PRODUCTION LOGISTICS AND CONTROL

Case Study in Kerneos, a French building materials company

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**Abstract**

In a production cycling, the time spent on logistics activities is much longer than the actual time spent in the process. Therefore, the potential space of improving production logistics is very large in many aspects, such as the ability of researching production logistics, the time saving, and the labor saving in the company. By studying the function of the company's production logistics, we can deeply improve our understanding of it, and make the production logistics work efficiently during the whole process of the production cycling. As we know, there are two main modes of production, pull and push production. Choosing a right or better one is the most important in production logistics. The purpose of thesis is to make production logistics work efficiently by analyzing the current production mode in Kerneos (small subsidiaries in Guiyang City in China) as an example. Firstly, we want to make known what is production logistics and production mode, providing readers with production logistics functions and principles of choosing production mode. Then, we will analyze the current production mode of our case company. Finally, basing on our knowledge, we would like to share our opinions or ideas on how to choose a proper way to make our production logistics better in this article. The literature of thesis is focus on pull and push production, and how to choose an effective production type that suit for the enterprise situation. According to the research completed, we suggest using “push” in the enterprise which has large quantities, less variety, and the production cycle is plenty. In the small quantity, variety, and short-cycle, we suggest using “pull”. Otherwise, there come out a new production type named CONWIP(Constant work-in-process), through compared the different advantages and disadvantages between pull and push, our case company Kerneos is suggested to use this new production

**Key words**: Kerneos, Pull Systems, Push Systems, Production, Efficiency, Effectiveness
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1. Background

1.1 production logistics

In logistics activity of every enterprise, production logistics is an important process. In the whole logistics activity, the logistics range of production system is from raw materials and outsourcing to final finished-goods storage, through production and working. It runs through overall process of production, across the whole enterprise (These include plant, transmission, stock and so on). Once material is into production, logistics has been formed, and changes physical form itself by time course all the time (through working, assemble, store, transport and waiting), it also change its place (every factory, working place and storage). Production logistics is aimed to all the materials which needs in production are in time and space movement process, it is a dynamic performance of production system. So, materials (includes raw materials, ancillary materials, spare and accessory parts, in-process materials and finished goods) is through all the production periods or processes, this whole movement is called production logistics.

Analyzing from the point of the production, production logistics reverse to all the logistics activities during the process of production in any enterprise. That is materials are continuously moved to another process, constantly moved up and down, or forward moved, paused and so on. All the logistics activities are working with whole production process, and it is actually part of production. So, production logistics is the combination of production activity and logistics activity in enterprise. These two are inseparable.

Production logistics is an important part of whole supply management. It is a major consideration based on optimizing resources ability for producers to produce the best production with the lowest cost at the fastest speed to satisfy customers’ demand quickly, such as production varies quality, quantity and date, which can build up the competency, increase efficiency, and decrease the decrement service.

Production logistics optimization and design lie in three main aspects:

✓ The affection the production process to the logistics line.
✓ The demands the production ability to the logistics facilities.
The affection the cycle time to the amount of logistics.

The whole production logistics process should match five conditions below:

- Continuity----Materials are transferred by elevators within the shortest time and the lowest cost until finishing the whole production process.
- Parallelism: During production process, the productivity in every work stage should keep pace with each other. It is necessary to adjust every stage to keep pace with each other.
- Rhythmicity: Every work stage should work rhythmically to keep the working press stably and matched the productivity, not too high or too low.
- Proportionality: Take into Consideration of the loading and unloading quality conformity rate in every work stage.
- Adaptability: The production system should expand with multiline variety and small-batch production. It requires better production system and logistic system’s strain capacity.

1.2 Pull production and Push production

In a push system, a job is started on a start date that is computed by subtracting an established lead time from the date the material is required, either for shipping or for assembly. A pull system is characterized by the practice of downstream work enters pulling stock from previous operations, as needed. (Mark L. Spearman, Michael A. Zazanis, 1992) Pull mode and push mode are used in production process based on the different reality of the organization. It is better for companies with less variety, large scale and long production period to use push mode; and it is better to use pull mode for the companies with small scale, more variety and short production period.

