when finally getting the error in the finished products, many over-production will be produced and many wasteful work will be added to those defective products. Also the worker who is self-inspecting their own work, or source-inspecting the work produced, will have more passion to be engaged to control the production line. Also if the production is stopped, the supervisor will give immediate attention to the problem the worker has discovered and provide help and solution.

To control every step in the production and to stop and fix problems as they occur rather than pushing them down the line to be resolved later, all these gives much higher efficiency. Also to achieve zero-defect and eliminating the inventory for JIT, quality improvements have been done during the process of autonomation but not by checking one by one and reworking on the defects after the production.

For Omet now, thanks to the technicians, all the automatic machines have been installed a button for the operator to stop the working. This has been already a good news for the lean strategy approach, but in reality, the machine will only be stopped by some big problems. Those small production defects could not be detected by the operators, because the operator won't measure the dimension of the product or test it with some other properties, or even some turning scratches will be detected only after the production when executing the quality control, because the product falls into the warebox as soon as the procedure has been done. Now Omet is trying to apply a quality check after each small batch to solve the problem. However this still slows the production and does not solve the problem from the very root. In the future, if we also apply some techniques for "Poka Yoke", which is to verify the error in a easy way, even the simple operator could stop the machine and tell where is going wrong for the property of the products, we may improve the quality immediately without producing more other defective products. The quality check procedure after the production will be eliminated and the production will run more fluently.

All these are based on lean strategy. In mass production, people insist higher level of automation will surely cut down the working cycle-time for one product and also reduce the cost for operators. But the focus is on the breakdown of the machine and also on the final products inspection. Usually these two cost much more compared to the time lost and the over-production of defective products. And in lean production, all the processes will be controlled carefully. At once a error happens, quick reaction and later quick feedback will be at service. All no-value added activities will stop immediately. For careful study, such error situation will be eliminated once for all. To repeat this cycle again and again, the real fluent flow will be realized, also with some extra bonus: zero-defect and inventory reduction.

Omet is on the way of changing, but still at the very beginning. But as far as Omet needs to improve the automation level, this kind of lean thinking could be the reference for the advancing direction.

3.6 Kanban

Before talking about Kanban, we'd better to see how the company is operating now. Let's take one year as an example, see figure 3.11.

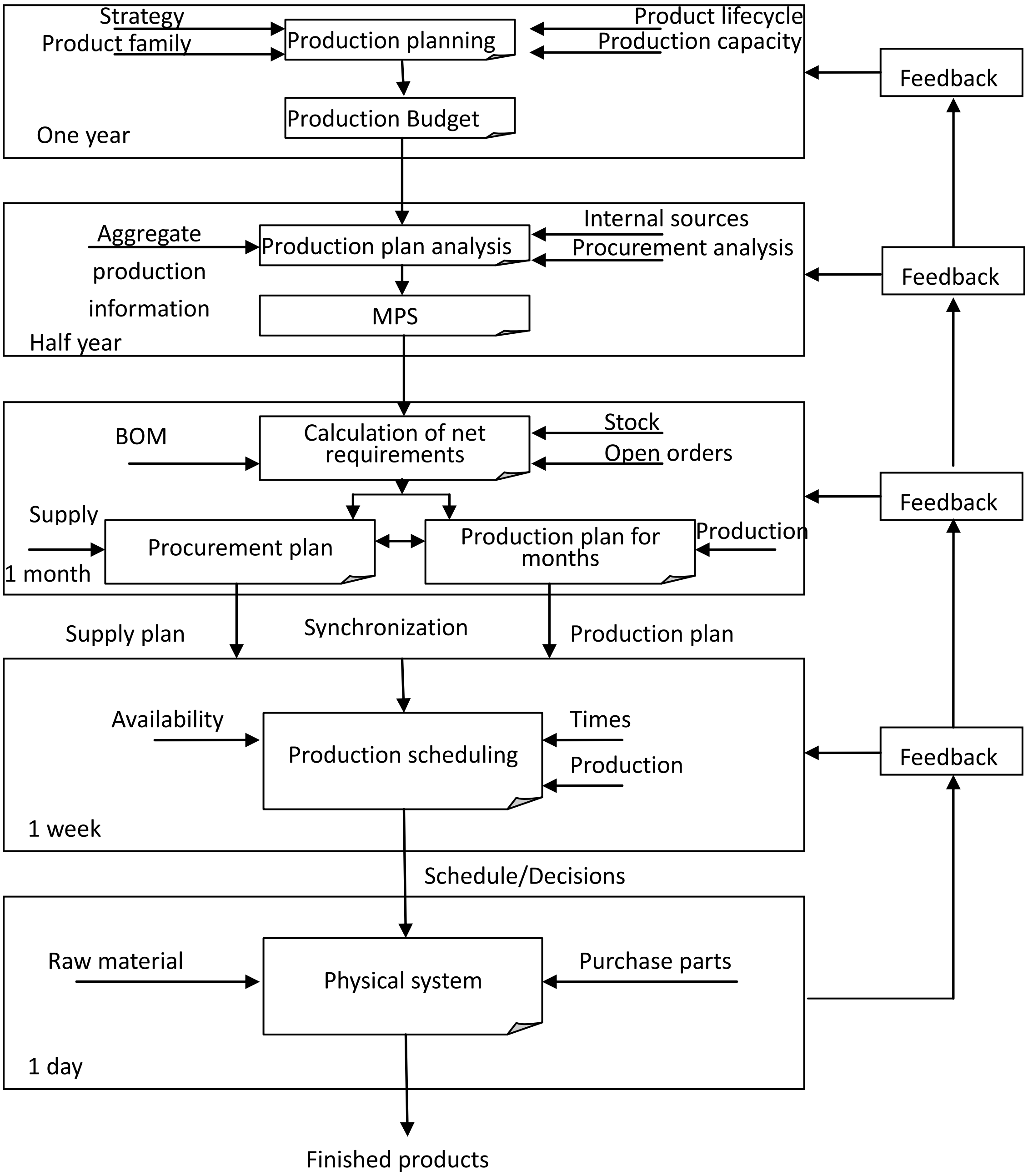


Figure 3.11 Production Organization chart for Omet now

This is a "push" system, which means the finished products are pushed out by the forecast and scheduling. Once if there is postpone or a cancelled order, wastes appear. So now we introduce Kanban into the system.

When we arrive the daily production plan, the operation manager should do the production via Kanban, which means the downstream step triggers request to upstream, like figure 3.12:

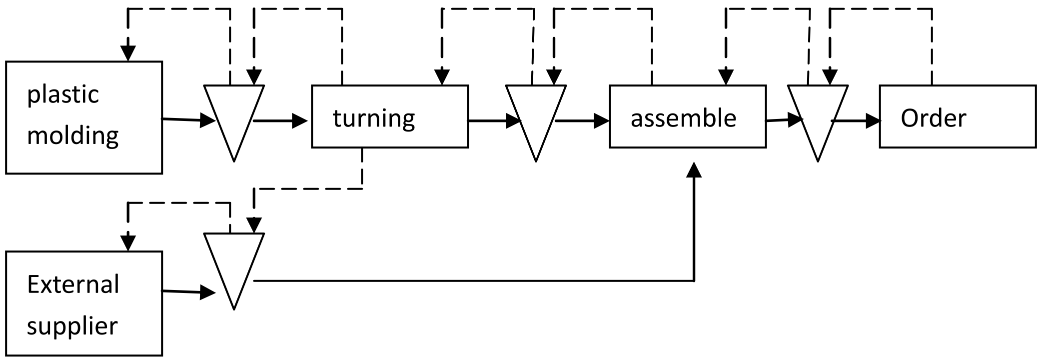


Figure 3.12 downstream triggers upstream

Kanban system is a "pull" system, which is to say the production volume depends not on the basis of a forecast of demand but on a result of the replacement of the number of pieces picked up for consumption. Kanban controls the information flow and synchronize the supplier and internal production. It provides both production control and inventory control, for the cards indicate what we should prepare in the inventory for the future customer. However the color of the cards illustrates the level of the emergency, which means we could stock information based on the number of cards in the inventory but not physical products. And the color of the cards determines the priority of production.

The Kanban carries the information which calls no more production than what is immediately required by the next step. This simple idea avoids the risk of creating high inventories. Over-production will be prevented by "no Kanban, no production".

For figure 3.13, we could have an idea what information should a Kanban contain.

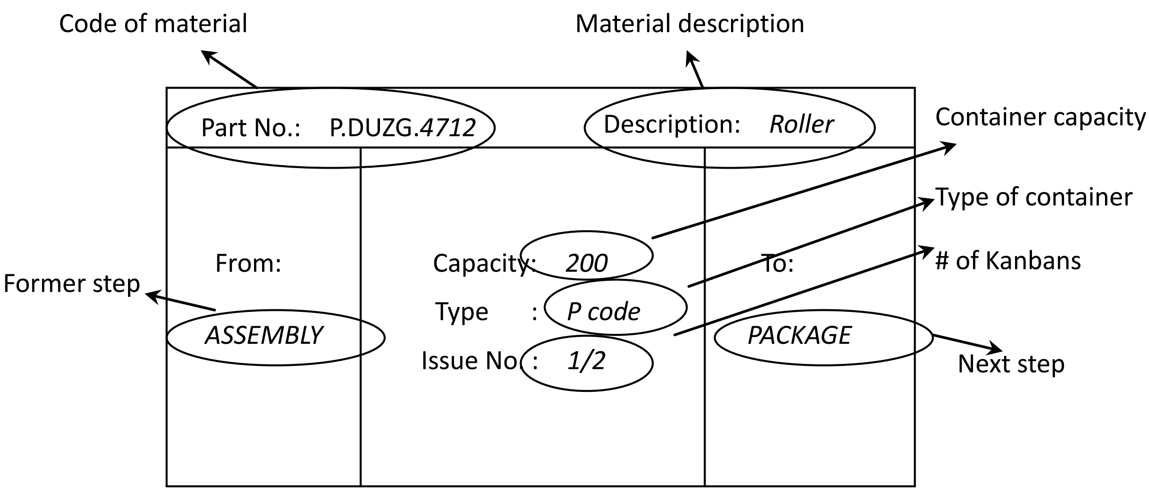


Figure 3.13 downstream triggers upstream

When we are applying Kanban to the system, we prefer working in a U-shape and compressed space that all the workers are place side by side to see directly the material in Kanban square. This will make the operator cease to work immediately when the downstream square is full. No more waste should be produced.

However we should see that Kanban system requires for some conditions:
1. Demand for finished goods level is stationary
2. Low set-up time, production of small batches
3. Exuberant production capacity for changes in demand
4. Quality at source
5. Timeliness of suppliers

In these conditions, Kanban system will function very well. However for Omet now, small batches mean much higher cost and quality could only be achieved by tests after tests. For sure, Kanban is an important tool to achieve JIT production. We could use Kanban to control some of the standardized parts, which occupy a large quantity in the inventory. But for the situation nowadays, before applying Kanban to all the types of products, we have some more work to do.

3.7 Other respects

I. *Steps to Visual Management:*

Visual workplace means "an environment where, within 5 minutes, a stranger can recognize the area's vision, their mission, and the key performance measures critical to their success." All this needs no conversation of any kind. This kind of visual management could begin with 5S principles. Housekeeping could not only increase the efficiency of the work for the operator and provide a better workplace for workers, but also make potential customers satisfied with work ambient. The 5S principles must work in conjunction with each other and shown as followings:

(1) seiei (organization) : keeping on hand only what's needed for the process, removing the rest to make it easy to see the clear process in its uncluttered state.
(2) seiton (orderliness) : a place for everything and everything in its place for immediate retrieval and use.
(3) seiso (cleanliness) : keep the workplace clean, spotless, and shining to improve the quality of the products.
(4) seitetsu (standardized cleanup) : everyone plays a role to keep the 3 principles above.
(5) shitsuke (discipline) : to make a habit of maintaining the established procedures every day.

II. *Performance Measurement*

Whenever something needs to be changed, it has to be measured, both before and after. In a traditional "push" production factory, we measure the output and efficiency of department and machine, with a goal to keep people and machines busy. Then piled-up inventory between department and long lead-time will not be surprising. In Omet, to apply lean strategy, flowing value has to be achieved. Lead-time needs to be cut down and we need to measure whatever we need to change. For example, if we want to reduce the change-over time, then it should be measured and results must be fed back quickly to see the change and also to prepare for the next step. Of course those things we need to change all should be considered with the customers' satisfaction.

Only after measuring the performance, we could get the feed-back. Feed-back gives the company about the idea how they are handling the problem and what is the next could be improved. If without measurement, we could not even tell exactly what has changed compared with before. So the effort we have taken will become useless.

III. *Lean Product Design*

Considering that thousands of design should be done in Omet, we have to design a product "lean" enough at the beginning. Investment in quality and cost reduction at the design stage is much more effective than an investment after production begins. There are seven aspects to pay attention in design:

(1) Complexity: Omet need to keep it simple. Complexity improves the opportunity for waste and cost increasing.

(2) Reuse: some of the design elements like bearings, inner ring, pins and so on could be standardized and reused. This not only reduces mold cost, but also ensures that documentation and interface standards are followed.

(3) Design for Quality: build six sigma performances in from the start. Every process capability needs to be estimated, and critical tolerances should be identified. If possible, acceptable ranges need to be as large as possible. Manufacturing processes should also be considered for choosing to plot capability rations for each process variation.

(4) Modular Design and Mass Customization: develop families of products bases on core product platforms, rather than independent point designs. Mass customization means assembling features and options onto a standard platform as late in the manufacturing process as possible. We could group different parts of the product into logical and separable sub-assemblies, which share common elements.

(5) Lean Machines: smaller, simpler, dedicated machines often work better than large multi-purpose equipment.

(6) FMEA: failure modes and effects analysis is a process for examining what could go wrong with the design in manufacturing process or in use.

(7) Activity Based Costing: Allocate all costs to individual products rather than to cost centers. This will help to show the real cost of complexity.

Except for these more theoretical thinking methods, there are also a lot of practical guides in the real production. Above all provide the direction, now we begin to discuss about the path we take.

4 Current Step

4.1 Value to be stocked

For now, most of the products we stock in our warehouse are the final products. When the customer purchases one order, then goods will be shipped. This leads to a thinking, even if the total production we can't change in a short time, which means we could not cut the quantity of the products in the stock immediately, we could reduce the value we stock in the inventory. But this also needs to treat the lead time of the production for each step very carefully, otherwise delay will occur. So we pick some important products (how to pick "important" products will be studied in the next chapter) to analyze.

To take the following product A, which is composed by 3 parts, as an example,

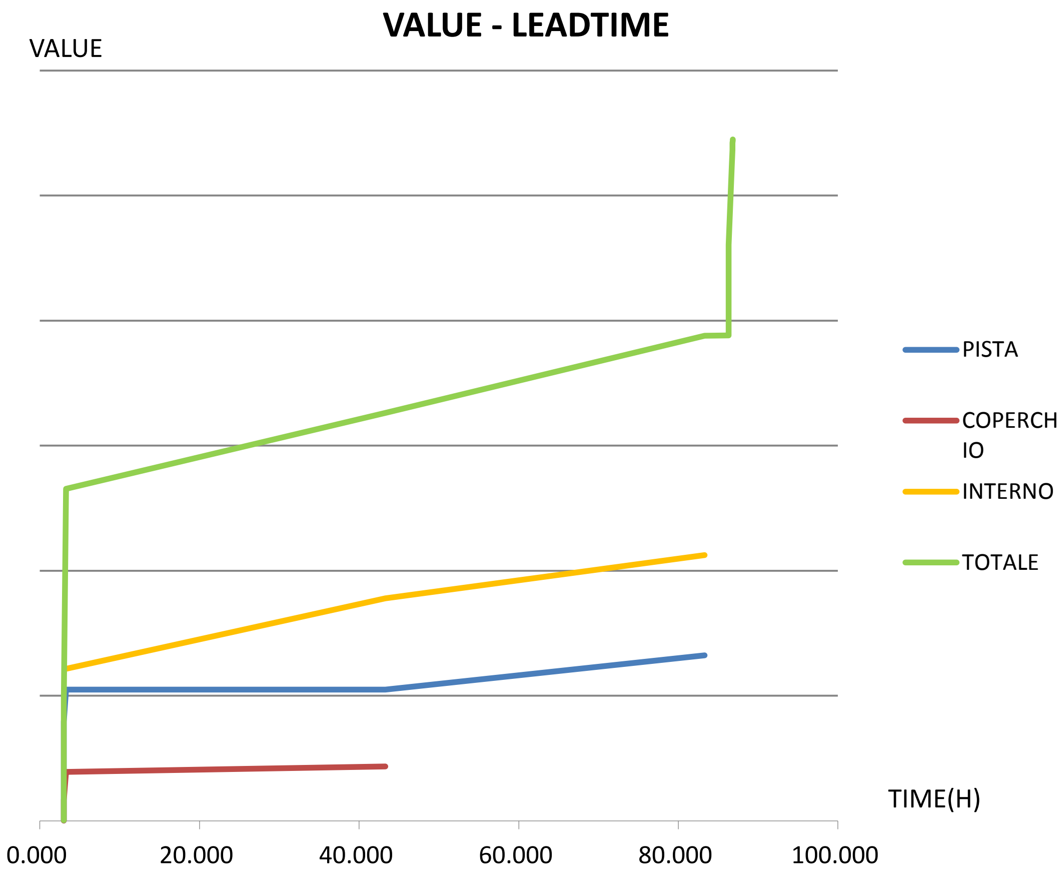


Figure 4.1 The relationship between cumulated time and cumulated value for product A

Figure 4.1 shows how the cumulated value changes along with the cumulated lead-time of the product, but it's more convenient to see the them in percentage.

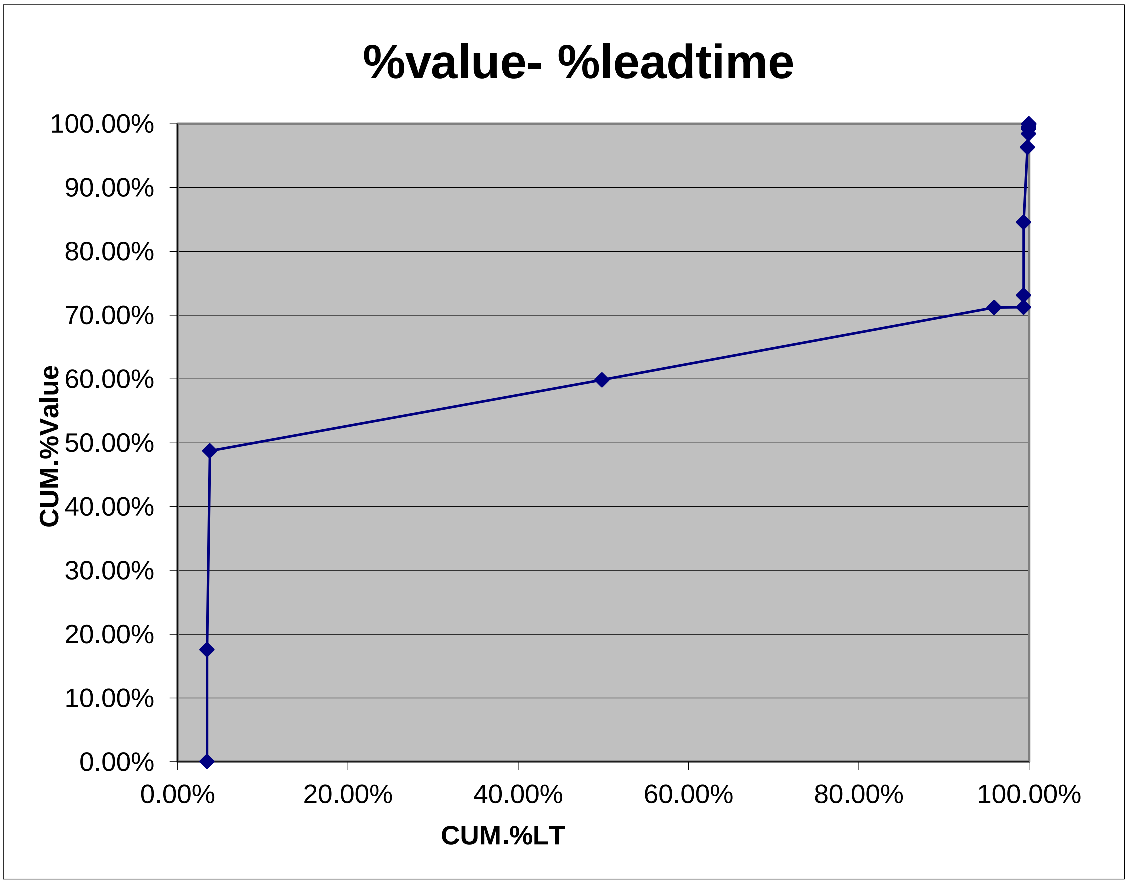


Figure 4.2 The relationship between cumulated %time and cumulated %value for product A

From figure 4.2, we could easily get the conclusion that almost 70% of the value cumulates within 99% percent of the lead-time, which means from above that after we have finished three divided parts, we could do the assembly and packaging very quickly. So if we need some safety stock for the products, we could just stock in inventory the parts of this family of products but not the final ones, which otherwise will cost 30% more value. Even this kind of safety stock will be eliminated according to the depth of lean revolution that we will go, but for now, it's a good choice the release some of the value tied up in the inventory and more funds will be available to be invested into field for the next step.

Also we can check the percentage of lead-time for each step. Figure 4.3 tells where is the main obstacle : the operation needed to be done by the external supplier. Those processes take almost 92% of the total lead-time. This is the point we should concentrate our focus on to improve, which we have discussed the solution before, like lean supply chain.