1.2.1 Pull production:

Pull Production is an important support which achieved "Just in Time"(One of two backbones in Toyota's production mode). This production is learned from the sell mode of American supermarket by Japanese named Taiichi Ohno. Opposite to push production, the first production step must follow the demand of the second step. In 1992, Mark L.
Spearman, Michael A. Zazanis had presented, most of the literature dealing with Kanban and other pull systems is descriptive in that few mathematical models have been developed and the number of cards (Kanban) in the system creates an upper limit on work-in-process (WIP).

1.2.2 Push production

Push Production is an opposite production type to Pull Production. Generally, the traditional production type is Push Production, which can cause production accumulate. Push Production is one type of production which follows the logic of MRP; every department is also working by the MRP of company. The first step need not care about the second step, after working; the production will be moved to the next step as the plan of first step.

1.3 Kerneos – Case Company

Kerneos is a French building materials company, which is found in 1908. Kerneos has around twenty subsidiaries worldwide and its products are sold in more than one hundred countries. Reference suppliers, who develop, produce and sell oregano-mineral products based on calcium aluminates for a wide variety of uses. The diversity of their expertise is crucial in realizing their ambitions. Our object of study is the first branch office of Kerneos in Guiyang, Guizhou, China. It was built in 2007, whose gross investment is € 9,500,000 and the total staff is 270. The reason why we choose this company is that we know the human resources department manager called Ping Luo, who is a so kind a person that we think we can get much information of the company from her, and it is also good for us to learn much. Kerneos is a large scale industry enterprise, which has normative institution and system, so we think it is good for us to research and learn much about what is the real company and how it works, especially the part of production. Although we have learned much about company, we can not understand how to operate a company, how to manage the production and so on. Because of limitation of distance, we can communicate with the company by phone or E-mail, and can not enter the company, go to the work shop, or collect all data ourselves. Their main productions are all kinds of aluminates cement, calcium aluminates powder and bauxite. Products are generally used for building, metallurgy, electric power and Purifying agent. Product sales market has spread East, South, Southwest and other provinces in China. It has
been exported to Southeast Asia, Europe, North America and North Africa. It has small scale, one factory and storage. But the company has not paid much attention to storage, and only focus on its production; sometimes they only produce when they get orders. In their subsidiary, it has a small storage to store their temporary finished goods till customers get them away. Our two main products are calcium aluminates cement and bauxite. The raw material of calcium aluminates’ cement is calcium aluminates and limestone, which should go through the equipment (feeding machine, crus–her, double-shaft pug mill, pulverizer, rotary kiln and packing machine), and output of finished products (calcium aluminates cement). And the raw material of bauxite is bauxite ore, it should be go through the same equipment as calcium aluminates’ cement, but some spares of equipments need to be changed; we will give more detail in our finding part.

2. Purpose

Introduce the current internal production logistics system aspects in Kerneos, focus on mode of production. Adjust the mode selection, and make production logistics can work efficiency in the company. We will analyze these following questions in the case company:

- What is pull/push system?
- How to choose an efficiency production system, pull or push?
- Today, in our case company, which system are they used?
- Which system is better for the case company, and why?

3. Methodology

This thesis is based on case study; deep research is made by arranging several mail interviews with main managers and employees, named Ping Luo who works in human resource department in Kerneos, Zhijie Hu, the manager of production department, and Zhonggui, Ren, who is the Scene manager of Operation department. Other important information is collected from published articles, books and internet site. Besides, the data for the study is obtained through documentations and inside news in Kerneos. The concepts and principles of production logistics form a foundation of the whole thesis and some of the aspects will be
analyzed in detail.

The thesis is written basically under the guidance of the following resources:

- Reading the book *logistics and supply chain management* by Patrik Jonsson and the documents on blackboard.
- Presence of the courses (Such as supply chain management, manufacturing logistics).
- A case with information about small subsidiaries in Guiyang City in China.
- Search many articles on the internet.

### 3.1 Research approach

#### 3.1.1 Qualitative

A key aspect to consider in qualitative research is how a researcher’s “worldview” or “orientation” would influence choices about methods. (British journal of Cardiac Nursing, 2009). Qualitative research is analysis based on the "quality" of the object (Punch, K. 2005). This is a research including collecting, analyzing, and interpreting data by observing, to find the solutions of problems.