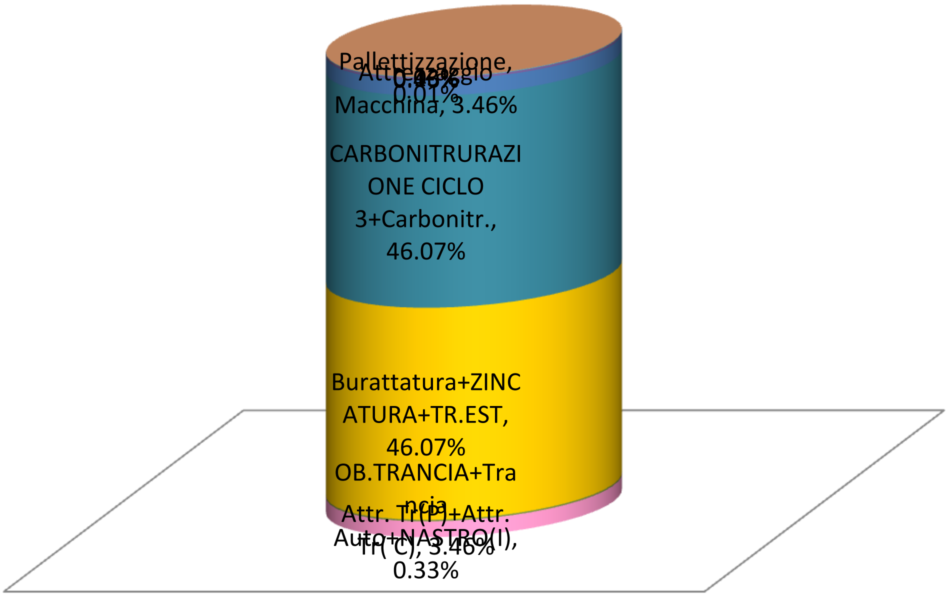


Figure 4.3 the lead-time percentage of each process for product A

However, this kind of method depends on the family of the products, which means not suitable for all the products, for example the following product B, we could draw the relationship between cumulated %time and cumulated %value for product B, figure 4.4

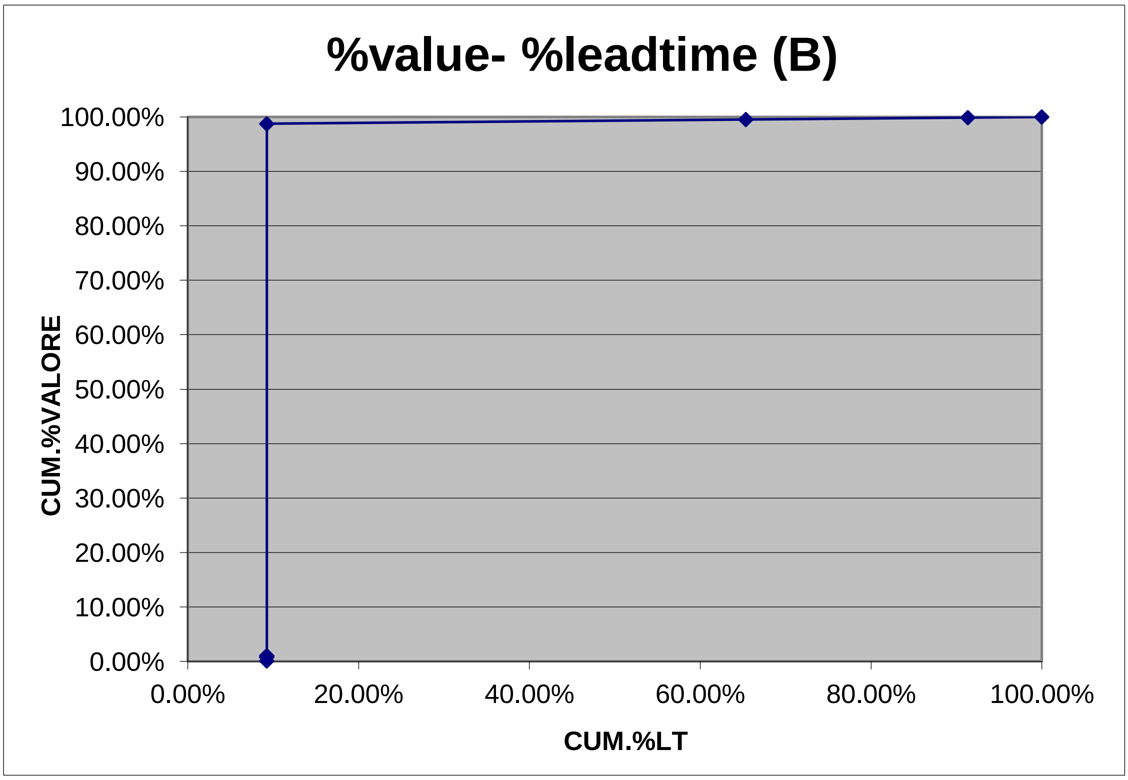


Figure 4.4 The relationship between cumulated %time and cumulated %value for product B

For product B, the value cumulates to the total value within 10% of the total lead time. Situations have changed and we need to apply different treating ways.

This method of reducing the value in inventory may not eliminate immediately the waste in the lean's point of view. But revolution comes not in one step. We define the total flow of the value of the production, and at the beginning we eliminate parts of the waste then parts of another. Step by step, the company will get leaner. However, we should focus our forces on the most important area. So next I will show some methods I have done to find the most important products in the factory.

4.2 ABC method

To define the most important products for Omet, we have to pick some KPIs to be measured. There are three important and can be easily analyzed KPIs: the cumulated value of the product downloaded from the inventory (which means to be sold), the download times of the product (which means batch numbers and wide field of demand), and the nowadays stock level of the product (which means the very point to be leaned in this case of Omet).

For these three KPIs, we use ABC method (Activity Based Classification), which is also famous as Pareto diagram. In ABC theory, for most cases, 20% quantity of the terms has 80% impact on the overall situation.

For example, in Omet's case, we could first divide the entire products into different families. Then list the download value of the family in order and calculate the percentage cumulated value for every family. After dealing with the data, we could draw this Pareto diagram.

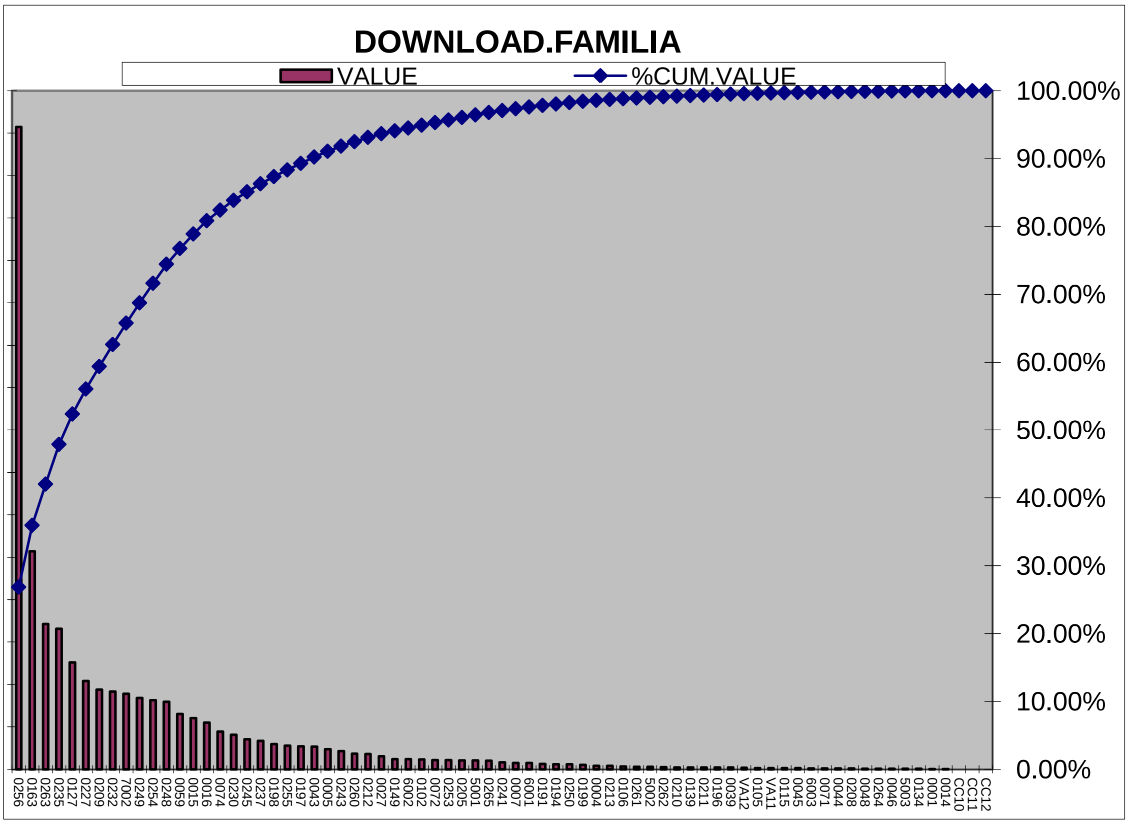


Figure 4.5 Pareto diagram for download value of different family

In figure 4.5 we could see that the first 10 families (almost 18% of the total families) of the products occupy almost 80% of the total download value.

Then we could classify those families occupy the 80% of the value as Class A. Those 30% of the families occupy the 15% of the total value as Class B. The others are to be defined as Class C.

Because of the high value and low quantity of Class A, A family could be considered as most important. The deeper analysis should be provided to A to ensure we could use the least force to get most effect on the operation of the company. To apply JIT or some other paths first on these families A would give great improvement.

To find the most important products needed to be dealt with further, we need to apply the above analysis to those three KPIs we have chosen. When we classify them into A/B/C classes, we may get some products with three A. Those AAA products should be applied for more analysis like that in the former chapters. We need more communication to those AAA products' customers and suppliers to justify what is the very value required and what is the main problem in delivery lead-time. To be lean with these objects is able to significantly reduce the value piled up in the inventory. For now, Omet is using large safety stock for these products to avoid stock-out and delays. Changes must be done. MRP system could forecast precisely what the demand is in the next 3 months, so Omet has to decrease the lead-time for these AAA products.

4.3 Upload&download flow analysis

To those AAA products discussed in the former chapter, we check the upload and download flow of these products to see if we are doing the right thing.

As following, figure 4.6, we will show the upload and download from year 2010 to May of 2012 for one AAA product, we call it Product I.

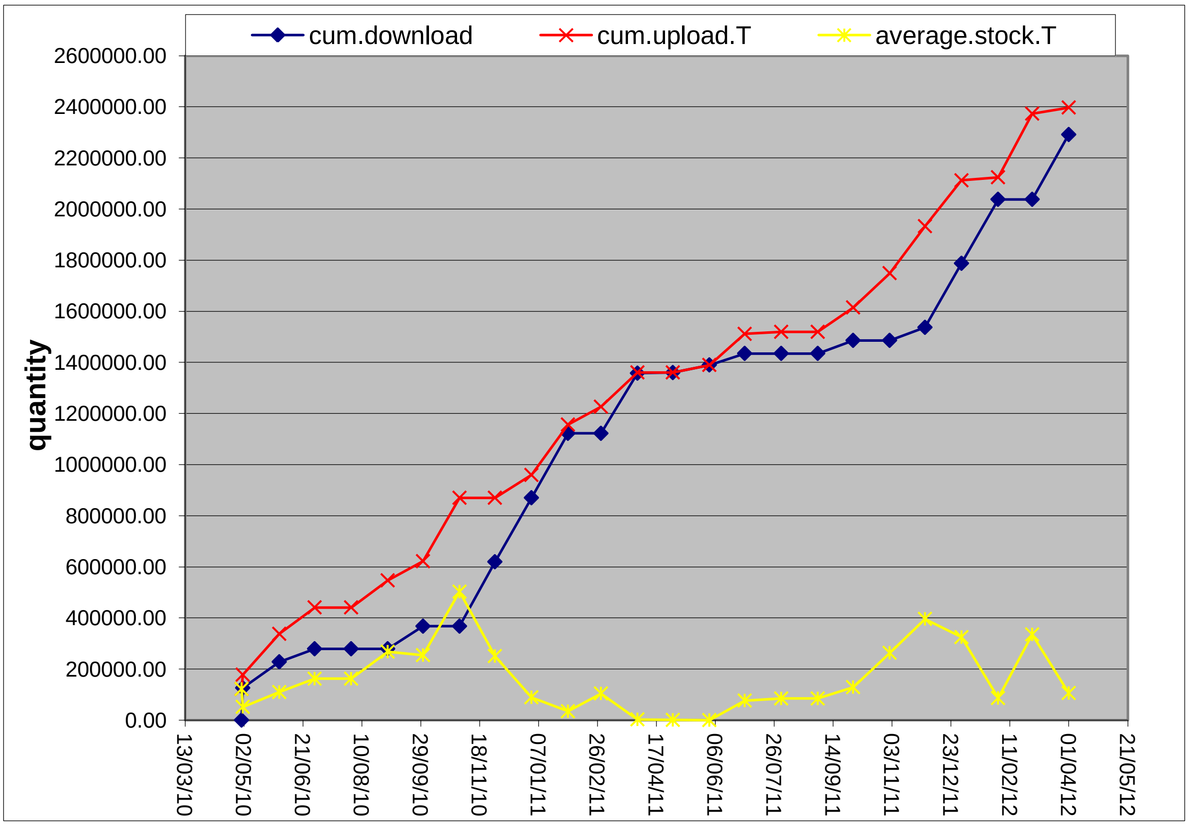


Figure 4.6 upload and download for Product I

We may see from the stock changing that the time between 2 batches is almost two months. Actually we make this by one large batch and upload them all in the stock, then when arrives the customer's order date, we download from the inventory and deliver them to the customer. But before the order arrives, we continue to produce and deliver the products every two months. The products pile up in the inventory to a certain quantity, like 400000 pieces, then the production will reduce a lot or stop until the stock falls to a level, we start the batch upload, usually more than the demand, again. During April of 2011 to June of 2011, there is a time of almost zero-inventory, but because of small batch's costing (material cost and transportation cost) and maybe some delay, Omet decides to upload a standard size of batch every period of time and keep the stock. Situation gets better but this is built on the increasing level of inventory. We need to organize the production for this product more reasonably, like to send the product to customer also in small batches but not in one longer time by one large batch.

For another AAA product II, figure 4.7, we may see a worse situation:

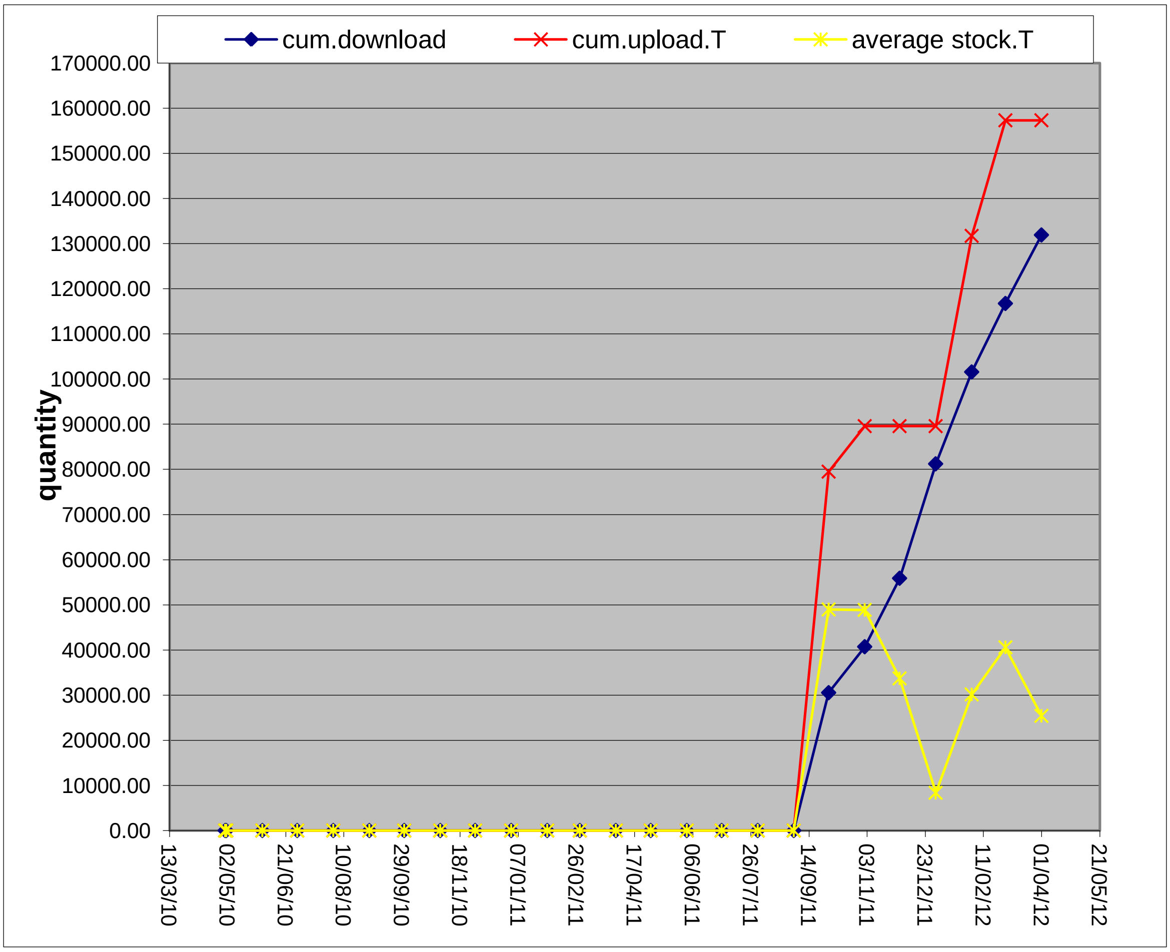


Figure 4.7 upload and download for Product II

Because the demand of the product II is less than product of I, but the minimum quantity for a batch doesn't change. This makes the situation worse. But nowadays, the quantity of balls and bearings, which are customized by the customer, should be ordered by a large batch quantity at one time, because the supplier also needs to ask the upper supplier for the raw material and the supplier for the raw material, for example steels, produces a batch of steels in one time, and the batch quantity depends only on the blast furnace size, which requires too much cost to change. Small volume for each batch seems impossible by now, but Omet has a second solution that to upload low value into the inventory instead of uploading the final products by operating once on the whole batch of materials. Later by negotiating with the supplier and discussing about the producing method, a path to JIT will be possible, which could be smaller batch but shorter delivery interval time.

But also, there is some good example of controlling the production to eliminate the over-production and excess stock, like following Product III, figure 4.8.

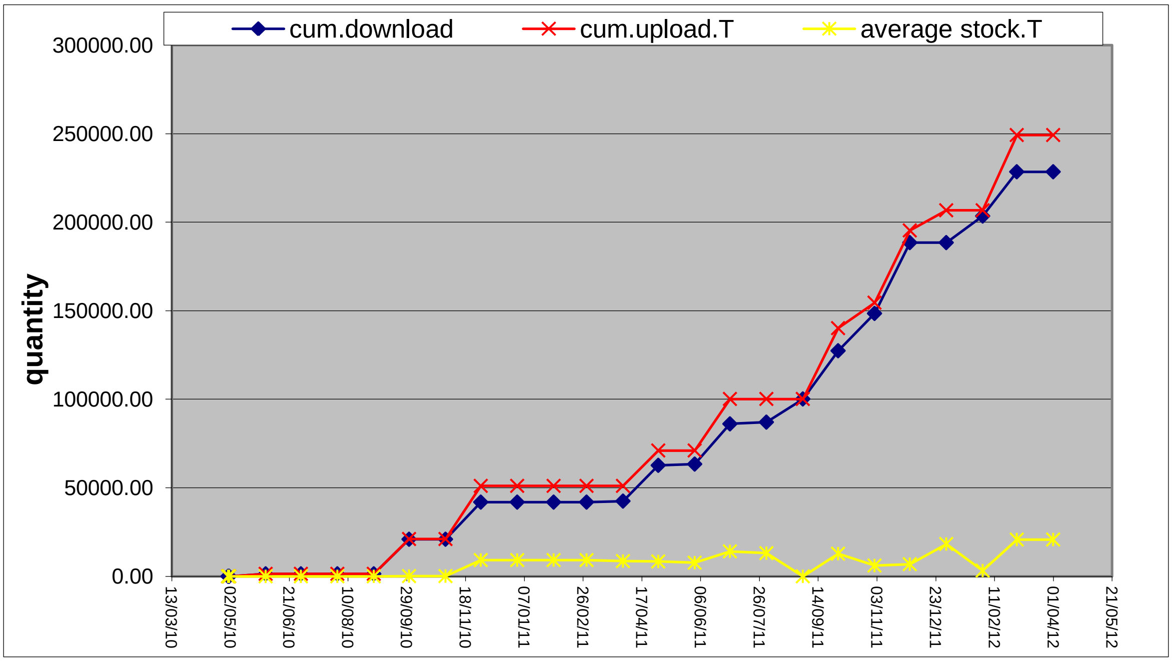


Figure 4.8 upload and download for Product III

The main reason for this product III achieving almost JIT is that it is composed of standardized parts. The supplier could stock large quantity of standardized parts in their inventory, because even Omet doesn't need them, they could sell these parts to other customers. Thus Omet could order small batches of any quantity as they like and most important is "at any time as they like". The lead time of standardized parts could be much shorter than the specialized ones. So now we know where is point we need to find a exact solution, maybe like changing the parts to standardized design or developing a special production line with the supplier for small batches of specialized parts. Anyway the direction towards the future which we have recognized is clear, now we have to find the way.