#### 3.1.2 Quantitative

The quantitative approach grows out of a strong academic tradition that places considerable trust in numbers that represent opinions or concepts (Dilanthi A, David B, Marjan S, Rita N, 2002) Quantitative research is includes deeply interview someone, request them answer questions in detail. It is related to experimental study, and mainly based on the levels of the object.

### 3.2 Data collection

Data is mainly used to support the total research, so the collection of data is the main part of our paper.

In Primary data part: It observed or collected directly from first-hand experience. Primary data is the raw results that return after someone has conducted a study, questionnaire or survey.
In our thesis, we collect and get the primary data by interviewing manager of HR department in Kerneos and sending us almost useful information through e-mails by her.

Questions that we have asked:

- There are many kinds of productions in your company, what are the main productions? Where have they gone? What’s the output and market demands per month?

- What kind of production mode is used in your company, Pull or Push? Can you introduce the whole production process? And how to control the production process (Is there any production planning? How to limit WIP? Is there any way to quantity surveying? Etc.)

- Can you supply the layout of your company? And the information of equipments? How do they work? What is the lead-time for every production? How are the semi-productions delivered in the production process? Is there any storage for raw-materials or finished goods?

In Secondary data part: It has already been collected and is available to the public. The sources of secondary data contain books, journals, census data, biographies, articles and databases. In this thesis, we get the secondary data mainly by searching web site and analyzing some journals to get enough statistical data to support our discussion of this case study. In addition, we have learned more theory and literature about production logistics by ourselves. Meanwhile, we have got a lot of useful secondary data by documentary research

3.2.1 Validity

We get the primary data from the manager who works in small subsidiaries of Kerneos. She is a manager of HR department in the company, and there is no doubt that our data is reliable. Our secondary data is collect by search internet, the articles or journals are also from an official websites, and some come from research papers. We choose the data very carefully to make sure its validity.

3.2.2 Reliability

In this thesis, we write, analyze, and research also depending on the theory of production logistics and its control. And production logistics have been applied in a lot of companies all over the world. We can confirm its reliability in the thesis.
4. Theoretical Framework

The ideal arrangement for flow production should resemble a watershed; the river being the main assembly track, fed by tributaries in the shape of sub-assembly lines which, in turn, would be supplied by streams representing the machine lines fed by brooks typifying the material conveyors. Each part should flow continuously forward. There should be few bends, no eddies, no dams, no storms, no freezing should impede the inevitable flow to estuarine waters – the dealers – and ultimately to the sea – the customers (M.L. Emiliani and P.J. Seymour, 2011)

4.1 Push-pull production introduction

Many people believe that pull systems are inherently better at reducing stocks because they try to eliminate queues, not provide for them, whereas push systems encourage queues to cushion operations and to increase work station utilization but at higher cost. However, the definitions of push and pull are inconsistent between different researchers. Worse, arguments about performance are sometimes circular. Thus, if the performance of a pull system is poor then it may be suggested that this is because the fundamentals of JIT are not being observed, whereas, if the performance of a push system is poor, then that is a consequence of it being a push system. (M. C. Bonney et al, 1999). As we can see the difference from figure 1, in the pull system, the first workstation starts to work when it get signal from the second process, and so on.

![Diagram of Push and Pull Production Systems](image)

**Figure 1 Push and Pull Production Systems**

Source: David Ang, 2009
4.1.1 Push system

(Haruki Matsuura and Hitoshi Tsubone, 1991) define the push production as one in which production orders are issued on the basis of forecast demands and inventory information collected centrally from all the production stages. And it has mentioned that MRP (material requirements planning) is the most popular example of a push-type production ordering system. It is a common way for processes to be managed, and often seems a sensible option. Push scheduling and its associated inventory do not always help companies to be more responsive. (Alan Harrison, 2002)

It is more sensible way for processes to be managed. Push systems are very popular in the form of materials requirements planning (MRP) and its successor manufacturing resources planning (MRP II) (Mark. L.S, David. L.W, Wallace. J.H, 1990) this specific character takes advantage of the push system with respect to the WIP control while more robust, flexible and easier to implement than other pull systems

4.1.2 Pull system

A “pull” system exists when a work center is authorized to produce only when it has been signaled that there's a need for more parts in a downstream (user) department. This implies no work center is allowed to produce parts just to keep workers or equipment busy. Frequently, it's believed that the pull system creates the benefits in JIT. (Thomas, E.V, et al, 2005) It is a system of controlling materials whereby the user signals to the maker or provider that more material is needed. Material is sent only in response to such a signal. (Alan Harrison, 2002).