CODE(T)	START DATE	CLOSE DATE	TOTAL DOWNLOAD	AV. download (per month)	AV. stock (per month)	MAX DOWNLOAD	MAX STOCK	%AV.STOCK / AV.DOWN	DURATION (mese)
T.0163.AAGG	aprile-11	marzo-12	909600.00	75800.00	31266.67	150000.00	80000.00	41.25%	12
T.0256.BEZG	settembre-10	ottobre-11	278786.00	19913.29	22637.86	35424.00	42942.00	113.68%	14
T.0256.BOZG	settembre-10	marzo-12	385430.00	20285.79	18699.47	42710.00	40880.00	92.18%	19
T.0248.ASGG	maggio-10	dicembre-11	671760.00	33588.00	204657.25	361750.00	300950.00	609.32%	20
T.0227.ADTS	giugno-10	marzo-12	228457.00	10384.41	7127.95	40000.00	20750.00	68.64%	22
T.0256.DUGG	febbraio-11	aprile-12	472000.00	31466.67	128834.00	60000.00	370950.00	409.43%	15

T.0127.BBGG	maggio-10	aprile-12	2291250.00	95468.75	161550.00	253500.00	502500.00	169.22%	24
T.0015.AQZO	maggio-10	aprile-12	651500.00	27145.83	48895.83	86000.00	105000.00	180.12%	24
T.0059.AOTS	maggio-10	aprile-12	224378.00	9349.08	14033.33	48420.00	44687.00	150.10%	24
T.0232.BMTG	maggio-10	marzo-12	650000.00	28260.87	52363.48	100000.00	191780.00	185.29%	23
T.0256.EMZG	ottobre-11	aprile-12	131904.00	18843.43	33712.57	30528.00	48960.00	178.91%	7
T.0016.AAGG	maggio-10	aprile-12	1103000.00	45958.33	151295.83	176000.00	311100.00	329.20%	24
T.0249.AIGG	maggio-10	gennaio-12	1010000.00	48095.24	82968.57	259760.00	260340.00	172.51%	21
T.0256.AMZG	maggio-10	aprile-12	141150.00	5881.25	6613.33	21130.00	25990.00	112.45%	24
T.0127.AITG	maggio-10	aprile-12	1058250.00	44093.75	86162.50	144000.00	242250.00	195.41%	24
T.0254.AUZS	maggio-10	marzo-12	197550.00	8589.13	17973.52	24600.00	47970.00	209.26%	23
T.0255.ABGG	maggio-10	aprile-12	530000.00	22083.33	71208.33	40000.00	125000.00	322.45%	24
T.0256.AOZG	maggio-10	aprile-12	141800.00	5908.33	4600.00	21130.00	11000.00	77.86%	24
T.0237.AEGG	giugno-10	aprile-12	375000.00	16304.35	37876.09	25000.00	97900.00	232.31%	23
T.0074.AAGO	maggio-10	novembre-11	194250.00	10223.68	10500.00	24000.00	34250.00	102.70%	19
T.0043.AWG G	maggio-10	marzo-12	670000.00	29130.43	36734.78	75000.00	61450.00	126.10%	23
T.0249.ALGG	maggio-10	marzo-12	702460.00	30541.74	261637.39	130320.00	394310.00	856.66%	23
T.0235.CGNG	maggio-10	aprile-12	225000.00	9375.00	50429.17	20000.00	99250.00	537.91%	24
T.0235.EUNG	maggio-10	aprile-12	230000.00	9583.33	23689.58	27000.00	60000.00	247.20%	24
T.0232.BVZG	settembre-11	aprile-12	200010.00	25001.25	66365.00	200000.00	103790.00	265.45%	8
T.0254.ABZS	maggio-10	aprile-12	502750.00	20947.92	23950.00	144000.00	130700.00	114.33%	24
T.0245.AEGG	maggio-10	aprile-12	336000.00	14000.00	36035.42	30000.00	95700.00	257.40%	24
T.0235.FTNG	febbraio-11	aprile-12	84000.00	5600.00	26290.00	14000.00	68290.00	469.46%	15
T.0235.FDGG	maggio-10	aprile-12	206100.00	8587.50	66533.33	27000.00	121150.00	774.77%	24
T.0232.ATGG	maggio-10	settembre-11	95400.00	5611.76	80447.06	50000.00	109000.00	1433.54%	17
T.0235.DSNG	settembre-10	gennaio-12	150000.00	8823.53	16567.65	25000.00	55200.00	187.77%	17
T.0230.BUGG	ottobre-10	settembre-11	120000.00	10000.00	31416.67	16000.00	69620.00	314.17%	12
T.0198.AZTG	agosto-11	ottobre-11	100000.00	33333.33	38423.33	50000.00	55090.00	115.27%	3
T.0235.CVNG	maggio-10	aprile-12	98000.00	4083.33	22182.50	10000.00	57750.00	543.24%	24
T.0235.DGGG	settembre-10	novembre-11	79600.00	5306.67	16233.33	20000.00	39600.00	305.90%	15
T.0102.ACZG	maggio-10	marzo-12	122000.00	5304.35	12286.09	14000.00	33500.00	231.62%	23
T.0230.BTZG	maggio-10	marzo-11	180000.00	16363.64	19710.91	30000.00	61500.00	120.46%	11

Table 4.1 the summary of all the important products' download and upload analysis

For those yellow lines in Table 4.1, the average stock / average download is higher than 400%, which means stock level is too high compared to the download level. The production of these products should be controlled more urgently. The quick way to reduce the inventory immediately now is to calculate the consumption and lead-time of these yellow products, then to set a safety stock for the situation now and to modify the schedule of the production for these productions. The production could even be stopped to prevent periodic delivery if necessary.

4.4 KANBAN order and delay analyze

To synchronize the supply and production in FA with FB, Omet use one method called "KANBAN order". Below Table 4.2 is one example of the KANBAN order

GESTIONE ORDINE 4912000013 - 31185w	P0263ATCS					B2B
Nome attività	RESP	SUPPLIER	PLAN END	RISCH END	REAL END	STATUS
PURCHASE ORDER FOR P0263ATCS						
Sales dept. Request	COMM	-	2012.07		2012.07	
BOM from OMET WUJIANG	D	-	2012.07		2012.07	
Sales dept activity for order confirm	COMM	-	2012.07		2012.07	
Sale order check	L	-	2012.07		2012.07	
Sale order signature	O	-	2012.07		2012.07	
Sale order signature of customer	COMM	-	2012.07		2012.07	
PO from ITA to CHINA (+ all drawings)	G	-	2012.08		2012.08	
COMPONENT 31049w						
Purchase order	M	A	2012.08		2012.08	
1° Solicit	M	A	2012.10		2012.10	
2° Solicit (Visual check)	M	A	2012.12		2012.12	
Delivery of the PO (10.500 pcs)	M	A	2012.14		2012.14	
1° partial delivery	1° QUANTITY:					
2° partial delivery	2° QUANTITY:					
Delivery of the PO (10.500 pcs)	M	B	2012.16	2012.20	2012.20	
1° partial delivery	1° QUANTITY:					
2° partial delivery	2° QUANTITY:					
Stocking / QC / SAP load	D	-	2012.16			
COMPONENT 31071w						
Purchase order	M	A	2012.08		2012.08	
1° Solicit	M	A	2012.10		2012.10	
2° Solicit (Visual check)	M	A	2012.12		2012.12	
Delivery of the PO (10.500 pcs)	M	A	2012.14		2012.14	
1° partial delivery	1° QUANTITY:					
2° partial delivery	2° QUANTITY:					
Delivery of the PO (10.500 pcs)	M	B	2012.16	2012.20	2012.20	
1° partial delivery	1° QUANTITY:					
2° partial delivery	2° QUANTITY:					
Stocking / QC / SAP load	D	-	2012.16			
COMPONENT 31181w						

Purchase order	M	C	2012.08		2012.08	
1° Solicit (Visual check)	M	C	2012.13		2012.13	
Delivery of the PO (10.500 pcs)	M	C	2012.15		2012.15	
1° partial delivery	1° QUANTITY:					
2° partial delivery	2° QUANTITY:					
Stocking / QC / SAP load	D	-	2012.12			
1° SHIPMENT (1.100 pcs) BY AIR						
FACTORY						
QUALITY CHECK	D		2012.16		2012.16	
PACKAGING	D	-	2012.17		2012.17	
ARRANGE SHIPMENT	E	-	2012.17		2012.17	
SHIPMENT FROM SHANGHAI	G		2012.18	2012.20	2012.20	
OMET ITA ARRIVE	E	-	2012.19			
ITALY QUALITY CHECK	M	-	2012.19			
SHIPMENT TO CUSTOMER	E	-	2012.20			
CUSTOMER REQUEST	COMM	-	2012.20			
GOODS IN ITALY (hyp D)	D	-	2012.19			
2° SHIPMENT (9.400 pcs)						
FACTORY						
QUALITY CHECK	D		2012.17			
PACKAGING	D	-	2012.17			
ARRANGE SHIPMENT	E	-	2012.18			
DEAD DATE FOR SHIPMENT BY AIR	**DAVIDE**		**2012.19**			
SHIPMENT FROM SHANGHAI 5.600 pcs	G		2012.18	2012.21	2012.21	
SHIPMENT FROM SHANGHAI 2.600 pcs	G		2012.18	2012.25		
SHIPMENT FROM SHANGHAI 400 pcs	G		2012.18	2012.25		
SHIPMENT FROM SHANGHAI 600 pcs	G		2012.18	2012.26		
OMET ITA ARRIVE	E	-	2012.24			
ITALY QUALITY CHECK	M	-	2012.24			
SHIPMENT TO CUSTOMER	E	-	2012.25			
CUSTOMER REQUEST	C	-	2012.25			
GOODS IN ITALY (hyp D)	D	-	2012.24			

Table 4.2 one example of KANBAN order

For the long transportation lead-time, most of the work in Omet is scheduled by weeks. The Italian headquarter makes the schedule and every week, usually Monday, they will contact with factory in China to check the progress rate of every event. For each product in one order, they will make one sheet of KANBAN order which contains the raw materials, the producing schedule and the shipment dates. FA and FB will decide that from which supplier and how many batches they will order the raw material. If the order time and delivery time differ a lot, they will also arrange some production check within the period. For every event they will work out the person who is in duty and the planning date of closing the event. Every Monday FB will contact with FA to check if everything is on progress or some postponing should be done. If necessary, the check will be more than once a week. FA will also contact with FB if they are facing some problems in achieving the dead-line or find some practical problems on the drawings of the product. After the communication between FA and FB, there will be a meeting in FB themselves to check the status of all the orders, and for those delayed cases, they will try to find the causes and solve it to prevent it occurring next time. For analysis and showing the result, they have the following figure 4.9.

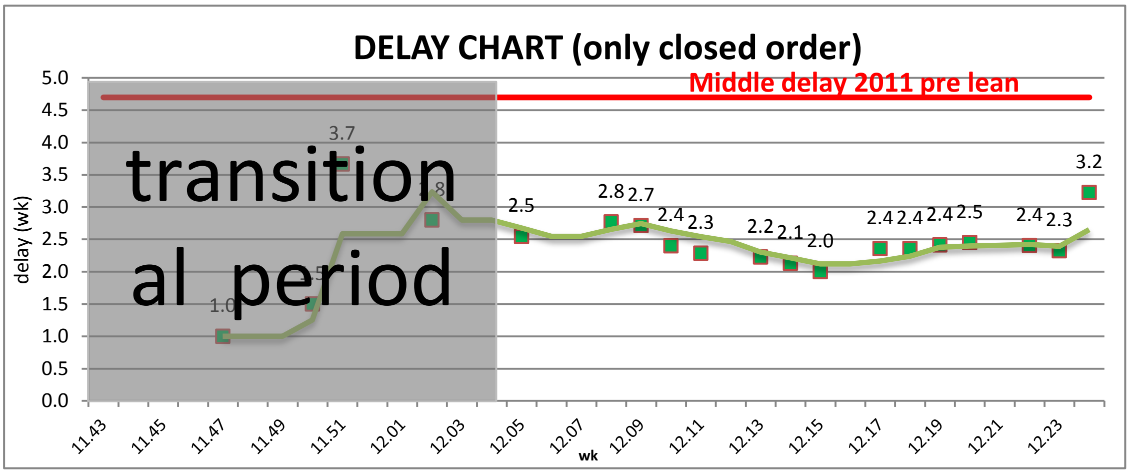


Figure 4.9 delay chart (only closed order)

With the lean progression going on, Omet keeps discovering the problems and finding solutions to solve them. From figure 4.9, we can find that the situation of delay has been improved since year 2011. Because by using KANBAN order, Omet is able to find exactly in which step during the whole chain exist problems. This is a powerful tool for Omet to apply the solution to the root base, which is to say that little effort but big effect.

By reducing the delay of the products, Omet is also able to reduce the safety stock for every product which originally is prepared to keep the reputation for no-delay and no-stock-out. Also if delay problem has not been solved, we will get to a worse condition. For some delayed products, we have to organize some special days to accelerate their production. But that production which has been replaced will have delay and the production schedule will get into a mass. Later delay after delay, the time of delay will get longer.

The only solution before is to produce some large batches and to keep a higher inventory to buff the delay in a longer time. That's why the inventory of Omet is almost doubled as we have shown in the former chapter. However delay problem is still there, which means delay time has not been cut down. Now trying with KANBAN order, Omet is on the way to solve the core problem in delay issues. When everything goes smoothly, the inventory level will decline naturally.

4.5 Postponed production

For some old customers, they will not order one batch and provide a delivery date like a new customer. They ushe contract for the long period time and ask Omet to deliver one batch usually eveually will negotiate with Omet with a contract for one year of half year. They forecast their demand in try two months. When Omet receives such order, they will make the schedule and KANBAN order, produce one batch every month and send it to FB from FA for quality check and packaging. After receiving the customers' phone call for delivery, they pick the defined quantity from the inventory to ship them to the customers.

The ideal situation is that at the exact delivery date, there are exact quantity of products that customers require. But for the economic market changing every day, the customers' demand will also change. Sometimes those customers will ask for a postponing for the defined delivery date in the contract. This may lead to some problems. Because for the defined the schedule, it's not that easy to modify and FA will continue to produce and deliver the products to FB every period of time, then the products will pile up in the inventory of FB. When the production manager of FB finds the problem and want to stop the production of FA, there have been already some batches on the sea.

For timely communication between FA and FB for such postponing, they should check every delay details.

POSTICIPI DI CONSEGNA - MESE MAGGIO 2012							
Numero Ordine	**Provenienza Prodotto**	**data cons. precedente**	**Quantità Posticipata**	**Mesi Posticipati**	**Nuova Consegna**	**Stock(md04)**	**Note**
V-20110113	IMPORT	apr-12	10000	3	Jul-12	19,220.00	NON arrivato
V-20110113	IMPORT	apr-12	10000	3	Jul-12	19,220.00	NON arrivato
V-20110056	IMPORT"OMET CHINA"	apr-12	5000	1	May-12	4,860.00	arrivato e consegnato
V-20110056	IMPORT"OMET CHINA"	apr-12	5000	3	Jul-12	4,860.00	NON arrivato
V-20110348	IMPORT	May-12	26000	2	Jul-12	27,600.00	arrivato
V-20110602	MADE IN"OMET ITALY"	May-12	250500	5	Oct-12	402,900.00	NON arrivato
V-20110602	MADE IN"OMET ITALY"	Jun-12	249000	5	Nov-12	402,900.00	NON arrivato
V-20110630	MADE IN"OMET ITALY"	Jun-12	43800	6	Dec-12	49,300.00	NON arrivato

V-20110267	IMPORT	Jun-12	2680	6	Dec-12	17,560.00	NON arrivato
V-20110266	IMPORT	Jun-12	3200	6	Dec-12	21,880.00	?
V-20111070	MADE IN"OMET ITALY"	Jun-12	350	3	Sep-12	0.00	NON arrivato
V-20111070	MADE IN"OMET ITALY"	Jul-12	650	3	Oct-12	0.00	NON arrivato
V-20110514	MADE IN"OMET CHINA"	May-12	2500	1	Jun-12	2,500.00	NON arrivato
V-20110515	MADE IN"OMET CHINA"	May-12	2500	1	Jun-12	2,500.00	NON arrivato
V-20100321	MADE IN "OMET ITALY+CHINA"	Jun-12	3000	1	Jul-12	22,275.00	arrivato
V-20100321	MADE IN "OMET ITALY+CHINA"	Jun-12	23300	6	Dec-12	22,275.00	NON arrivato
V-20120003	MADE IN"OMET CHINA"	May-12	10000	1	Jun-12	0.00	NON arrivato
V-20120004	MADE IN"OMET CHINA"	May-12	1000	1	Jun-12	0.00	NON arrivato
V-20120005	MADE IN"OMET CHINA"	May-12	10000	1	Jun-12	180.00	NON arrivato
V-20120006	MADE IN"OMET CHINA"	May-12	1000	1	Jun-12	0.00	NON arrivato
V-20120001	MADE IN"OMET CHINA"	May-12	3500	1	Jun-12	3,873.00	arrivato
V-20120002	MADE IN"OMET CHINA"	May-12	1000	1	May-12	1,040.00	arrivato
V-20110075	IMPORT	May-12	4000	2	Jul-12	4,270.00	NON arrivato?
V-20110076	IMPORT	May-12	2000	2	Jul-12	2,280.00	NON arrivato?

Table 4.3 The postponed order of May 2012 for Omet

Table 4.3 is an example in Omet that they check the postponed order in May. Then they contact with FA to stop producing those not arrived but inventory of which is already enough for the next batch. And the restart date and production rate need to be calculated in order to prevent from delays for the next batch.

However, the occurrence of this problem is because of the inflexible production schedule. The batch is too large and the delivery period is too long. If we could reduce the quantity in one lot and deliver more frequently, the reaction time will decline and the waste of over-production will be decreased a lot. We will discuss this later in the chapter of HMLV.

4.6 Lean meeting and Kaizen for managers

As we have said before, for every Monday, there will be a lean meeting to discuss about all the issues of last week and to make the plan of improvement for this week. They want to build a united passion to improve, to learn, and also some consultant will analyze the problems and give some advices.

For example, there are three managers for the sales department. Each has their own sales strategies with their customer, while this leads them to have different lean level.

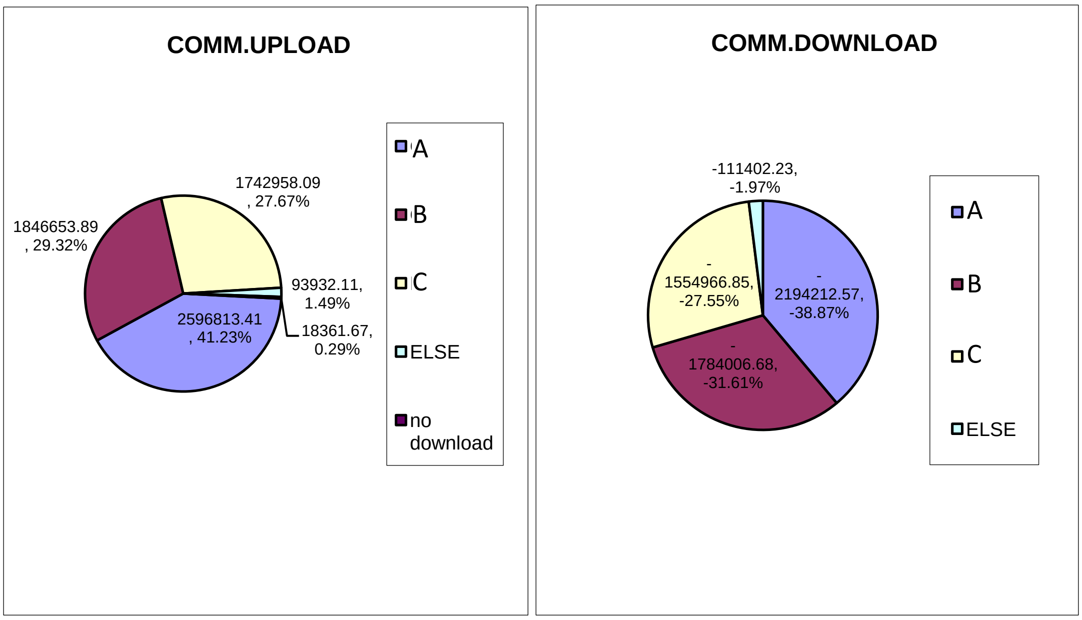


Figure 4.10 upload and download value for different sales manager in 2 years

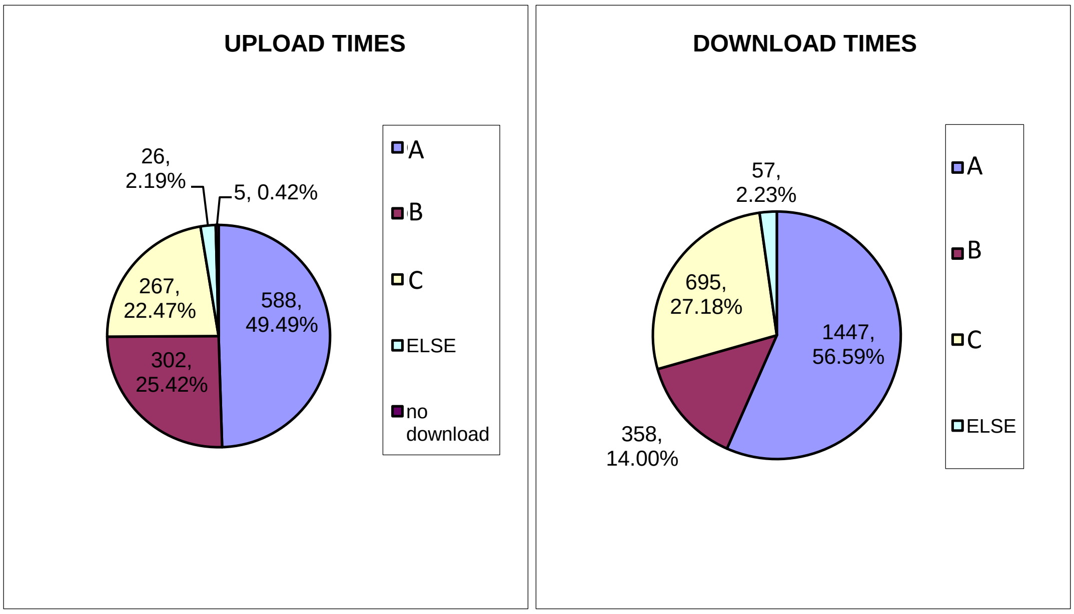


Figure 4.11 upload and download times for different sales manager in 2 years

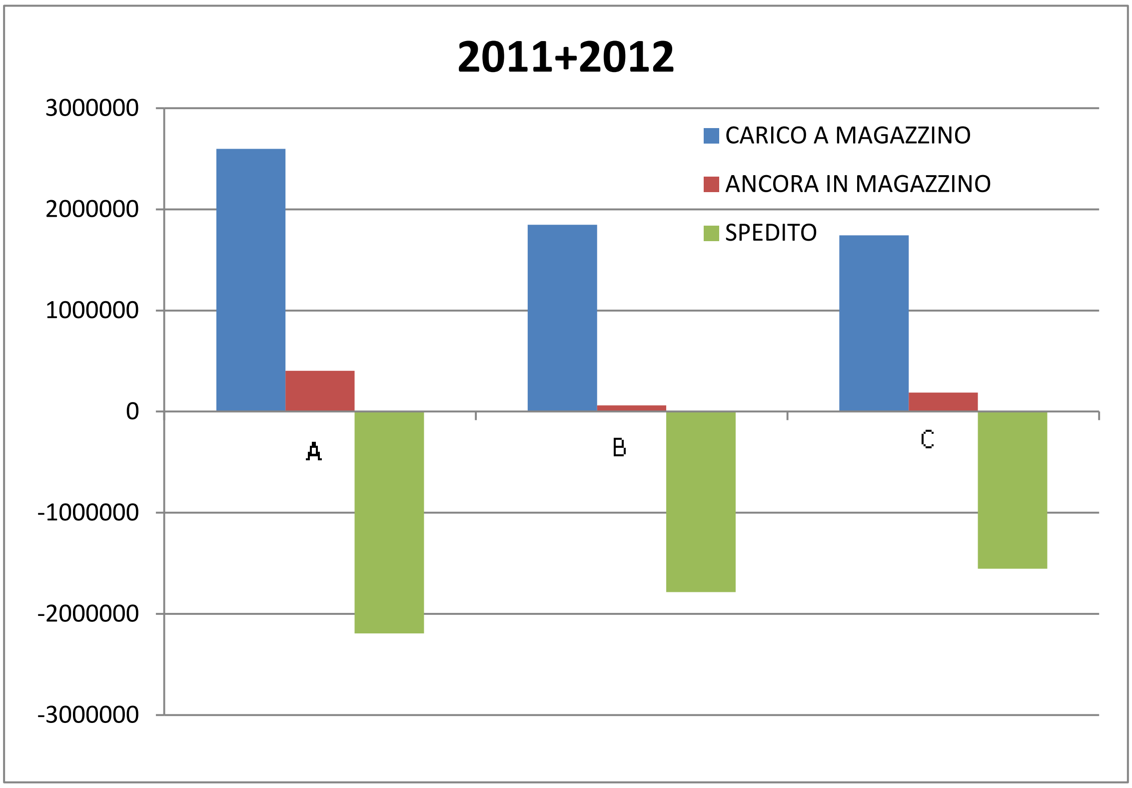


Figure 4.12 stock for three sales manager in 2 years

From figure 4.10, 4.11, and 4.12, we could clearly identify 3 different styles of the sales manager. In comparison of the three kinds of issues, we might find that the sales manager B operates the business not larger but a little better considering the upload and download times and the stock occupied by B. For A and C, the download time is almost 3 times the upload, which may be the reason that they upload into the inventory with large batches and consume it with orders. This leads to higher stock ratio for them compared with B's stock. On the meeting, B could present the method he/she deals with the business. The successful point to reduce the stock and balance the upload and download times (which means JIT) could be introduced to all the sales department and help to improve the behaviors for all.

Also on the meeting, they will provide and discuss the suggestions among all the departments, like design, production, sales and so on. Where the flow could be blocked needs to find a solution, all the departments should present their difficulties and thinking, lean group (usually created up by all the mangers from different departments) will give a integrated idea until all the departments agree on the proposal. And every result will be recorded, further improvement will never stop. Step by step, with the meeting, the failure of the production will be reduced and delay problems will be eliminated. The necessary inventory level will also reduce according to these. The company will keep on the way of KAIZEN.

4.7 Some "Rubbish" in the inventory

For years of operation, we have found that the inventory has increased also for another possible reason. In the early years, to ensure they could provide the required quantity of good quality products, often Omet will produce more than necessary to tolerate some percentage of defective products. Although Omet is applying zero-defect, which we will discuss in the later chapter, those excess-stocks and over-production, which have already piled up in inventory, are still there. They are mainly divided into three kinds:

(1) Some of the products are specialized and beyond any customers' need because the former customers have already changed the production or some else reason, they don't need the product any more. And for the specialty of the product, other customer can't use the format.

(2) Some other "rubbish" in the inventory is the stock for testing samples. Sometimes if FA sent too many samples for testing and FB didn't use up them all, parts of them went into the stock.

(3) Because FA sends the product every period of time and when FB asks them to stop the production for some reason, there have already several batches on the sea. When these batches arrive in FB, they become excess-stock.

So now we should check those stock in the inventory to see which are in the three kinds of product above, Table 4.4 :

Materiale	Qtà stk. val.		N. mov.	Rot. inv.	Data 1°cons.	Note
T.0260.AAZG	2,460.00	PZ	3	0	Disponibile	-
T.0139.ACGS	5,680.00	PZ	3	0	Disponibile	st.1680(-4000,05.04.2012) (5040, 05.04.2012)
T.0243.ANGG	8,650.00	PZ	0	0	Disponibile	-
T.0256.AIZG	4,414.00	PZ	0	0	Disponibile	st.2110(-2304, 03.05.2012)
T.0127.AFTG	27,500.00	PZ	0	0	Disponibile	-
T.0043.AVGG	30,600.00	PZ	0	0	Disponibile	-
T.0196.AGGG	20,800.00	PZ	0	0	Disponibile	-
T.0196.ANZG	19,300.00	PZ	0	0	Disponibile	-
T.0043.ATGG	23,850.00	PZ	0	0	Disponibile	-
T.0235.CQGG	8,050.00	PZ	0	0	Disponibile	-
T.0243.AING	3,250.00	PZ	0	0	Disponibile	-
T.0045.AAZO	17,100.00	PZ	0	0	Disponibile	-
T.0059.AIBS	1,540.00	PZ	0	0	Disponibile	-
T.0230.BLGG	8,890.00	PZ	0	0	Disponibile	-
T.0236.AAZS	5,350.00	PZ	0	0	Disponibile	-
T.0235.COGG	8,000.00	PZ	0	0	Disponibile	-
T.0137.ADGS	2,700.00	PZ	0	0	Disponibile	-
T.0235.AMNG	5,500.00	PZ	0	0	Disponibile	-
T.0230.ALGG	9,000.00	PZ	0	0	Disponibile	-
T.0243.ATNG	900	PZ	0	0	Disponibile	-
T.0017.AAZS	6,700.00	PZ	0	0	Disponibile	-
T.0002.AGGO	4,060.00	PZ	0	0	Disponibile	-
T.0243.AAGG	2,250.00	PZ	0	0	Disponibile	-

T.0135.AHZS	7,970.00	PZ	0	0	Disponibile	-
T.0043.ACZG	7,900.00	PZ	0	0	Disponibile	-
T.0235.DFGG	4,450.00	PZ	0	0	Disponibile	-
T.0235.ECNG	2,650.00	PZ	0	0	Disponibile	-
T.0243.AGNG	1,530.00	PZ	0	0	Disponibile	-
T.0154.AAZG	5,200.00	PZ	0	0	Disponibile	-
T.0198.ABGG	4,800.00	PZ	0	0	Disponibile	-
T.0102.AFZG	10,000.00	PZ	0	0	Disponibile	-
T.0243.AONG	1,090.00	PZ	0	0	Disponibile	-
T.0252.AANO	3,100.00	PZ	0	0	Disponibile	-
T.0246.AAGO	2,500.00	PZ	0	0	Disponibile	-
T.0245.ADNG	5,550.00	PZ	0	0	Disponibile	-
T.0235.DTGG	850	PZ	0	0	Disponibile	-
T.0235.CPGG	2,850.00	PZ	0	0	Disponibile	-
T.0043.BNGG	5,200.00	PZ	0	0	Disponibile	-
T.0043.ARGG	6,150.00	PZ	0	0	Disponibile	-
T.0222.AAZS	2,000.00	PZ	0	0	Disponibile	-
T.0127.AHGG	4,250.00	PZ	0	0	Disponibile	-
T.0245.AQGO	6,200.00	PZ	0	0	Disponibile	-
T.0059.AABS	900	PZ	0	0	Disponibile	-
T.0043.BAZG	4,100.00	PZ	0	0	Disponibile	-
T.0211.AGGS	670	PZ	0	0	Disponibile	-
T.0197.ABTS	430	PZ	0	0	Disponibile	-
T.0015.AHZO	1,100.00	PZ	0	0	Disponibile	-
T.0134.ABZO	2,650.00	PZ	0	0	Disponibile	-
T.0246.ACGO	2,000.00	PZ	0	0	Disponibile	-
T.0232.ALGG	2,000.00	PZ	0	0	Disponibile	-
T.0162.ABBG	580	PZ	0	0	Disponibile	-
T.0059.AQTS	800	PZ	0	0	Disponibile	-
T.0240.AAGS	10,300.00	PZ	0	0	Disponibile	-
T.0220.ADNG	1,335.00	PZ	0	0	Disponibile	-
T.0001.AQGO	2,090.00	PZ	0	0	Disponibile	-
T.0256.AVGG	770	PZ	0	0	Disponibile	-
T.0001.ACGG	1,820.00	PZ	0	0	Disponibile	-
T.0232.AOGG	3,450.00	PZ	0	0	Disponibile	-
T.0127.AIGG	2,400.00	PZ	0	0	Disponibile	-
T.0235.DEGG	1,550.00	PZ	0	0	Disponibile	-
T.0243.AUNG	730	PZ	0	0	Disponibile	-
T.0260.AOZG	67	PZ	0	0	Disponibile	-
T.0198.ASGG	1,850.00	PZ	0	0	Disponibile	st.0(-1850,22.03.2012)
T.0048.AEGS	700	PZ	0	0	Disponibile	-
T.0235.FBNG	1,080.00	PZ	0	0	Disponibile	-
T.0016.AAGO	2,020.00	PZ	0	0	Disponibile	-
T.0015.ARZO	1,070.00	PZ	0	0	Disponibile	st.570
T.0245.AGNG	2,050.00	PZ	0	0	Disponibile	-
T.0027.AA38	1,300.00	PZ	0	0	Disponibile	-
T.0210.AEZG	91	PZ	0	0	Disponibile	-
T.0260.ACGG	94	PZ	0	0	Disponibile	-
T.0208.AAGO	1,400.00	PZ	0	0	Disponibile	-
T.0198.AHZG	1,080.00	PZ	0	0	Disponibile	-
T.0245.ALGO	1,200.00	PZ	0	0	Disponibile	-
T.0212.AFGG	1,000.00	PZ	0	0	Disponibile	-
T.0256.CSAG	86	PZ	0	0	Disponibile	-
T.0239.ACGS	2,170.00	PZ	0	0	Disponibile	-
T.0260.ANZG	40	PZ	0	0	Disponibile	ord.-1500(26.10.2012)
T.0209.AQZG	186	PZ	0	0	Disponibile	-
T.0043.AVZG	1,650.00	PZ	0	0	Disponibile	-
T.0235.EGNG	750	PZ	0	0	Disponibile	st.0(-750, 02.04.2012)
T.0247.AAGO	350	PZ	0	0	Disponibile	-

T.0001.AAGG	950	PZ	0	0	Disponibile	-
T.0002.ABGO	1,060.00	PZ	0	0	Disponibile	-
T.0043.ARGO	1,600.00	PZ	0	0	Disponibile	-
T.0212.AETG	930	PZ	0	0	Disponibile	-
T.0232.APGG	1,450.00	PZ	0	0	Disponibile	-
T.0043.BUGG	1,200.00	PZ	0	0	Disponibile	-
T.0254.AAGS	6,000.00	PZ	0	0	Disponibile	-
T.0218.AA01	350	PZ	0	0	Disponibile	-
T.0256.BMZG	180	PZ	0	0	Disponibile	st.30
T.0235.ETNG	690	PZ	0	0	Disponibile	-
T.0249.ATGG	490	PZ	0	0	Disponibile	-
T.0249.ABGG	1,070.00	PZ	0	0	Disponibile	-
T.0235.EHGG	430	PZ	0	0	Disponibile	-
T.0227.AABS	100	PZ	0	0	Disponibile	-
T.0016.AJGG	650	PZ	0	0	Disponibile	-
T.0043.BTGG	750	PZ	0	0	Disponibile	-
T.0235.ESNG	500	PZ	0	0	Disponibile	-
T.0198.ATGG	490	PZ	0	0	Disponibile	-
T.0207.AA01	500	PZ	0	0	Disponibile	-
T.0254.AENS	360	PZ	0	0	Disponibile	-
T.0134.AAZG	370	PZ	0	0	Disponibile	-
T.0007.ACBS	200	PZ	0	0	Disponibile	-
T.0254.AFNS	320	PZ	0	0	Disponibile	-
T.0257.AABG	180	PZ	0	0	Disponibile	-
T.0232.BBGG	200	PZ	0	0	Disponibile	-
T.0235.ASGG	200	PZ	0	0	Disponibile	-
T.0005.BDBS	74	PZ	0	0	Disponibile	-
T.0260.ABGG	23	PZ	0	0	Disponibile	-
T.0260.ADGG	11	PZ	0	0	Disponibile	-
T.0254.ACZS	385	PZ	0	0	Disponibile	-
T.0105.ABZO	110	PZ	0	0	Disponibile	-
T.0001.ABGO	170	PZ	0	0	Disponibile	-
T.0002.ACGG	150	PZ	0	0	Disponibile	-
T.0001.ADGO	150	PZ	0	0	Disponibile	-
T.0254.AZZS	31	PZ	0	0	Disponibile	ord.-5000(30.11.2012)
T.0115.AAGG	40	PZ	0	0	Disponibile	-
T.0014.AAZO	60	PZ	0	0	Disponibile	-
T.0237.ADTG	50	PZ	0	0	Disponibile	-
T.0106.ACZO	30	PZ	0	0	Disponibile	-
T.0245.ACGO	50	PZ	0	0	Disponibile	-

Table 4.4 "MUDA" in the inventory

All these products above have no movement of the inventory or customer's order in the past 6 months. So we check them one by one to see if there is order within one year in the future. If not, then the products could be eliminated and disposed directly. Even in the future, let's say 3 months later, there will be an order from the customer, then we still could to reconsider the production schedule for it. Anyway they have been tied up in the inventory for too long.

Besides these final products, there are also some semi-products and raw materials Omet has prepared for the cancelled or over-production order in the past. Omet also did the same analysis to them. The "muda" costs much more than imagination. And from now on, to carry on the business with some old or new products, Omet needs to think twice before taking the action to prevent such situation happening again.

4.8 Project W

During the thesis, as the lean evolution going on in Omet, the company has formed a special group for related issues. They are responsible for putting forward the changes for improvement and react to the feedbacks from the new actions. After analyzing the situation nowadays, considering about the target to reduce the stock level and the behavior in the past, they start to conduct a big project with lean strategy.

There are three big orders from a customer. We define them as order A, order B and order C.

In the past years, the company purchases the raw materials once or twice a year. Then the production planning is implemented according to whole year's required quantity. After all the production, the products were sent by orders. The rest will stay in the inventory for the next command from the customer.

Now the manager of Omet is planning a new type of production organization. To order the raw material from the supplier week by week and to arrange the production according to the weekly demand of the customer are two main solving methods to decreasing the stock level. In theoretic, this will keep the inventory at the zero level, however for many real emergencies and for the beginning of the project, the safety stock should be contained and production arrangement differs from month to month considering about the festival holidays in China and Italy.

First of all, the manager has to decide the quantity of products to be ordered weekly. This quantity size should be the ELS (economic lot size) which means with this size of lot, the cost of the whole process, concluding the purchase cost, setup cost, holding cost and so on, will be at the least level compared with other size of lot. By using the EOQ model, the following equation could be obtained:
We define:

D = demand (unit/year)
i = holding rate (%/year)
q = purchase lot or production lot (unit/lot)
r = production rate (unti/hour)
a = order issure cost or set up cost (Euro/lot)
H = yearly working hours (H)
p = purchasing prize or variable production cost (Euro/unit)

Then,

$C_{total} = C_{purchase/production} + C_{order\ issue/setup} + C_{holding}$

$$C_{total} = pD + \frac{Da}{q} + pi\frac{q}{2} \quad (Eur/year)$$

As q increases the cost of order issue will decrease however the cost of inventory holding cost will increase. When $q = \sqrt{\frac{2Da}{pi}}$, the total cost reaches minimum value. This "q" is called as ELS. However the equation above considers about the situation with infinite production ability, for order B and order C, Omet in Italy orders the finished products from China and directly sends them to the customer, which means no production needed after ordering, so they match to this equation. But for order A, there will be a riveting process after the ordered materials arrive in Omet Italy, which means the workability after order is not infinite, so we should use the equation below:

With r = finite, $C_{total} = pD + \frac{Da}{q} + pi\frac{q}{2}(1 - \frac{D}{Hr}) \quad (Eur/year)$

The ELS turns to be as following:

$$ELS = q = \sqrt{\frac{2Da}{pi(1-\frac{D}{Hr})}}$$

Applying the data collected from each department, we get ELS = 13000 units/lot for order B and order C. As the production rate is very high for the simple riveting step, for order A the ELS is just a bit higher, like 13200 units/lot. Here we eliminate the small differences and set 13000 units/lot also for order A. Then we get the plan of delivery quantity and date in Table 4.5.

PLAN OF DELIVERY QUANTITY AND DATE											
Order A				Order B				Order C			
6.500 pcs/wk.= 26.000 pcs/m.				6.500 pcs/wk.= 26.000 pcs/m.				6.500 pcs/wk.= 26.000 pcs/m.			
Date from CN	Qty. from CN kpcs	Date to client	Qty. to client kpcs	Date from CN	Qty. from CN kpcs	Date to client	Qty. to client kpcs	Date from CN	Qty. from CN kpcs	Date to client	Qty. to client kpcs
02/11/12	13	09/01/13		02/11/12	13	09/01/13		02/11/12	13	09/01/13	
		16/01/13				16/01/13				16/01/13	
16/11/12	13	23/01/13	6.5	23/11/12	13	23/01/13	6.5	23/11/12	13	23/01/13	6.5
		30/01/13				30/01/13				30/01/13	
07/12/12	**26**	06/02/13		**07/12/12**	**26**	06/02/13		**07/12/12**	**26**	06/02/13	
		13/02/13				13/02/13				13/02/13	

04/01/13	**26**	20/02/13		**04/01/13**	**26**	20/02/13		**04/01/13**	**26**	20/02/13	
		27/02/13				27/02/13				27/02/13	
COMPLETE THE FOUNDATION OF THE SAFETY STOCK OF 26.000 PCS = 4 WEEKS' DEMAND OF THE CLIENT											
11/01/13	**15**	06/03/13	6.5	**11/01/13**	**15**	06/03/13	6.5	**11/01/13**	**15**	06/03/13	6.5
		13/03/13				13/03/13				13/03/13	
25/01/13	**15**	20/03/13		**25/01/13**	**15**	20/03/13		**25/01/13**	**15**	20/03/13	
		27/03/13				27/03/13				27/03/13	
CLOSE FOR THE SPRING FESTIVAL IN CHINA - Feb. 2013											
01/03/13	**14**	03/04/13	6.5	**01/03/13**	**14**	03/04/13	6.5	**01/03/13**	**14**	03/04/13	6.5
		10/04/13				10/04/13				10/04/13	
15/03/12	**14**	17/04/13		**15/03/12**	**14**	17/04/13		**15/03/12**	**14**	17/04/13	
		24/04/13				24/04/13				24/04/13	
29/03/13	13	02/05/13		29/03/13	13	02/05/13		29/03/13	13	02/05/13	
		08/05/13				08/05/13				08/05/13	
12/04/13		15/05/13		12/04/13		15/05/13		12/04/13		15/05/13	
		22/05/13				22/05/13				22/05/13	
26/04/13		29/05/13		26/04/13		29/05/13		26/04/13		29/05/13	
		05/06/13				05/06/13				05/06/13	
10/05/13		12/06/13		10/05/13		12/06/13		10/05/13		12/06/13	
		19/06/13				19/06/13				19/06/13	
24/05/13		26/06/12		24/05/13		26/06/12		24/05/13		26/06/12	
		03/07/12				03/07/12				03/07/12	
07/06/13		10/07/13		07/06/13		10/07/13		07/06/13		10/07/13	
		17/07/13				17/07/13				17/07/13	
21/06/13		24/07/13		**21/06/13**		24/07/13		**21/06/13**		24/07/13	
		31/07/13				31/07/13				31/07/13	
IN MAY 2013, THE MODIFICATION WILL BE EVENTUALLY VALUED IN ORDER TO CATCH THE DELIVERY IN AUGUST JUST REQUIRED BY THE CLIENT(KANBAN)											
21/06/13	13	31/07/13	6.5	**21/06/13**	13	31/07/13	6.5	**21/06/13**	13	31/07/13	6.5
			6.5				6.5				6.5
21/06/13	13		6.5	**21/06/13**	13		6.5	**21/06/13**	13		6.5
		28/08/13	6.5			28/08/13	6.5			28/08/13	6.5
28/07/13	13	04/09/13	6.5	28/07/13	13	04/09/13	6.5	28/07/13	13	04/09/13	6.5
		11/09/13				11/09/13				11/09/13	
09/08/13		18/09/13		09/08/13		18/09/13		09/08/13		18/09/13	
		25/09/13				25/09/13				25/09/13	
23/08/13		02/10/13		23/08/13		02/10/13		23/08/13		02/10/13	
		09/10/13				09/10/13				09/10/13	
06/09/13		16/10/13		06/09/13		16/10/13		06/09/13		16/10/13	
		23/10/13				23/10/13				23/10/13	

20/09/2013		30/10/13	6.5	20/09/2013		30/10/13	6.5	20/09/2013		30/10/13	6.5
	305	06/11/13	6.5		305	06/11/13	6.5		305	06/11/13	6.5
04/10/2013		13/11/13	6.5	04/10/2013		13/11/13	6.5	04/10/2013		13/11/13	6.5
		20/11/13	6.5			20/11/13	6.5			20/11/13	6.5
		27/11/12	1.0			27/11/12	1.0			27/11/12	1.0
			300				300				300

Table 4.5 Plan of delivery quantity and date

To build the safety stock in the inventory, we increase the quantity of lot size to twice for the third and fourth delivery. And for the Chinese Spring festival, the scheduling and the lot size changed a bit around that period. As the project going, which the planning the date is in the May 2012, Omet will try to organize this business with the help of KANBAN else than the forecast, to build a "supermarket" for the products and to do the production according to the consumption. This part of KANBAN will be discussed later.