Pull systems is authorize work releases based on system status.

The pull production system currently employed by the Japanese and some American companies is a way of implementing JIT (Just in Time) principles, with the finished product 'pulled' from the system by the downstream demand. (Samia Siha and H. T. David, 1994)

Pull/Kanban is based on the concept of building products to actual demand and not to forecast. A company should not make large amounts of stock and then try to sell it. Companies need to be aware of the market place and what the customers wants. The pull system uses visuals to signal when parts need to be replaced. (Pull production- Kanban, www.kentent.hubpages.com,
The Toyota production system is a pull method. To understand its tremendous success, one has to grasp the philosophy behind it without being sidetracked by particular aspects of the system, such as kanban. Kanban are instructions enclosed in clear plastic that at a glance communicate information needed at the work station. If the kanban system is introduced without being part of total philosophy, however, I feel problems will ensue. The system did not happen overnight but through a series of innovations—a method developed over 30 years to improve overall efficiency and to enhance the work environment. (Taiichi Ōno, 1988)

Conditions in implantation of pull system: (Mark L. Spearman, Michael A. Zazanis, 1992)
1. "Smooth" production involving a stable product mix;
2. Short setups;
3. Proper machine layout;
4. Standardization of jobs;
5. Improvement activities;
6. Autonomation (autonomous defects control).

### 4.2 Pull system VS Push system

The key differences between pull and push systems are Pull is to make to order, while Push is making to stock. Pull production systems are usually compared to the Push system of production where production is pushed from one operation to the next through the factory whether the product is needed or not. The pull system is the center of any synchronized factory; it works by working backwards, using signals or cards to trigger or start production. The process starts at the finished products warehouse or the shipping area. When a customer orders a product, the process triggers the previous operation to replace it; signaling more products is needed. The process continues backward through the factory to where raw materials are withdrawn which is in turn triggers the supplier to ship the raw materials.

(Steve Krar, Pull/Kanban systems) push and pull are not mutually exclusive approaches. For instance, MRP and kanban can be combined.
The main difference between push and pull production is the direction in which the information flows. In the push system, information flows in the same direction as production, whereas in the pull system, information flows in the opposite direction, starting with the consumer and ending on the production line. In pull production it is the consumer that decides when the production process starts rather than the manufacturer deciding when to produce and then hoping that the consumer will respond with an interest in purchasing equal to the amount being produced. (Pull production- Kanban, www.kentent.hubpages.com, 2011).

Figure 2 is a comparison which shows some characteristics of Push Production and Pull Production

![Push vs. Pull](image)

**Figure 2 Comparison between push and pull**  
Source: Robin von Haartman, 2010

What are the advantages with Pull over Push?

- Observability: we can see Work-in-process (WIP) but not capacity.
- Efficiency: pull systems require less average WIP to attain same throughput as equivalent push system.
- Robustness: pull systems are less sensitive to errors in WIP level than push systems are
to errors in release rate.

✓ Quality: pull systems require and promote improved quality.

The most important is because of the magic of Pull: the WIP cap (Fredrik Olsson, 2010) a production control system can also be a mixed push-pull system. Huang and Kusiak (1998) present a push-pull system that pushes through certain manufacturing stages and pulls elsewhere based on the characteristics of these stages. They argue that this is superior to a push system, while avoiding some inherent problems of pull systems. (Lauri.K, 1999)

4.3 CONWIP

One variant of a pull system is the Constant Work in Process (CONWIP) system (Spearman et al. 1990) which is known for its ease of implementation. It is also a hybrid push-pull system, and it is easier to implement and adjust. However, CONWIP is not necessarily the optimal means of controlling production in every situation. When beginning the production, all available cards are located at the beginning of the line (on a bulletin board). When orders arrive, and there are enough available cards in the system, the necessary cards are attached to the order, and together they proceed through the production line. When the order is processed completely in the line, and leaves the final station, the card is dropped off and released back to the beginning of the line. No order can enter the line without its corresponding card. To design a pattern of the CONWIP system, two fundamental questions should be analyzed, the administration of the backlog and the computing of the number of cards. (Oscar.R.O, Adolfo.C.M, 2003)