After finishing the planning about the reorder timing/quantity and delivery timing/quantity, secondly the delivery lead-time of the raw materials from Chinese supplier should be calculated, shown in Table 4.6, this concludes two parts:
1. Production time for the first batch
2. Production time in the continuous production (which could be also considered as the safety stock replenishment velocity)

LEAD TIME FOR PROJECT ITEMS					
Components	Supplier	Lead time			
		First batch 13000 pieces	Safety stock		
31146W	XYZ	40 Days	30 Days	26000	Pieces
31548W	YXZ	15 Days	30 Days	26000	Pieces
31107W	YXZ	40 Days	30 Days	26000	Pieces
78706W	YXZ	15 Days	30 Days	26000	Pieces
M2200000057	ZXY	20 Days	20 Days	1500	Kg
31550W	ZYX	15 Days	15 Days	13000	Pieces
31551W	ZYX	15 Days	15 Days	13000	Pieces

Table 4.6 Lead time for project items

For the third step, because there are other products needed to be produced, so the workload for each kind of machine has to be valued (Table 4.7), and also for the limited production ability (Table 4.8) and different products' requirement, it needs to know how many shifts are needed to be prepared for the following production.

INJECTION MACHINES		
Type	***Free hour/week during standard workload***	***Operator***
90T	around 20H	1 Operator + 50% manager
120T	around 20H	1 Operator + 50% manager
NOTE: Two injection machines for 90T and one for 120T,		

LATHE MACHINES		
n° LATHE	***Free hour/week during standard workload***	***Operator***
3	50H/Lathe	3 Operators

RIVETING MACHINE		
n° RIVET	***Free hour/week during standard workload***	***Operator***
1	around 30H	1 Operator

Table 4.7 Workload of each machine

ORDER A			
Moulding Step	***Moulding Average pcs/h***	***Injection Machine***	***Turning Average pcs/h***
31549w	280	120T	250

ORDER B				
Item	***Average pcs/h***	***Injection Machine***	***Turning Average pcs/h***	***Riveting Average pcs/h***
31551w	370	90T	270	600

ORDER C			
Item	***Average pcs/h***	***Injection Machine***	***Turning Average pcs/h***
31550w	320	120T	270

Table 4.8 Production rate of each order

After calculation, the molding step is to be found as the bottleneck of the whole processes. So for the limited load, also an additional outside supplier should be added to the planning. And the quotation of the supplier has to be measured and balanced.

With all the information above, for each delivery, a timeline scheduling could be drawn to show how the work could be ordered and by checking the current stock, we could find that when the following batches are needed by production.

Following Figure 4.13-4.16, we take first four times delivery of order A as an example:

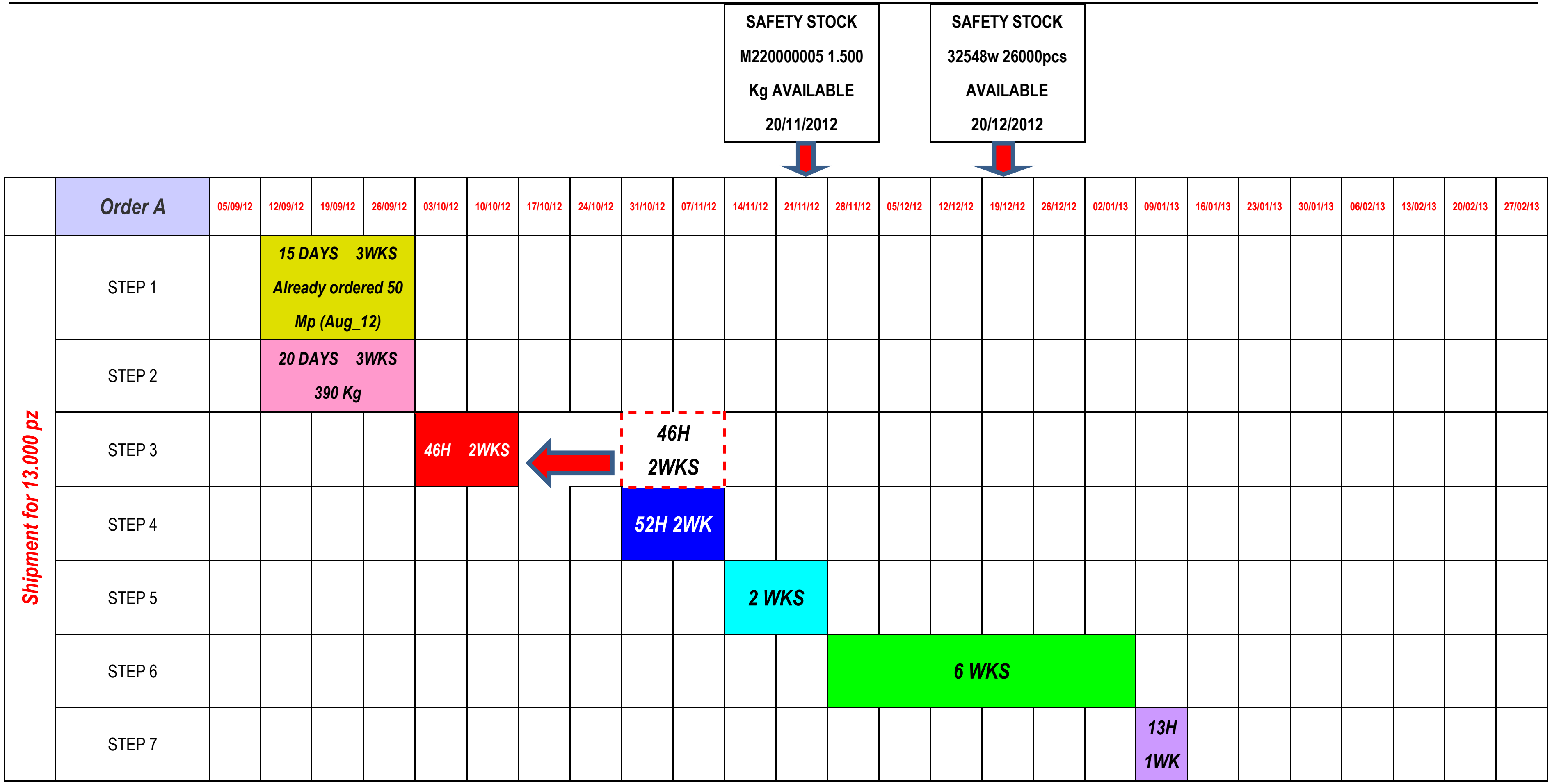


Figure 4.13 1st delivery scheduling of Order A

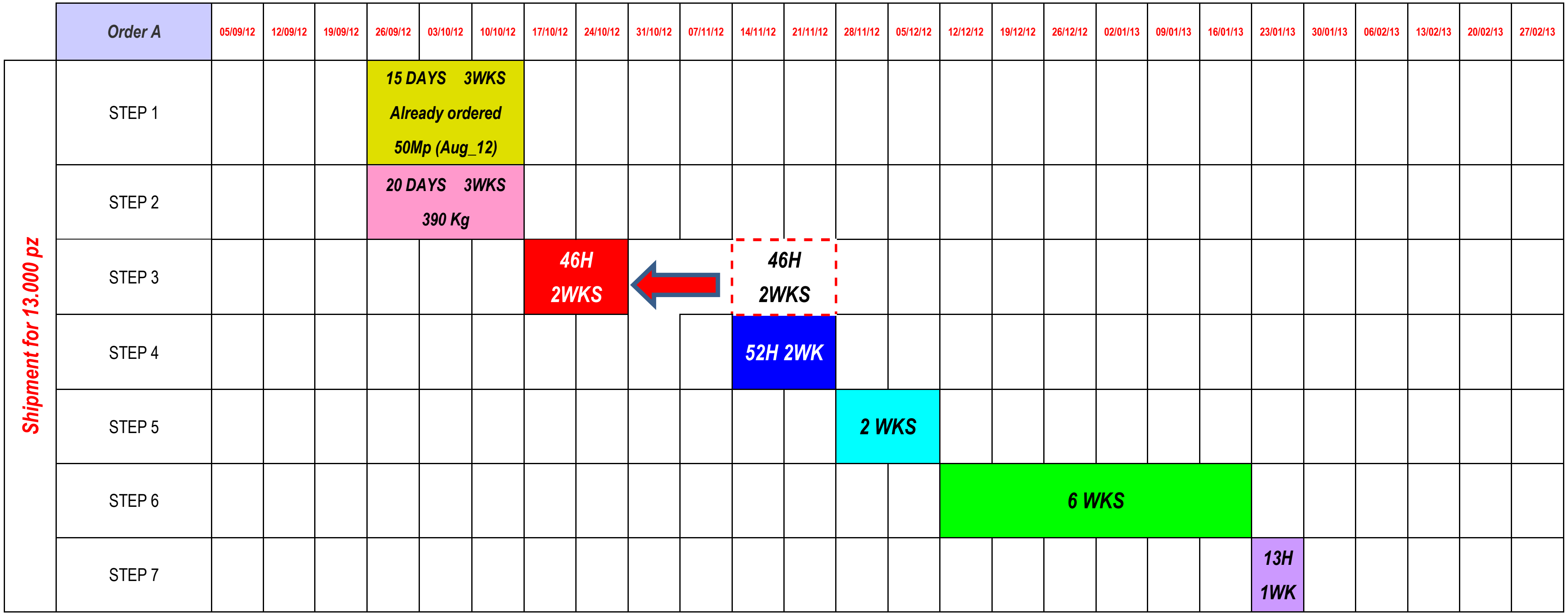


Figure 4.14 2nd delivery scheduling of Order A

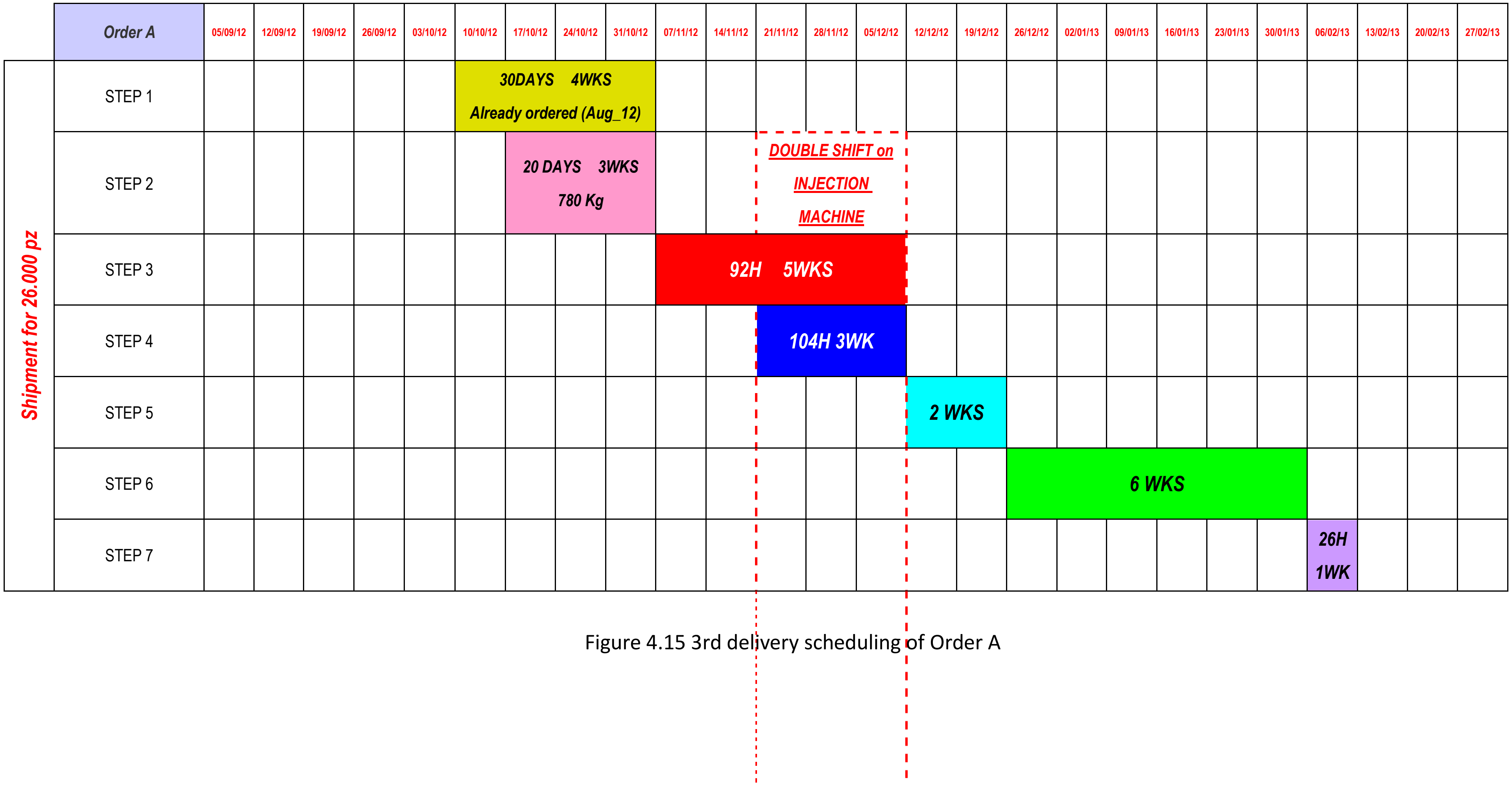


Figure 4.15 3rd delivery scheduling of Order A

	Order A	05/09/12	12/09/12	19/09/12	26/09/12	03/10/12	10/10/12	17/10/12	24/10/12	31/10/12	07/11/12	14/11/12	21/11/12	28/11/12	05/12/12	12/12/12	19/12/12	26/12/12	02/01/13	09/01/13	16/01/13	23/01/13	30/01/13	06/02/13	13/02/13	20/02/13	27/02/13
Shipment for 26.000 pz	STEP 1								30DAYS 5WKS																		
	STEP 2									20 DAYS 3WKS 780 Kg																	
	STEP 3												92H 5WKS														
	STEP 4														104H 3WK												
	STEP 5												DOUBLE SHIFT on INJECTION MACHINE					2 WKS									
	STEP 6																			6 WKS							
	STEP 7																									26H 1WK	

Figure 4.16 4th delivery scheduling of Order A

To apply this project of production, we could compare the stock rotation of now with before.

For now, we order and arrange the production with small lot size, see Figure 4.17:

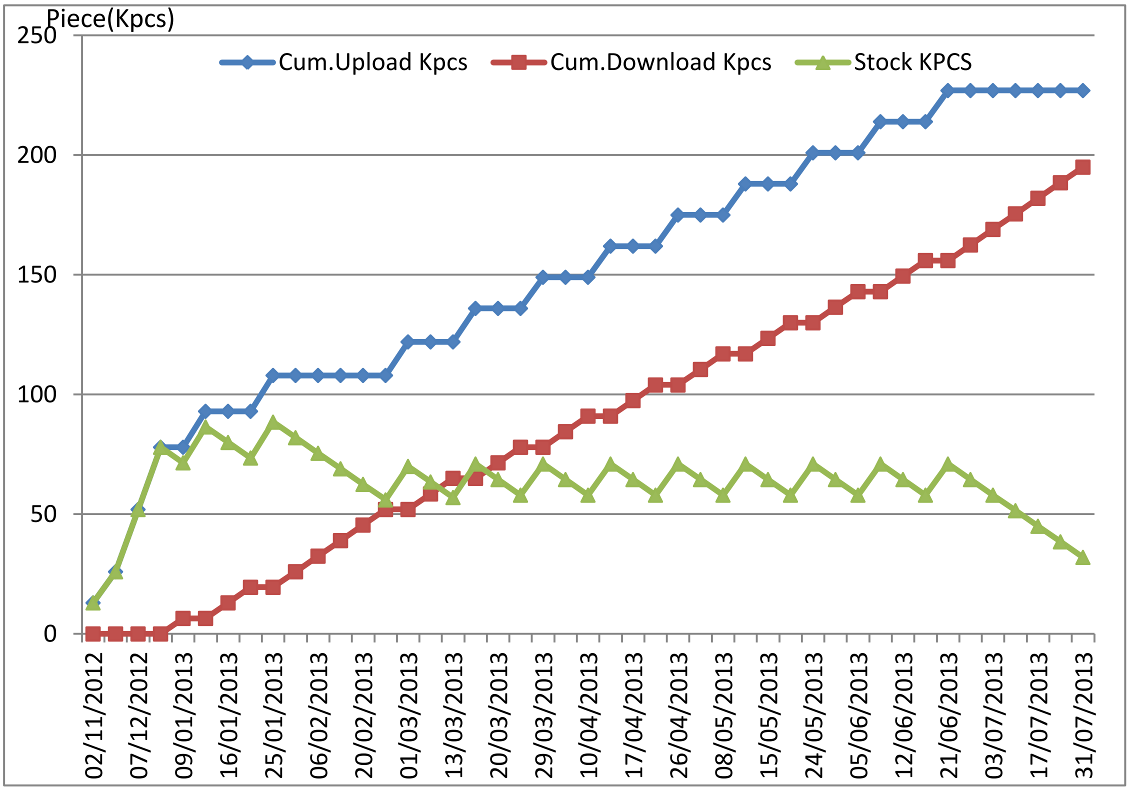


Figure 4.17 Upload, download trend and stock level of now

Date	Days	Stock KPCS	stock*days
16/11/2012	14	13	182
07/12/2012	21	26	546
04/01/2013	28	52	1456
09/01/2013	5	78	390
11/01/2013	2	71.5	143
16/01/2013	5	86.5	432.5
23/01/2013	7	80	560
25/01/2013	2	73.5	147
30/01/2013	5	88.5	442.5
06/02/2013	7	82	574
13/02/2013	7	75.5	528.5
20/02/2013	7	69	483
27/02/2013	7	62.5	437.5
01/03/2013	2	56	112
06/03/2013	5	70	350

13/03/2013	7	63.5	444.5
15/03/2013	2	57	114
20/03/2013	5	71	355
27/03/2013	7	64.5	451.5
29/03/2013	2	58	116
03/04/2013	5	71	355
10/04/2013	7	64.5	451.5
12/04/2013	2	58	116
17/04/2013	5	71	355
24/04/2013	7	64.5	451.5
26/04/2013	2	58	116
02/05/2013	6	71	426
08/05/2013	6	64.5	387
10/05/2013	2	58	116
15/05/2013	5	71	355
22/05/2013	7	64.5	451.5
24/05/2013	2	58	116
29/05/2013	5	71	355
05/06/2013	7	64.5	451.5
07/06/2013	2	58	116
12/06/2013	5	71	355
19/06/2013	7	64.5	451.5
21/06/2013	2	58	116
26/06/2013	5	71	355
03/07/2013	7	64.5	451.5
10/07/2013	7	58	406
17/07/2013	7	51.5	360.5
24/07/2013	7	45	315
31/07/2013	7	38.5	269.5
01/08/2013	1	32	32
∑ Total (number of days)	**272**	∑ Total stock*days	**15996**

Table 4.9 Time and quantity of the pieces in stock of now

After calculation with the data of now:

$$\text{Average stock} = \frac{\text{Total stock} \times \text{days}}{\text{Total days}} = 58.809 \text{ kpcs}$$

$$\text{Index of year rotation} = \frac{\text{Average stock}}{\frac{\text{Total download}}{\text{Total days}} \times \text{Days in one year}} = 0.22$$

$$\text{Average stock days} = \text{Index of year rotation} \times \text{Days in one year} = 82 \text{ days}$$

We get the yearly rotation of now:

$$\text{Yearly rotation} = \frac{\text{Days in one year}}{\text{Average stock days}} = 4.4$$

However if we order and arrange the production once for all like before (Figure 4.18):