CONWIP appears to share the benefits of kanban while being applicable to wider variety of production environments. Meanwhile, it is differs from kanban in three main ways:

(1) Use of a backlog to dictate the part number sequence

(2) Cards are associated with all parts produced on a line rather than individual part number

(3) Jobs are pushed between workstations in series once they have authorized by a card to start at the beginning of the line

The differences between CONWIP and push control stem largely from the built in feedback of the CONWIP system. (Mark.L.S et al, 1990) It is more general than kanban, and more effective than
push system.

Figure 3 compares these three production modes, push production is traditional production mode, in this production, every work stage must work following the material production schedule which is based on customer orders, production demand and storage data to work out what and how many production they should produce and when to produce. Opposite to push production, the characteristic of pull production is that every work stage works following the demand of the next step, a sign of pull production is a specific way to control the production line which is named Kanban. CONWIP works as a combination of push and pull, the pull embody at the two stop points, the first stop point starts to work when it get order from the second point, and all of the work stages between these two stop points produce in push production.

4.4 TOC

The theory of constraints (TOC) is a multi-faceted systems methodology that has been developed to assist people and organizations to think about their problems, develop breakthrough solutions and implement those solutions successfully. (R. Anthony, I., Martha. L.S, Kenneth. W.G.J, 2009). Goldratt (1984) summarized the application of TOC to the operational environment as having five key steps:

1. **Identify the constraint.** Every system has a constraint/bottleneck. This is the weakest link
that limits the system in some way. The system's effectiveness is defined by the rate of the weakest link, and these can vary from physical bottlenecks such as machines or equipment that have the least capacity in the system, or policy, or behavioral constraints and external constraints that are outside the system.

2. **Get the most out of the constraint.** There are several ways in which the effectiveness and efficiency of the constraint can be maximized.

3. **Support the constraint through subordinating the non-constraints to the constraint.** In this step, the non-constraint machines (i.e. the vast majority in the system) are subordinated to the constraint machine.

4. **Elevate the constraint.** The first three steps mainly focus on changing the way the constraint is used without spending money.

5. **Go back to step 1.** Goldratt argued that TOC was an iterative process of improvement. Introducing the steps described earlier usually means that another point in the system becomes the constraint. Therefore, you need to re-evaluate and hit the next constraint by going back to step 1.

### 4.5 How to choose the right way

In general, how to choose the way for production is based on market requirement, competition and customer loyalties. If the company is trying to popularize its new products in a competitive market, using Push Production is better to occupy the market than Pull Production. Such as auto trade in China; for some companies focus on heavy customers, it is better to use Pull Production to avoid large overstocking, such as textile industry in Zhe Jiang, China, overstocking resulted from large-scale produced blindfold. Pull production is a very clever way. To save space, it limits the warehouse place and quantity of WIP (work in process). In the pull production implementation, the timing that the back process gets the parts from the foregoing process is very suitable, this is much better than the push production.
Moreover, the waiting time is generally occurs after the worker finished work and go back to their process; you can use the waiting time to do other works. However, the waiting time will be wasted in the push production.

Actually, we judge the type for a company is based on the advantages and disadvantages of production types, and differs between them as figure2.

**4.5.1 A new production mode has comes**

In a CONWIP system the pull signal specifies only a certain routing. Any part that uses that routing can be started. Synchronization of assembly operations is accomplished by starting jobs in a predetermined sequence. Secondly, CONWIP addresses the problem of having many part numbers on a single line. For instance, a circuit board operation typically has a small set of product types (i.e., dimensions of the boards) and a large number of unique part numbers (i.e., different "artwork"). (Mark L. Spearman, Michael A. Zazanis, 1992)

CONWIP is not only a whole production line that from raw materials to the finished goods, but also can separate from the whole production line to many small parts, and every parts can be a CONWIP systems. This can be formed in series of CONWIP systems, and there are no storages between every two. CONWIP is similar to kanban when it just includes one work center. CONWIP doing production just based on the actual demand of customer, so many people let it be a pull system, and some of them treat it as a single period of Kanban system.

Figure 3 is CONWIP VS Pull VS Push
5. Findings/ Result

5.1 Case company

5.1.1 Organization structure

Our case company is the first branch office of Kerneos in Guiyang, Guizhou, China. More detail about the case company, see background part in the thesis. Otherwise, figure 4, 4.1, 4.2, 4.3 are details of the factory:

Figure 4 Panoramic view of Factory in Guiyang province

Figure 4.1 the raw material of cement.
Figure 4.2 Finish goods without packaging

Figure 4.3 Finish goods
They have 7 departments in the company, and each department is also has its managers to control all the working processes. The organization chart is described in the figure 5,

**Figure 5 Organization Structure of Case Company**

HR= Human Resource  S&EP= Safety and Environmental Protection  
M&P= Maintenance and Project  PT= Project Technology  
Source: Luo Ping, HR department manager of Kerneos

The General Manager is the top management of our case company, the department that in the green color is production manager, he control all the department of production, and that department is obverse in our mission to make the proposals. Here are the important responsibilities of every department:

**Financial and computer Department**

- Supplying financial service for all departments;
- Developing and managing assets and accounts of the company, and stocktaking regularly.
- Organizing and formulating the budget annual of the company, and tracing the execute state of budget and analyzing the reason of difference.
- Formulating monthly report and annual report, and reporting the financial state and cost analyze to the management.
- IT supports.

**Repair and project Department**
- Repair all facilities and equipments of the company, charging for surveillance, measurement and maintaining measuring instruments.
- Formulating project plan and budget, adjusting and controlling project costs and cash flow, managing implement of project and deliver process.
- Managing spares and weight house, charging the outsourcing about repairing and project.
- Developing preventive service system

**Technology Department**
- Establishing technology order, managing data and giving report depend on demand of other apartments.
- Researching and giving improvement of technology, increasing performance and quality of products, and supporting the development of production processes.
- Increasing technology content about interaction of production and technology, providing technology training to staff.

**Quality Department**
- Treatment of complaint from customers.
- Developing and improving production quality management system.
- Making production formula and supply to production apartment.
- Judging the quality of the products and decide if they have up to scratch.
- Formulating and implementing the quality plan, developing and managing QC data, and supply these data to other apartments.
Marketing Department
- Opening up market and keeping relationship with customers.
- Supplying market forecast regularly.
- Cooperating with logistic department to delivery on time.
- Collecting debts.
- Charging and cooperating with quality department for treatment of complaint from customers and feedback.

Logistic Department
- Managing transportation and freight forwarding.
- Treatment of orders and giving receipt depend on order treatment programmer.
- Formulating and implementing delivery plan.
- Treatment Exportgeschäft.

Purchase Department
- Researching and analyzing the supply of market, choosing the supplier and managing supplier performance.
- Making purchase plan depend on users’ demand, and purchasing all materials.
- Controlling negotiates of procurement price and purchase costs.
- Developing and managing contract for purchase and order data collection.

Human Resource Department
- Advertising staff and making the plan for succeeding, charging new staff training and career planning and development.
- Charging and controlling the budget of human resource cost, formulating human resource report regularly.
- Auditing and granting salary, paying for social insurance.
- Supplying administrative service to other departments.
- Formulating and implementing the laws of rewards and punishments for employees.
- Developing and improving the operation flow and the management system of the
company, charging ISO9001.

Production Department

- Managing of the raw materials, semi-finished products, and finish goods.
- To manage Company’s factory transport vehicles, security, choosing raw material, and cement grinding mill
- Producing based on the production planning, quality or craftwork, and send the report to managers.

5.1.2 Current Production

During the talking with the production department manager Mr. Zhijie, we knew that the aluminates cement is the major production, its production and demand is larger than others. Therefore, we decided to treat the aluminates cement and its production line as our analyze target. The process of the production is in figure 6.