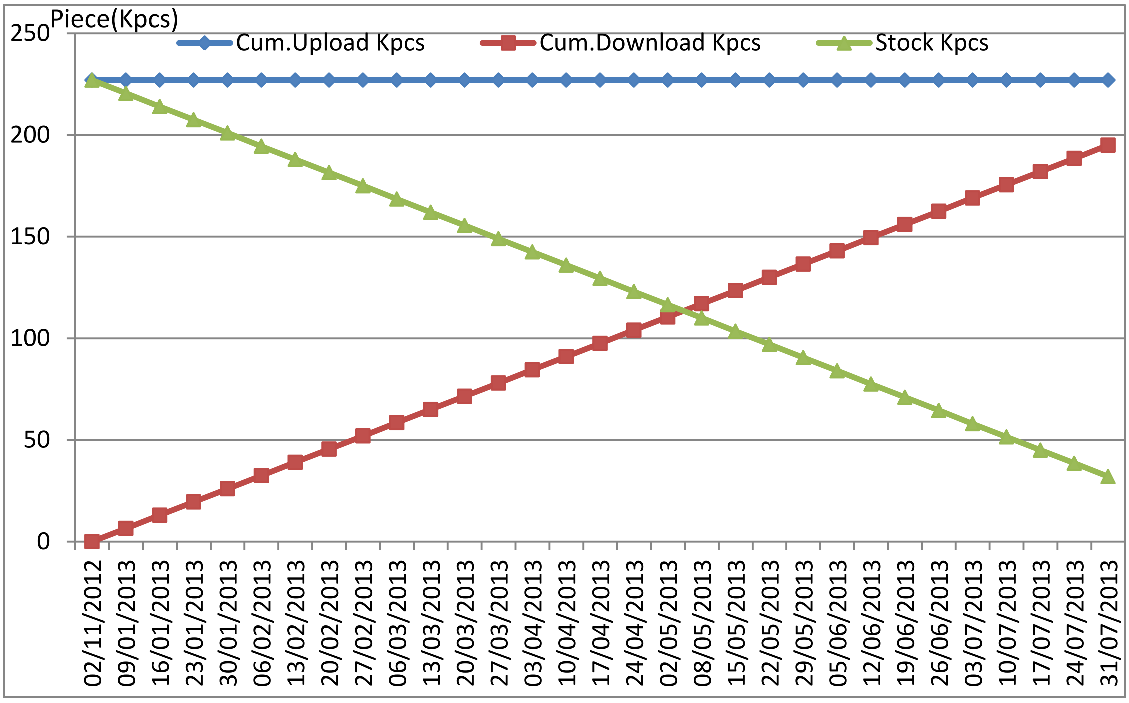


Figure 4.18 Upload, download trend and stock level of before

Date	Days	Stock KPCS	stock*days
09/01/2013	68	227	15436
16/01/2013	7	220.5	1543.5
23/01/2013	7	214	1498
30/01/2013	7	207.5	1452.5
06/02/2013	7	201	1407
13/02/2013	7	194.5	1361.5
20/02/2013	7	188	1316
27/02/2013	7	181.5	1270.5
06/03/2013	7	175	1225
13/03/2013	7	168.5	1179.5
20/03/2013	7	162	1134
27/03/2013	7	155.5	1088.5
03/04/2013	7	149	1043
10/04/2013	7	142.5	997.5
17/04/2013	7	136	952
24/04/2013	7	129.5	906.5
02/05/2013	8	123	984
08/05/2013	6	116.5	699
15/05/2013	7	110	770
22/05/2013	7	103.5	724.5
29/05/2013	7	97	679

05/06/2013	7	90.5	633.5
12/06/2013	7	84	588
19/06/2013	7	77.5	542.5
26/06/2013	7	71	497
03/07/2013	7	64.5	451.5
10/07/2013	7	58	406
17/07/2013	7	51.5	360.5
24/07/2013	7	45	315
31/07/2013	7	38.5	269.5
01/08/2013	1	32	32
∑ Total (number of days)	**272**	∑ Total stock*days	**41763**

Table 4.9 Time and quantity of the pieces in stock of before

After calculation with the data of before:

$$\text{Average stock} = \frac{\text{Total stock} \times \text{days}}{\text{Total days}} = 153.540 \text{ kpcs}$$

$$\text{Index of year rotation} = \frac{\text{Average stock}}{\frac{\text{Total download}}{\text{Total days}} \times \text{Days in one year}} = 0.59$$

$$\text{Average stock days} = \text{Index of year rotation } \times \text{Days in one year} = 215.35 \text{ days}$$

We get the yearly rotation of before:

$$\text{Yearly rotation} = \frac{\text{Days in one year}}{\text{Average stock days}} = 1.69$$

Applying for this kind production planning, the rotation of the stock is 2.6 times better than the traditional "once for all".

Here there is still another thing needed to be considered: the cost. Increasing the rotation rate will significantly reduce the inventory holding cost. However the enhanced frequency for purchasing could leads to a cost increasing in logistic issues (like transportation). For Omet, the raised logistic cost will be much lower than the reduction of inventory holding cost. Here is the reason: the main logistic cost of Omet is the transportation of goods from China to Italy, which however mainly depends on the weight of the goods. That means $C_{logistic} = k \times \text{weight} + C_{fixed}$, and this C_{fixed} could be ignored compared with the cost caused by weight. So $C_{logistic} \approx k \times \text{weight}$.

Then if we deliver the total weight in one time or deliver them in several times, the cost differs little. While the cost of holding the inventory will reduce a lot. That's the waste eliminating process.

However, there is another problem that the Lean group in Omet is considering. If the client doesn't offer one order in any week, the schedule responses very slowly, which means the purchasing and production wouldn't stop until there are some batches of excess-stock appear in the inventory. So step by step, from May, Omet wants to use KANBAN to control the next production instead of only following the production scheduling. KANBAN will be related to the consumption of the clients. No consume, no production, so the production system could change from push to pull. And KANBAN will transport such information among the control centre in Italy and the production base in China automatically. In this way, the producer and buyer just need to check the KANBAN boards and prepare for the next action, but not like now communication with mail, and even more with 6 hours time delay caused by the jet lag.

To use KANBAN, the most important idea should be spread among the company that changing from producing based on the forecast of the demand to producing only when consumed. Stock will be replaced by the new idea of "supermarket", figure 4.19:

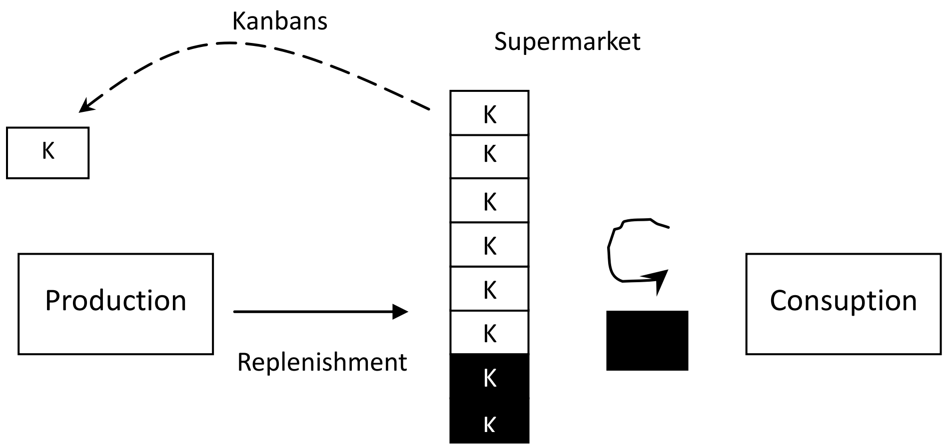


Figure 4.19 KANBAN production: no consumption, no production

And now the KANBAN board should be built by considering the supermarket size and priority of the 3 orders.

The board contains in the columns the 3 orders to produce. The board is fed by adding cards from top to down, so the new kanbans are added to the pre-existing at the bottom). Each column is divided into 3 different parts: Green zone (maximum economy in production), White zone (normal production), Red zone (urgency production).

The operator uses the board as a system for indicating the priority of production: first it produces what is in the red zone, then in the white zone, and finally in the green zone. The KANBAN board is shown as a example in figure 4.20:

KANBAN BOARD	Order A	Order B	Order C
Green	K	K	K
	K	K	K
	K	K	K
	K	K	K
	K	K	K
	K		K
White	K		K
	K		K
	K		K
	K		K
	K		K
	K		K
	K		
	K		
	K		
	K		
Red	K		

Figure 4.20 example of KANBAN board

Now the size of KANBAN board for W needed to be calculated:
N = number of kanbans cards
d = average demand (units / week)
LT = lead time for production of one part (weeks / unit)
SS = safety stock
Cs = capacity of a container (number of units per container)

$$N_{min} = \frac{d \times LT + SS}{Cs}$$

If we assume Cs = 6500, we get N_{min} for the 3orders:
For order A, Na = 19
For order B, Nb = 20
For order C, Nc = 17

The KANBAN number above is for the KANBAN board of production department. For the purchase department, the lead-time of supplier needs to be added, which means KANBAN cards will be a little more than those on the production department's board.

After deciding the total number of KANBAN on the board, we have to calculate the size of 3 zones (green, white and red) on the board:
Green zone (occurs only if there is nothing else to do) dimensioning steps:
1) Calculating the weeks of total annual production (Hf) required from upstream center (supplier) to do all the codes assigned to the department
2) Calculating the maximum number of weeks of possible set-up (Hsu = Hd-Hf, Hd is the total available weeks in one year)
3) Calculation of Hcp duration of a production campaign (campaign is defined as the set-up cycle which allows the production through all the orders (Hcp = ΣTsui, Tsui is the time needed for each set-up cycle))
4) Calculating the maximum number of campaigns that can be produced (Ncp= Hsu / Hcp)
5) Calculation of the size (minimum) in the production batch (for the order i, LMi = Hfi / Ncp * Pi) (where Pi = pieces/week for product i)
6) Calculating the corresponding number of containers (KANBAN) in the green zone (for the code i, Ncgi = LMi / Csi) where Csi is the number of item for 1 container

Red zone (the production kanban cards corresponding to this area are to be performed immediately) dimensioning steps:
1) Calculation of the maximum waiting time for the completion of a container already in production (different code) (Tmax = max(Tsuj + Tpj) (of a container of order j))
2) Calculation of the production lead time Tpi of a container of the order in the red zone (Tpi = Tprodi + Tsui (of a container))
3) Calculation of the minimum possible lead time (the sum of the previous times + overdue unexpected, eg. fault) (LTmin = Tmax + Tpi + Tfault)
4) Calculate the consumption of units of the center downstream in the minimum lead time: (Ci = Di * LTmin, Di is the consumption rate of order i)
5) Calculating the corresponding number of containers in the red zone (Ncri = Ci / Csi)

White area (area of normal operation of the production) dimensioning steps:
1) Calculation of LMi minimum production lots of each order (resulting from requests of the centers downstream) (LMi = Ncvi * Csi)
2) Calculation of LTi production lead time of a batch of each order (LTi = LMi / rhythm prod. i)
3) Calculating the maximum expected wait Tmax for completing the production of a batch in progress (Tmax = LTimax +Tsui)
4) Calculation of the maximum lead time of production of the code under LTmaxi (sum of the previous time + time to produce a lot of code in question + increase expected for spare waits)
5) Consumption of the code in that time (Ci = Di * LTmaxi)
6) Calculating the corresponding number of containers in the area white + red (Nc (w + r) i = Ci / Csi)
7) Calculating by difference the number of containers (kanban) of the white zone (Ncw i = Nc (w + r) i -Ncri)

	Green	White	Red
Order A	2	1	16
Order B	2	2	16
Order C	1	1	15

Table 4.10 KANBAN zone division for production department

The cards in red zone is much more than the card in other zones is because that the lead-time of transportation and lead-time of non-production are too long compared with the production consuming time. Only if all the processes kept in the rhythm of control, the production will be normal.

However at the beginning to start the entire project, a quick feedback must be guaranteed. Planning will never be perfect at the first time. With the theory of PDCA, a quick response to the problem occurred during the practice is needed. So there will be two managers in duty of valuing the whole process from period to period. Quicker the reaction, less the loss.

5 Future Prospects

5.1 HMLV(HIGH MIX LOW VOLUME)

Omet is evolving towards high-mix manufacturing because customers are demanding more solutions that fit their needs. The company, which is slow to increase the breadth and depth of the offerings cost-effectively, will cease to live on the nowadays market.

The thinking way of the company must move towards "time based, and one-piece flow thinking", which brings people, processes, and technology together rapidly and effectively to compete and win against the best.

While non-repetitive, job-shop and make-to-order are the norm, many parts of Omet's knowledge still focus on the repetitive manufacturing model. For repetitive manufacturing, cost and quality are most important to be measured. But now, delivery and responsiveness, which means processing time, capacity constraints, sequencing decision, lot sizing, are getting increased attention.

Now High-Mix-Low-Volume (HMLV) manufacturing systems are more and more popular in worldwide. HMLV increases the manufacturing systems flexibility, which we have discuss before has the ability to fit the specific customer demands and also improve the capabilities for emergency issues. Although HMLV system has many advantages, the system itself has some obstacles, like repeated machines setup requirements, low capacity of utilization, low productivity and so on. The analyzing and optimization of HMLV system is very important.

For the original production schedule, Omet produces like this way:
There are A, B, C three types of products in demand. A needs 5000 and 3000 for B, 2000 for C, in one month. First thinking way is to finish them one by one and deliver all in the end of the month, like Table 5.1

	A	B	C
1st week	5000		
2nd week		3000	
3rd week			2000

Table 5.1 Original Production Style

This method saves the set-up time and cost. For each product, only one set-up needs to be done. But the operation of the business becomes very inconvenient. For example if any of the product has been postponed, the whole batch needs to wait in the inventory and it is impossible to give customer some parts of the products if they ask to deliver some quantity in advance.

So Omet begins to think about some kind of level scheduling, like Table 5.2,

	A	B	C
1st week	2000	1000	800
2nd week	2000	1000	800
3rd week	1000	1000	400

Table 5.2 Level Scheduling Production Style

This balances the workload for each production and increase the agility for the business. But this is surely not enough. We have to continue to decrease the quantity in on batch and lead-time of delivery, like Table 5.3,

	A	B	C
1st day	250	150	100
2nd day	250	150	100
3rd day	250	150	100
...	...	...	...
19th day	250	150	100
20th day	250	150	100

Table 5.3 HMLV Production Style

The cost of this production style now is too high. But as the technology of quick changing of the injection mold improves and more numerical turning machines with different programs for different type of operations, we could move towards the HMLV system to suit the lean requirement with sufficiently low-cost and if we could deliver the products every day, the inventory for the products will vanish. In the very situation, for example if the customer postpones the demand of today, we could stop the production immediately and change to other products. Then over-production and excess stock could be prevented.

When we achieve the HMLV production system, we could also satisfy the demand for some scattered customers and expand to field of market. This also will benefit when in the future we have more styles of products to produce, because HMLV system could handle the wideness of production well, while the original system could only deal with large batch and repetitive production.

5.2 Zero Defect

To talk about zero-defect, there is one thing we must recognize it very clearly, zero-defect does not mean to check all the final products we have produced one by one and then rework or eliminate all those defective parts. The idea of zero-defect is first raised by Philip B.Crosby in the book of "Absolutes of Quality Management". There are 4 principles in the theory:

(1) Quality is conformance to requirements
(2) Defect prevention is preferable to quality inspection and correction
(3) Zero-defect is the quality standard
(4) Quality is measured in monetary terms - the Price of Nonconformance (PONC)

That means zero-defect could be considered as to eliminate and prevent the defects of the products or services to meet the maximum satisfaction of the customer and to create max value of quality according to the customer's requirement. The defect could be defined as the difference with customer's expectations. So zero-defect means fully conforming to the demand of the customer.

Zero-defect management concerns more about the process continuously to eliminate the defects and prevention of the defects. The final quality level should be considered as the result of the management but not the controlling part.

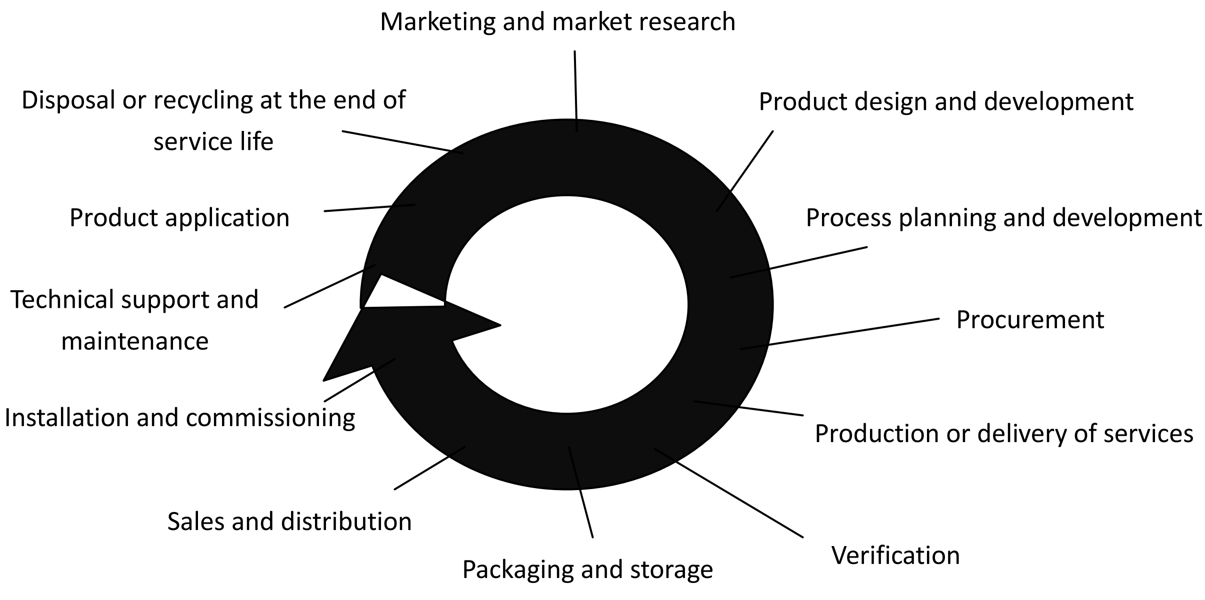


Figure 5.1 Perfect processes to achieve zero-defect

In figure 5.1 we could see that, if we want zero-defect within the total life of product, controls on all the processes are needed.

Omet now is implementing the quality control system like ISO9001 and so on. The control moves from the end of the procedure to the prevention at the beginning by controlling the design and each of the process. The prevention means two aspects. One is that every employee must have a zero-defect mind and control his/herself behavior to achieve the maximum quality level. The other aspect is that when one defect occurs, the employees need to solve the root based problem of this defect to prevent the defects occurring any more. That is to say, zero-defect asks the company to "do the things right at the first time and every time".

"Quality is free". This means it shouldn't cost from the returned purchase, from the rework and repair, from the inspection and testing, from the change of the design. For quality control management, we need to root the awareness into the mind every operator and manger.

In practical, from the beginning of the production, the technicians who design the drawings should be very clear with the requirement of the customer, and according to the requirement, some tolerance and parts could be chosen after the discussion with the customer and the operator who really work on this. To keep no defects and no disconformities with the design, then every process below could go correctly.

For the working procedure, the operator should standardize his/her operations, eliminating the misuse of the tools or the machines. And for machines, every failure needs to be recorded for the scientific analysis. If the products have some defects in one process, the whole line of the production needs to be stopped at once, the worker needs to report the defect or try to fix the problem from the very cause in order to let it happen no more. Some error-proof methods should be introduced. Use the cases in Omet as example, every important diameter needs be check whether it could go through or not-through the pass regulations. Every plastic molding surface could be checked by sensor whether or not there are bubbles. The radian of the shape of the bearing could be checked by the projector. For plastic molding and turning, the parameter and shape of the molds have to be designed technically and the tools and coolant of the turning machine need to be chosen carefully. And some other important requirement asked by the design or the customer could be checked as early as possible. If some defects are found, the production has to wait until the defect forming process has been fixed. The main idea is to prevent the defect passing to the next step or even leading to over-production of the wastes.

Zero-defect awareness should be improved from the manger to the operator. Everyone should have the responsibility in the quality management. Documents about the defects need to be built for the new worker to learn the company's production idea quickly. To make sure "zero-defect" of the machine, we need to keep the data of the machine and track on the running situation of the machine. Operators need to think more about their work and give suggestions to improve the work of the machine, because they are the most familiar people who are directly working on it and some of their opinions may be very practically effective. As new products get more and more, the quantity of new parts and molds will also increase. For the logistics management, we need to make it possible to track on each part of the product and each tool, each mold. The standardized working guidance should be continuously improved according to the changes we take during solving the current problem. At last, to achieve "zero-defect", it is not a one-day job. Even we are getting some steps forward, while we still need to keep going on.

If all these are conducted very well, inspections after production could be eliminated. No need for sample testing any more. And the value in the production could flow from the beginning to the customer without adding waste. Zero-defect is born under such situation.

However, there is also another sound to be considered. A process can be over engineered by an organization in its efforts to create zero defects. Whilst endeavoring to create a situation of zero defects increasing time and expense may be spent in an attempt to build the perfect process that delivers the perfect finished product, which in reality may not be possible. For example, a lift customer's requirement may be a desire to buy a wheel that is 100% reliable in the elevator and never rusts or wears. However, with fatigue, in practice, if an organization doesn’t have some kind of built in obsolescence it will have a more limited life. Which means when we are on our way to zero-defect management, we should consider the effort correlated to the output value. If huge effort only improves tiny value-added processes, then we need to reconsider the improvement effort.

5.3 "Muda" detecting

For lean strategy, there is no end of improvement. In other words, there is always something better but not best. However, if we want this kind of continuous improvement, "muda" detecting program is needed.

To detect the waste, which is also called the "muda", in the production, we need to keep the records of operations in the company for analysis. For example, the table recording the delay of the courses (see Appendix D), the KANBAN order (example in former chapter), the price change of the cost and so on.

To have the delay summary, we could know in which product we have the problem. For analyzing the details of this delayed product, we need to check the record of KANBAN order, so that we could find exactly which part of the processes goes wrong. Some cost of the products changes a lot, and we need to reorganize the production strategy, like to MTO or to ATO. When we have tried to improve it with some methods, we need the records before for comparison.

Those cases, which we have done well, need to be studied carefully. We should try to spread and apply the success experience to other cases we are facing. And to understand what really causes the problem helps us prevent it happening again, which is the process eliminating the waste.

Actually in waste defecting, there is also another method very useful called ishikawa diagram (Figure 5.2), which is also called "cause and effect diagram". It's hard to have a whole imagination of the problem and even harder to know what a small piece of thing will cause effect on it. But a visible tool will help us to easily understand the complex relationship. When all the people from different departments come together, none of them could have all the pieces of a given problem or solution. But if they contribute their piece to see how it relates to those contributed by others, the impact as a communication tool generates much animated discussion and new understanding to the waste they are facing.

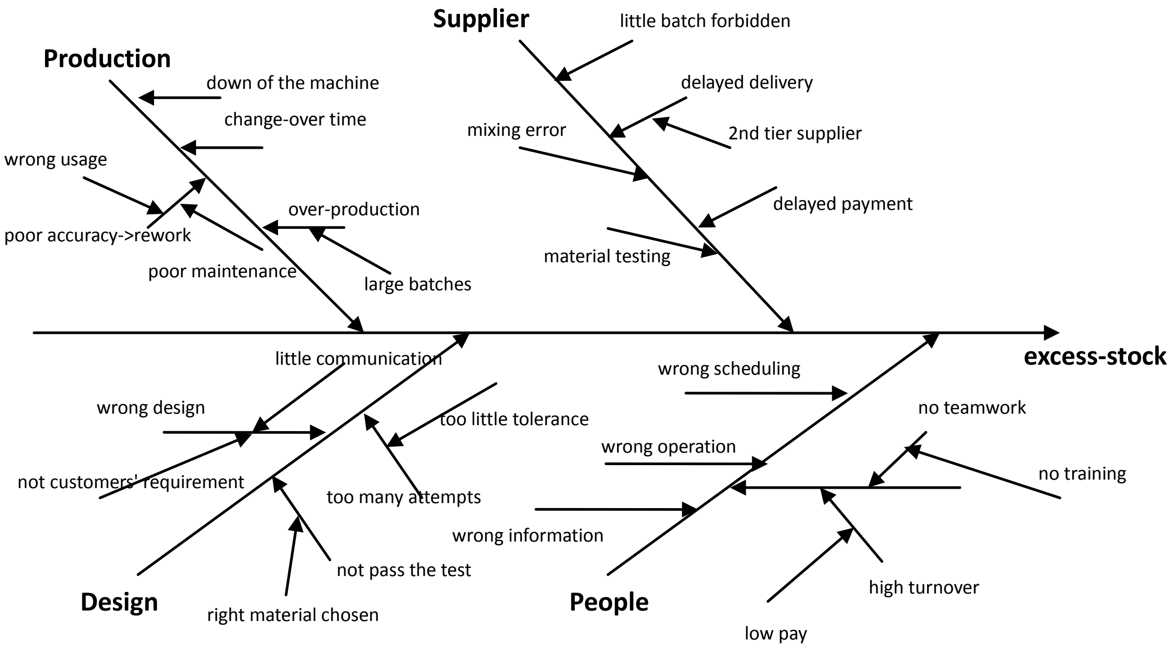


Figure 5.2 an example of ishikawa diagram for Omet's problem

After detecting one kind of waste, sometimes we couldn't eliminate it entirely. With the method PDCA, we could keep improving the performance. To plan with lean strategy and the experience from the successful cases. To do with the passion and a waste-detecting eye. To check with "zero-defect" management in the mind. To act and to improve where is not enough now.

Although most problems are caused by recurring families of causes, we still need to search every corner in the process. Everything is related to others, and every seemly small attack on the root problem may get effectively large changes, which for Omet is the reduction of inventory.

5.4 New supply chain relationship

In the former chapter, we have already discussed about the strategy in lean supply chain relationship. Now we need to plan in details for future status.

Now if Omet wants to improve the performance of a supplier, Omet keeps them into the competition with other suppliers. Quality of the components and the cost of the production are two mainly aspects Omet puts into consideration. However, now the purchasing department is going to find a new way to solve the present problems.

First, for some specialized products required by the customer, Omet sends the demands to all the suppliers we have. When Omet receives all the samples from them, they make the tests to see if the product could meet the requirement of the customer. After passing the test, Omet asks the suppliers to provide the quotation for mass production. Then with balancing the price and the quality, decisions will be done. However this leads to many problems we have talked about, like batch-size, excess stock, and dealy. Now we are searching a new path to cooperate with the supplier. We need to evaluate all the suppliers and choose one with all aspects better than others as our major 1st tier supplier. Then to build the trust between each other, to share the techniques and innovations in production, we need to invest on the major supplier to help them improve and to fit our situation more closely.

Second, after we have determined the major supplier, we need to fix some important factors in real production process. To meet the zero-defect requirement, we need to integrate the supplier early into design and development, then arrange controls on each steps. Or for standardized parts, the supplier needs to check the procedure of the production carefully in order to keep the quality level for all the products. When the supplier meets some problems, Omet should share its own knowledge to help them, like visual factory, error proofing, SMED, KAIZEN and so on.

For the production, the supplier should also detect the wastes continuously and take methods to eliminate them. For example, to order their lay-out according to the one-piece-flow and U-shape-cell, or to organize the schedule of the production. To synchronize the production between Omet and supplier, which is to say to achieve JIT, real-time information communication should be guaranteed.

For now, the biggest problem for Omet is the external zincification and carburization, which are limited to big batch and long lead-time. We need to discuss a solution to little batch every day with the supplier. A possible solution is the supplier sends those products to the zincification factory every day and the factory sends the galvanized products to Omet immediately after they finish them. Not like the situation of now, supplier produces all batches ready, then send them all for zincification then all batches back to the supplier. After checking then , all batches are sent to Omet. Too much waste is spent on the transportation.

For sure there will be some issues happening during the operation of the plans, however with deeper communications, the major supplier could try to work on the way with the help of Omet. For the beginning, Omet maybe needs some other suppliers to keep on the production. As tacit goes better between Omet and the major supplier, we could reduce the support suppliers to focus the investment on the major supplier for more tight links between each other.

With more experience in collaboration, Omet and the major supplier could understand each other better. If we change always the supplier with short-term relationship, Omet will face repetitive problems again and again with the new partner. Delay and quality problem (due to the misunderstanding) are inevitable, which leads to larger batch and more inventory. For close cooperation, we could see the value-stream flow between the two factories but not blocked by the boundaries of them. Omet and the supplier will discuss about the new products development together, so no misunderstanding exists and less samples are needed. To keep the profit of the supply and make the supply more competitive in the market, Omet shares the knowledge and cut down the cost for both sides. Because everything is visible to each other, to guarantee both benefits, everything is able to be discussed more openly and reasonably.

The story of supply chain relationship has to change now. Secrets between each other make it impossible to guarantee the quality while keeping the cost. Also communications for collaboration are blocked. With the conventional relationship, we are just like seeking treasure in a dark and black mountain while holding swords and shields. While Suppliers no longer need to hold production process as a secret to hide the real cost for bargaining for a good price, and Omet could share the same target with the suppliers. Now we could put the weapons down to pick up torches and maps. Treasure hunting is more convenient to be with a strategic alliance but not a "friend" holding secrets.

5.5 Just-In-Time

When all the details in above chapters have been conducted very well in the practical production systems of Omet, we could arrive in our final goal : Just-In-Time (JIT).

As I have written before in the chapter discussing about the tools of Lean, JIT is a tool very powerful in eliminating the inventory level but requires all the necessary factors to be prepared and cooperated well.

In real production, it's hard to provide JIT in all the sections of the operation in Omet. For example, for long term forecast and aggregate planning, JIT is not suitable. However when we reach the field of managing production scheduling and production control, JIT is the idea we should keep in mind.

So what is the philosophy of JIT? There are six objectives:
(1) zero inventory
(2) zero lead time
(3) zero failures
(4) flow process
(5) flexible manufacture
(6) waste elimination

We should try to deliver product right first time, on time, every time. In the former chapter we have discussed about the prerequisites like near to zero-defect quality, quick change-over techniques, flexible operators, a team approach, reliable suppliers, smoothed production program and so on. All these could also be treated as the objectives of JIT.

In JIT, we have to reorganize the workshop layout to form cells and to group parts or process on the basis of likeness according to the group technology. Instead of working in a straight line, we should approach to U shaped cell. With TPM, little lot size, reduced set-up time and high flexible operators (who could be assigned to different tasks), we could apply one-piece flow to JIT production.

Also to achieve just in time, we need to get few levels in BOM which makes the system more easily to be controlled. For design part, the designer have to ensure manufacturability in production cells, for example using standard parts and modular components. To create the variants of product, we could get it by assembling different components or sub-assemblies.

And to achieve JIT doesn't mean not considering about the quality problem. Poor quality may lower the market perception and lead to adding waste and disruptions to manufacturing system. In JIT idea, we should try to focus on prevention rather than rectification. Because during inspection, no value will be added but time consuming has increased. For the prevention, we have to do some housekeeping work like 5S, and apply some tools and techniques to process as well as production management. At last, responsibility for quality should be linked with the operators.

JIT for sure is not only a production schedule. It needs the anticipation of people. To perform job-rotation and cross-training may help the operators understand the whole work and improve their own job. Also working in teams and managing the autonomation machines let operators gain a great responsibility in the management. To improve the system continuously, a group of well-educated operators are necessary.

JIT system requires the supplier to behave like a strategic partner. On time delivery, minimal inspection and direct delivery to the manufacturing work floor are the important factors to be balanced. After the new relationship between supplier and Omet is set, the production could be predicted and synchronized.

At last, for the scheduling, if we could not apply Kanban to the system, we could combine MRP and Kanban together to fit different kinds of situations, like figure 5.3. MRP is used for high level central planning and control, lead time offeset, BOM and so on. For Kanban, we could use it for simple shop floor control, local ownership, continuous improvement. This combines the advantage of both sides that allows local pull control but central planning.

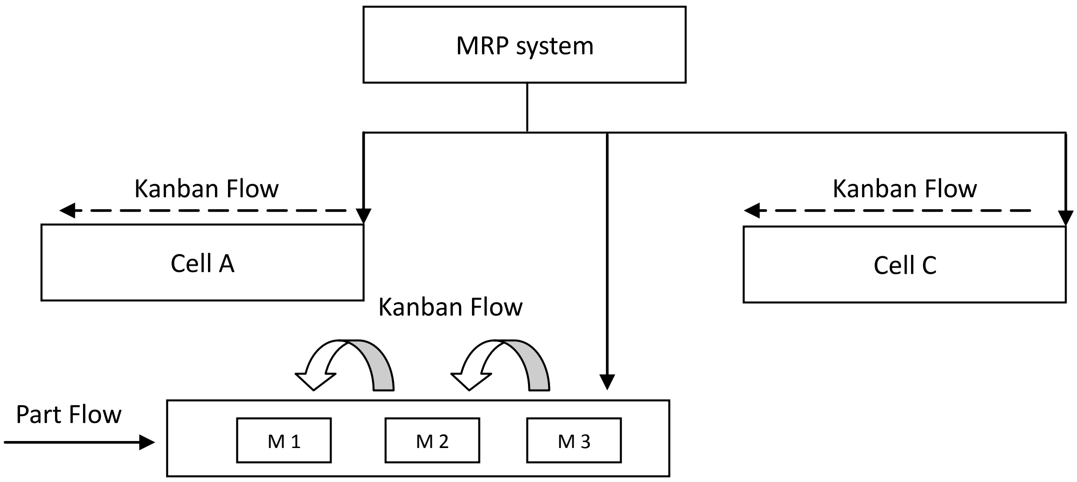


Figure 5.3 Combination of MRP and Kanban for scheduling

And for the work floor, there is also no need to use only Kanban, otherwise the transferring speed of the signal will be slowed. We could also apply MRP to support Kanban production system on work floor, Figure 5.4.

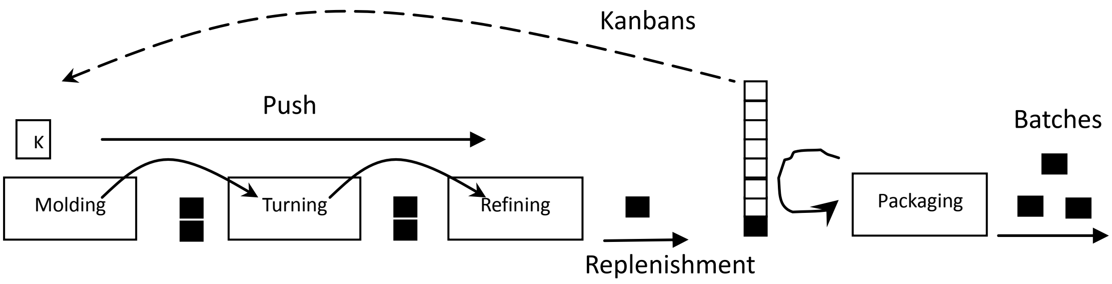


Figure 5.4 Combination of MRP and Kanban on work floor

All above are some possible solutions for the practical application of JIT system.

And we have to admit that JIT is not a system built in one day. During the application process, there will be many problems. We should apply PDCA methods to improve the JIT system continuously.

JIT provides lower WIP during the process. Lower WIP benefits in lower lead times. Lower lead times lead to less uncertainty. So the system becomes easier to control and we will need less reliance on forecast. Then less inventory level and better delivery performance will be achieved.

6 Achievements

6.1 Ascendant index of stock rotation

As the work of the "lean group" in Omet goes on, which mostly concentrates on the inventory level, situations for many areas are changing in a better direction.

Firstly the order mode and production arrangement have turned different from the traditional modus. In the past, as shown in Figure 4.7, Omet orders the raw material and produces them all in once for one customer's yearly or seasonally forecast demand. Products would wait in the inventory until comes the formal purchase order from the customer. However now Omet tends to order the raw materials and makes the arrangement only for the next shipment to customer, considering reasonable production lead-time. For the commercial department, in the past years they needed only to record the total quantity required by the customer for one year. However now in the new scheduling control forms, they are required to show the exact quantity required to be delivered on exact data claimed by the customer, which makes the logistic and production manager easier to make the arrangement for each delivery instead of once producing all the quantity for the whole year or season.

All of these efforts give a clear signal that the situation in Figure 4.8 is promoted gradually for more and more orders, which notably cut down the excess-stock in the inventory and increase the index of stock rotation shown in Figure 6.1 and Figure 6.2:

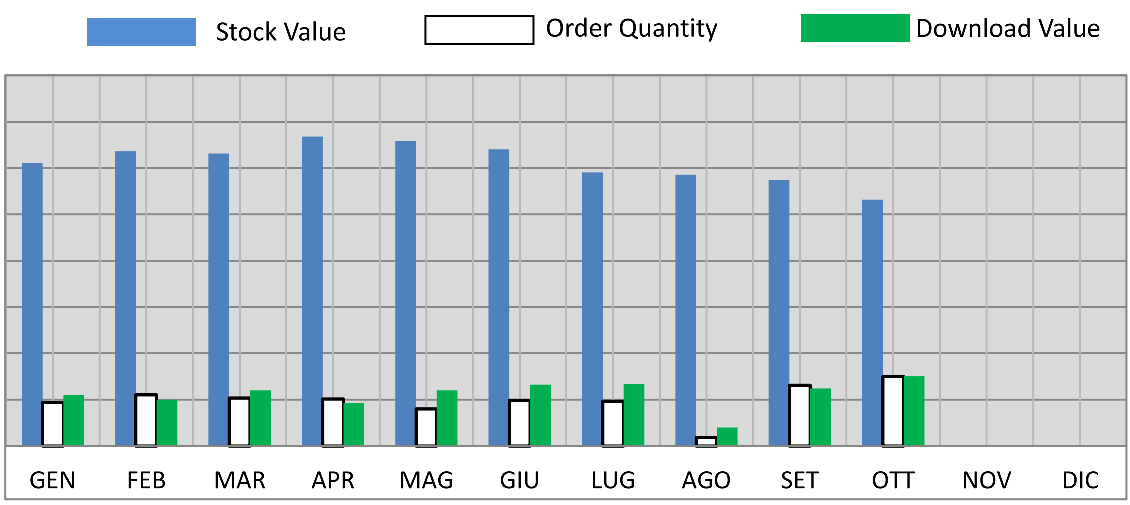


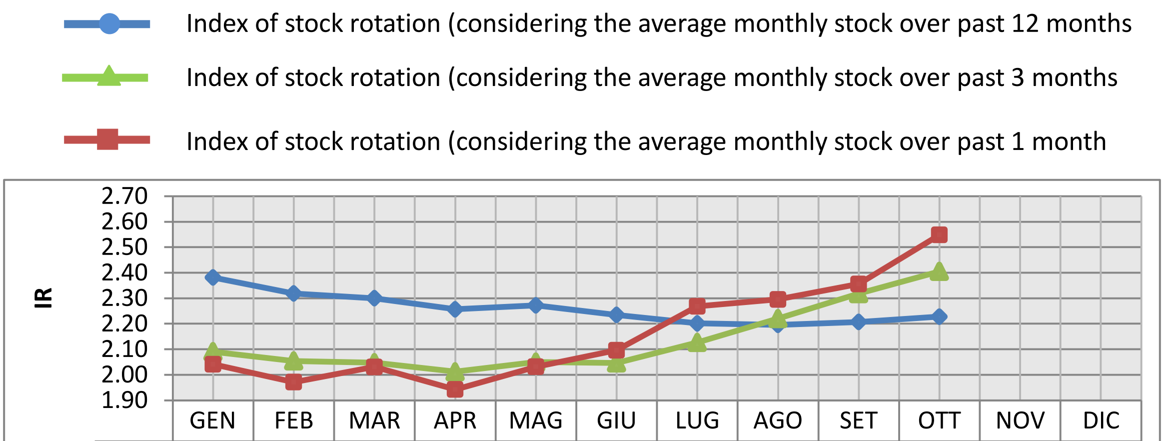
Figure 6.1 Value trend of stock/upload/download in year 2012

We could see from Figure 6.1 that the value "blocked' in the stock is decreasing in spite of increasing of new coming orders and download value. For the last seven months of this thesis period, the stock value has lessened at least *20%* from original.

The decline trend of the stock value is mainly caused by three reasons:

1. Reasonable order mode ---- order and produce only those needed for the next delivery but not for the further future. Excess-stock has been prevented as explained in Chapter 4.3.
2. Reconsider the order situation ---- As Chapter 4.5, rearrange the production according to the orders’ situation, for example postponed or cancelled, but not just follow the original production scheduling.
3. Revalue those already in stock ---- eliminate the “rubbish” from point of view according the method in Chapter 4.7.

Also some products are produced from MTS (Make-To-Stock) to ATO (Assemble-To-Order), which also could have an effect in the decline of the value blocked in stock as discussed in Chapter 4.1.



	GEN	FEB	MAR	APR	MAG	GIU	LUG	AGO	SET	OTT	NOV	DIC
past 12 months	2.38	2.32	2.30	2.26	2.27	2.23	2.20	2.20	2.21	2.23		
past 3 months	2.09	2.05	2.05	2.01	2.05	2.05	2.13	2.22	2.32	2.41		
past 1 month	2.04	1.97	2.03	1.94	2.03	2.10	2.27	2.30	2.36	2.55		

Figure 6.2 Trend of index of stock rotation in year 2012

As organized the production like Project W, the entire index of stock rotation has presented an increasing trend. The reason why the index of stock rotation which concerns the monthly average stock over past 12 months is still decreasing from January to June is that the large amount of stock in year 2011 has a significant influence and not that easy to eliminate. However we could tell from Figure 6.2 that the trend of decreasing the index of rotation is stopping and moreover from October the trend starts to lift up. It’s easier to see from the blue and red lines which indicate directly the situation of recent several months that Omet is conducting well with the new lean stock strategy. This trend of the index of stock rotation also means a capital turnover releasing from the inventory. As the lean efforts continue to work, the trend will go on, and the inventory of Omet behaves more like a BUFF instead of WAREHOUSE.

One point of view needs to be paid attention to is that from Figure 6.2 we could tell that the trend is good while situation has not leaped to a new level, which means the benefiting comes slowly. This is because the stock in the past has increased a lot and reducing and recycling the value in the inventory is not the business in one day. We couldn't just take them out and throw them away. And the relation between already existing stock and some certain purchase orders from the customer is hard to analyze in a short time. So for all the steps we take indicated in the fourth chapter, we could say that we have concentrated our force in the future business, which means we are focusing 80% of our efforts on **reducing and preventing the potential stock for new orders and new products**. As the consuming of the old stock and eliminating processes going on, it's guaranteed that the trend of stock-value-decreasing and rotation-index-increasing will keep going on. For sure later will appear a bottleneck of the trend, maybe blocked by the essential safety-stock or the long lead-time or quality control processes, but in the 3rd chapter the consideration direction and method have been posed. And Chapter 5.1 provides a way to flexible business, while Chapter 5.2 gives an idea for reducing the reliance on the QC processes.

In one word, "LEAN" provides not a solution but a way for continuous improvement.

6.2 Order delay reduced

As discussed before in the Chapter 4.4, Omet starts to use the kanban between FB and FA for communication on order situation and production arrangement. After weeks by weeks problem-finding-and-solving progress, Omet has reduced the delay of orders a lot, 2 weeks less compared with the average delay before the lean revolution. Here in Figure 6.3 and 6.4, the result is shown:

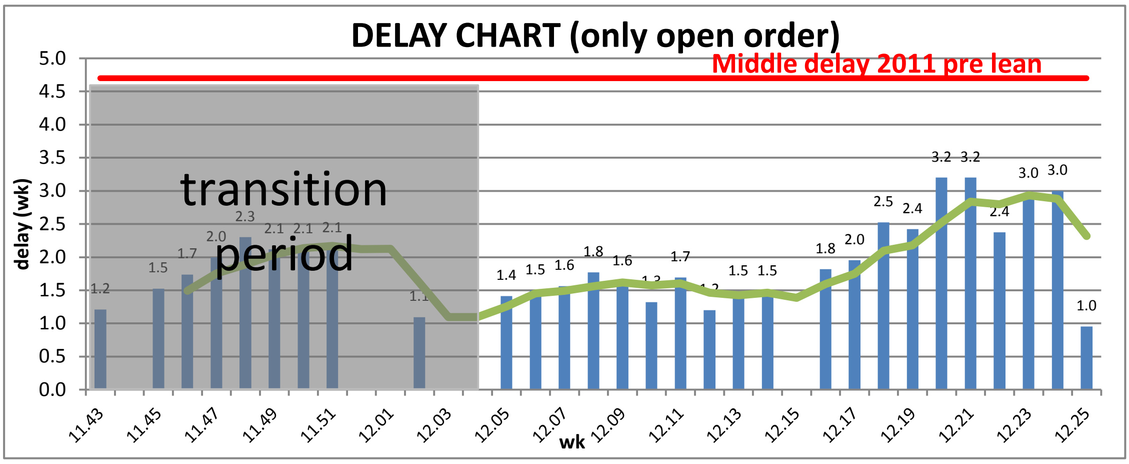


Figure 6.3 delay chart (only open order)

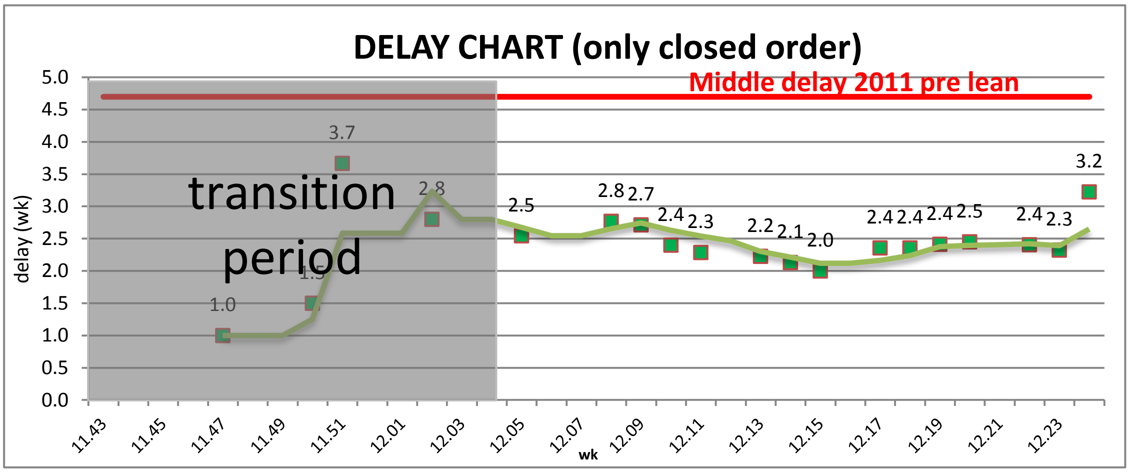


Figure 6.4 delay chart (only closed order)

Generally speaking the situation is much better compared with year 2011. However we could see from Figure 6.3 that some open cases trend to have a longer delay out of expected. This is mainly caused by the business expansion of Omet which leads to a temporary lack of work ability for some cases. In the last period of this thesis, Omet is seeking a solution, which we will discuss in the next chapter, for the workload problem. However now with the reduction of delay for every order, we could cut down the forecasted lead-time. Shorter lead-time also leads to less safety-stock which is set for the emergency cases in the long lead-time period. What's more, less delay also increases the competitive strength of Omet, which however is an extra benefit Omet could get from the lean revolution indicating for lower inventory level.

6.3 From push to pull

When this paper is coming to an end, Omet is conducting one new business and seeking for new ideas to handle this business, of course in a lean way.

By expanding the business, the lean group of Omet starts to classify the common components of different products for different customers and manage them from a total point of view.

In the past, Omet orders the raw material according to the quantity required by the purchase order for the final product, individually for every product. But now Omet starts to build a "supermarket" by making agreement with supplier for every raw material like bearings or pins. This "supermarket" is confirmed by a stock agreement (be clear that this is not the same with the former safety stock agreement) between the supplier and Omet defining that the supplier will keep a certain quantity of raw material for Omet. When Omet puts a purchase order, they draw the goods from the agreed stock, called "supermarket" here. And when the quantity in the "supermarket" reaches a level, which would be defined according to the production rate of the supplier, supplier is required to refill it to an agreed level.

This gives a significant change to the operation: from "**pushing the supplier every time providing the quantity of raw material according to the purchase orders**" to "**pulling the raw material from 'supermarket' built by agreement and filling the 'supermarket' to a reasonable level**". With this revolution conducting well, Omet could obtain the preconditions to build kanban system with the suppliers: consuming is the only signal for production and without consuming, no excess production will be conducted. Products are always there ready for delivering with no delay and no excess production even with postponed orders or with changed production scheduling. And also with the cooperation and new supplier relationship, quality problems will also get less and quality check could step by step be eliminated from the history.

All of these have given Omet a bright future prospect and also a lean's goal. We could say there is still a long way to practice for Omet, for example the reasonable level of the "supermarket" for each of the items and so on. However with a right direction and a useful improving method, it's not hard to tell what will happen next to Omet's inventory and to Omet itself.

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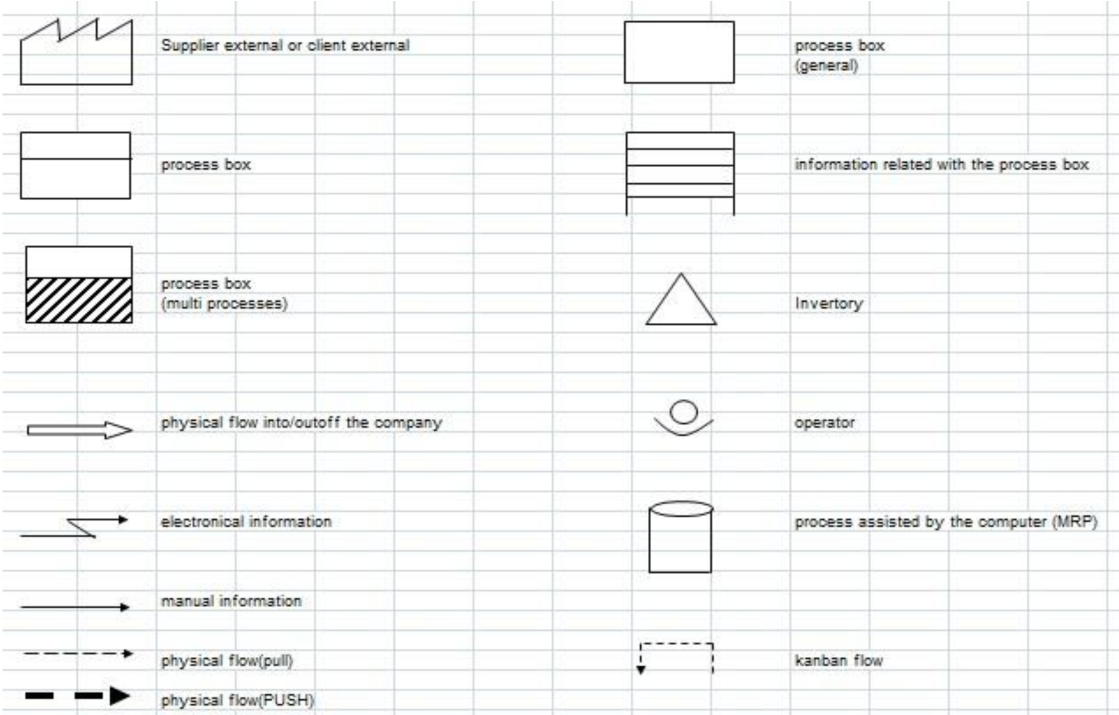
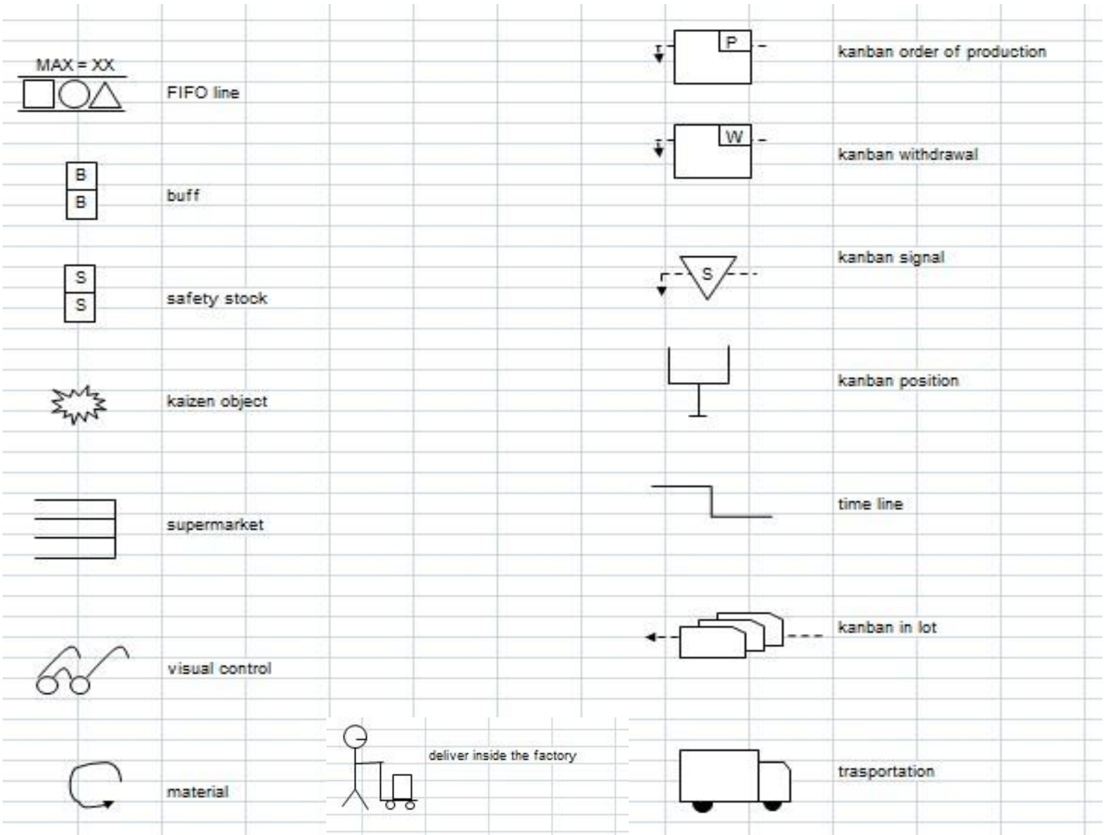
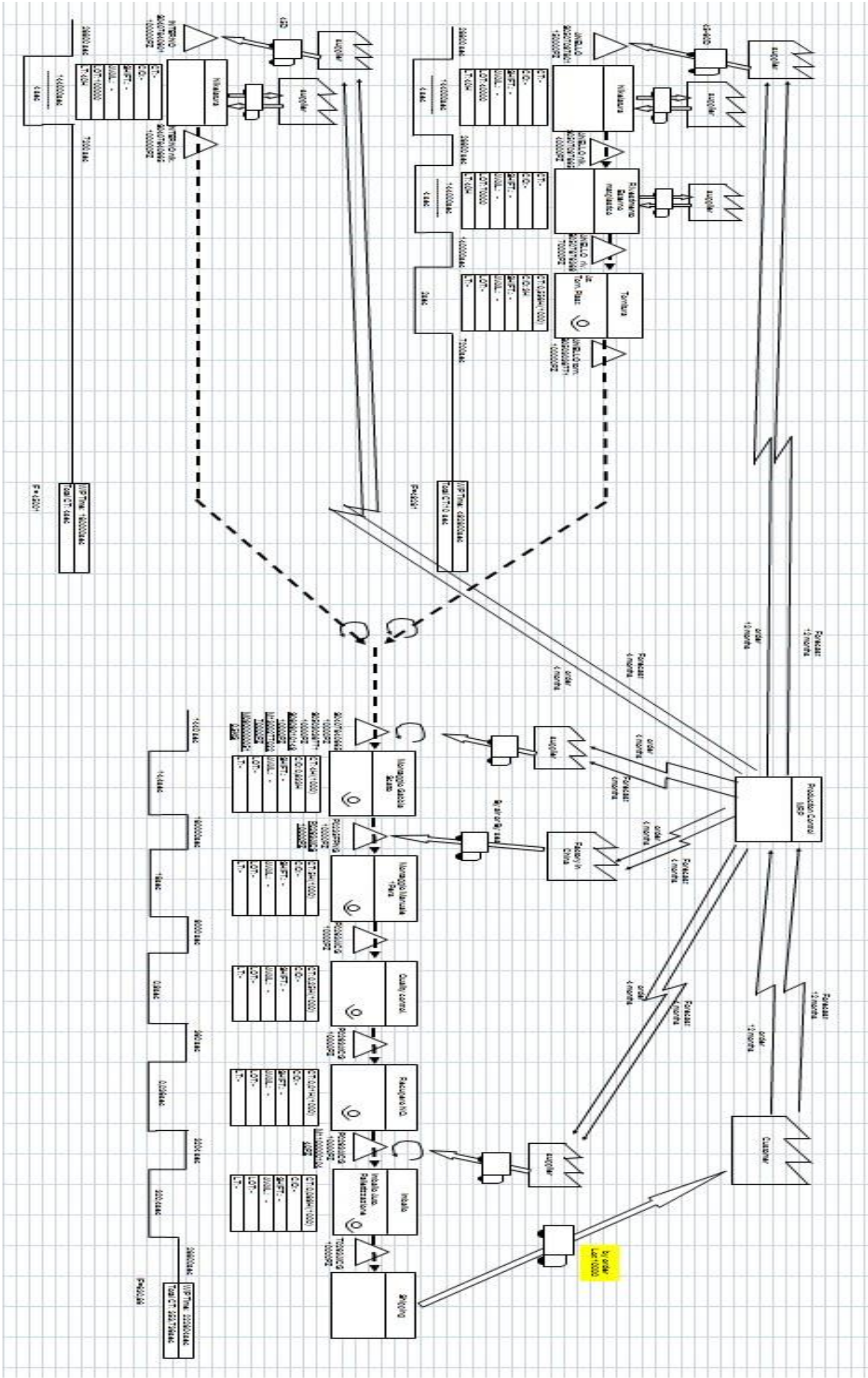
APPENDIX

Appendix A:

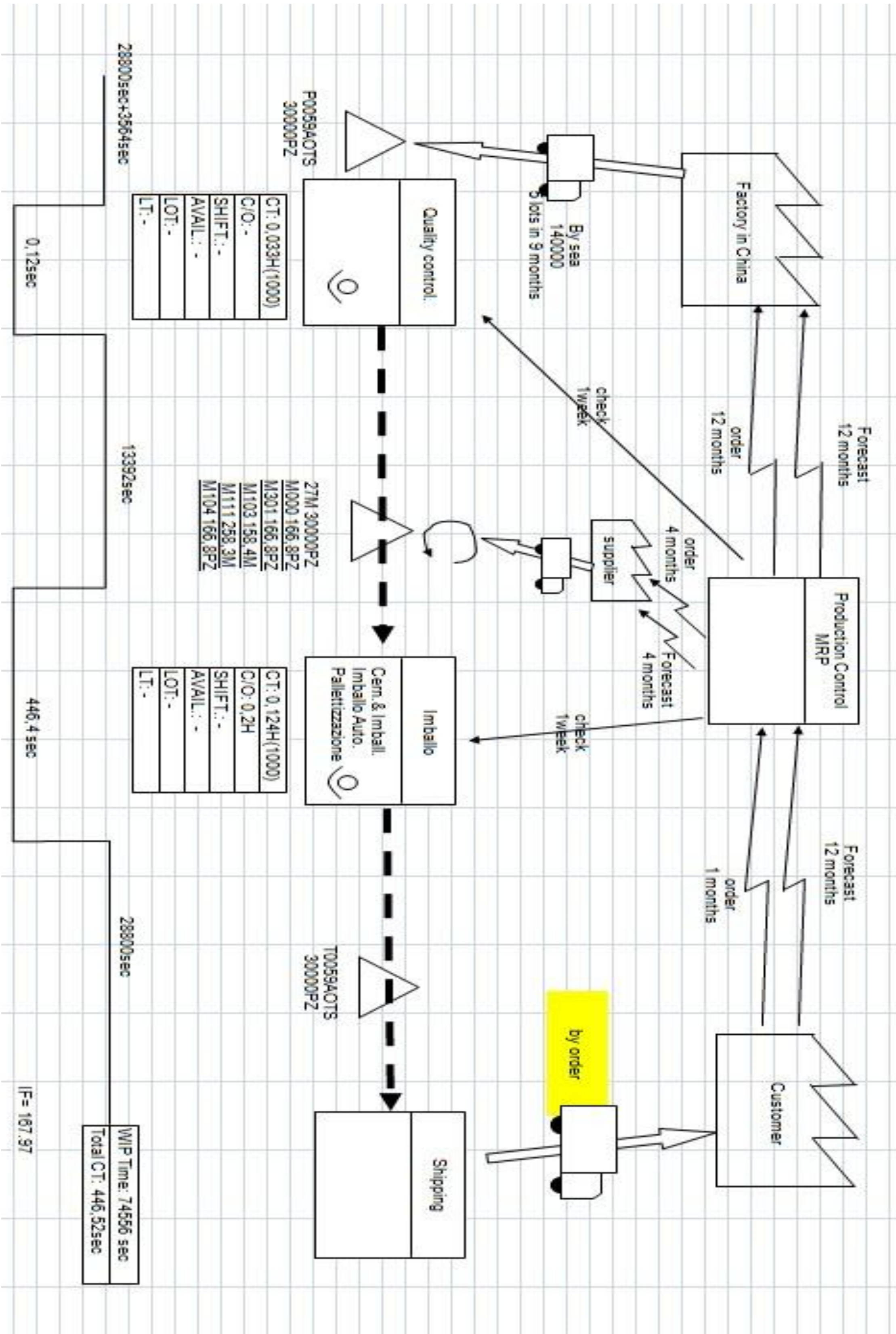




Appendix B:



Appendix C:


Factory in China
By sea
14000
5 lots in 9 months
P0059AOTS
30000PZ
Quality control
CT: 0,033H(1000)
C/O:-
SHIFT:-
AVAIL.: -
LOT:-
LT:-
check
1week
order
12 months
Forecast
12 months
Production Control
MRP
supplier
order
4 months
Forecast
4 months
27M 30000PZ
M000 166,8PZ
M301 166,8PZ
M103 158,4M
M111 258,3M
M104 166,8PZ
Imballo
Cem.& Imball.
Imballo Auto.
Pallettizzazione
CT: 0,124H(1000)
C/O: 0,2H
SHIFT:-
AVAIL.: -
LOT:-
LT:-
check
1week
Forecast
12 months
order
1 months
Customer
by order
T0059AOTS
30000PZ
Shipping
28800sec+3564sec
0,12sec
13392sec
446,4 sec
28800sec
WIP Time: 74556 sec
Total CT: 446,52sec
IF= 167,97

Appendix D:

Cimat Sistems | DELAY REPORT | Lean Project

Nr	Code	Customer	Ship from Shanghai (year, wk)	Total delay (wk)
1	P.0254.ABIS	HEB	12.02	1
2	P.0256.EVDG	V-Z	11.47	2
3	P.0256.EOIG	KLE	12.20	5
4	P.0256.EUGG	K-K	12.09	2
5	P.0261.ABIG	TOPP	12.19	4
6	P.0256.EEIG	MET	11.51	8
7	P.0256.ELGG	MEI	11.51	8
8	P.0256.EIIG	MEI (pin)	12.24	26
9	P.0256.DRIG	SEM	12.08	3
10	S1207519501	SEM	11.50	4
11	P.0196.AGGG	SEM	11.47	0
12	P.0199.BPIO	DED	12.02	3
13	P.0248.ATGG	Magaz.	12.17	11
14	S4402024180	BC-28	11.50	0
15	P.0209.BEIG	BRI	12.10	0
16	P.0256.CCIG	SCH	12.05	0
17	P.0256.EIIG	SEM	12.10	6
18	P.0249.AAGG	Magaz.	12.11	0
19	P.0249.ADGG	Magaz.	12.08	5
20	P.0254.AUIS	ISG	12.14	0
21	P.0256.FDGG	POR	12.02	0
22	P.0212.AHTG	MINU	12.10	2
23	P.0005.BEBG	VAL	12.02	2
24	P.0256.FAGG	K-K	12.10	0
25	P.0256.FCGG	K-K	12.24	9
26	P.0256.FEGG	K-K	12.17	3
27	P.0256.FBGG	K-K	12.24	9
28	P.0249.ASGG	MET	12.10	2
29	P.0256.FGBG	ALG	12.15	3
30	P.0256.FFIG	ALG	12.15	0
31	P.0256.DVGG	K-K	12.20	1
32	P.0005.BEBG	AC	12.15	0
33	T.0256.FO	AXX	12.22	1
34	T.0256.FN	AXX	12.24	1
35	T.0256.FP	AXX	12.24	1
36	P.0256.FTGG	X-F		
37	P.0262.ATCS	B2B		
38	P.0264.AAGG	MRE	12.13	1
39	P.0211.ANIG	BRI	12.20	
40	P.0256.BVGG	NOV	12.10	0
41	P.0254.AICS	LSA		
42	P.0254.ALCS	LSA		
43	P.0265.AACS	LSA		
44	P.0265.ADCS	B2B		
45	P.0254.BECS	B2B		
46	P.0254.BFCS	B2B		
47	P.0256.FDGG	POR		
48	P.0256.BSIG			
49	P.0256.BGIG			
50	P.0256.DRIG	SEM		
51	P.0261.ABIG	TOPP		
52	P.0209.BFIG			
53	P.0256.SRIG		12.23	1
54	P.0256.BFIG	MET	12.23	1
55	P.0256.FEGG		12.24	4

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