![Figure 6 Production processes of case company.](source: Zhijie, Hu, Production department manager of Kerneos)

The raw materials of Aluminates cement is calcium aluminate and limestone. It is the hydraulic cementing materials which grinded the grog refractory that the calcium aluminates are the main component and includes 50% of alumina by calcimine. Aluminate is productions that condense and harden are quickly, but the long term strength and other functions are lower. The long term strength is about 40%-50%, so it is not conducive to use on the long-term load-
bearing structure or environment which in high temperature and high humidity. It is just applied to emergency military engineering, such as build the street or bridge temporarily. Countering this production, the production mode that Kerneos used is pure-push production. The production department will make the MPS (Material Planning Schedule) through calculation and analysis when the companies get the order or the finished goods stock is lower than the safety stock. They make the suitable MRP (Material Requirement Planning) based on MPS, and the data that material gross requirements minus material on hand. The production work is beginning after the raw materials are purchased based on MRP.

While the process working, all steps in the process should work follow the MPS to keep the quantity and finish work on time. When one step has finished its production, the products will be delivered to the next step, while the production report will be feed back to Production Planning department. The Production Planning department should revise MPS depend on the current situation and give the new missions to all steps. On face of it, this production of Kerneos is using a traditional production management mode with waiting prepensely.

Figure 7 is the layout of our case company. There are two areas are used for stocking two kinds of raw materials; there are two feeding machines and six crushers in raw material shop; two double-shaft pug mills, three mill machine and fourteen dust collections in mill shop; two rotary kilns, four belt weightier and fourteen elevators. During the production, all semi-productions are delivered by elevators.

Figure 7 Layout of factory

Source: Zhijie, Hu, Production department manager of Kerneos
5.1.3 Production data

The main production of Kerneos is aluminates cement, 50kg a bag, and the price is 800yuan/bag. (800kr. /bag) The technique is suitable to other productions of the company, such as bauxite. (300yuan/T). Although the production technique and equipments of different production are much the same, we should analyze deeply different parts in different production process so that it is much clearly for distinguishing the characteristics between Pull Production and Push Production. At first, depend on the chart 3 upon, the technique of the production is:

Feeding→ Crush→ Raw material mill→ Calcinations→ Wrought material mill→ Package→ Delivery

The equipments relevant are feeding machine, crusher, double-shaft pug mill, pulverizer, rotary kiln and packing machine.

Output: About 2000 t per month.（Total amount）

Working time: 20 d per month (5 days per week)

The volume of finished goods for aluminates cement is 1000t, and the volume of finished goods for bauxite is 800t. The sale volume of aluminates cement is about 900t/m, and about 550t/m can be act as the fixed production for fixed customers, such as government, others will be supplied for other customers; The sale volume of bauxite is about 500t/m, and about 200t/m can be act as the fixed production for fixed customers, and others will be supplied for other customers. Generally, the size of order is about 80t, and the company will spend one day on preparing production and then ask the third part of logistics to delivery. The lead-time of aluminates cement is 38hours, and the lead-time of bauxite is 32hours.

Through combination of production process information that we have got from case company, we draw a chart as figure 8:

Aluminates cement:

<table>
<thead>
<tr>
<th>Process Name</th>
<th>Facility Name</th>
<th>Standard efficiency</th>
<th>Work time/ Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material- come into production</td>
<td>feeding machine</td>
<td>18-24T/per H</td>
<td>6 H</td>
</tr>
<tr>
<td>Raw material - shatter</td>
<td>crusher</td>
<td>17-22 T/ per H</td>
<td>6 H</td>
</tr>
</tbody>
</table>
### Raw Material - grind

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Standard efficiency</th>
<th>Work time/ Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>double-shaft pug mill</td>
<td>33-52 T/ per H</td>
<td>3 H</td>
</tr>
<tr>
<td>whisk</td>
<td>23-36 T/ per H</td>
<td>4 H</td>
</tr>
<tr>
<td>calcine</td>
<td>13-16 T/ per H</td>
<td>8 H</td>
</tr>
<tr>
<td>Wrought material (finish goods) - grind</td>
<td>25-29 T/ per H</td>
<td>4 H</td>
</tr>
<tr>
<td>Package- leave production</td>
<td>15-22 T/ per H</td>
<td>7 H</td>
</tr>
</tbody>
</table>

### Bauxite:

<table>
<thead>
<tr>
<th>Process Name</th>
<th>Facility Name</th>
<th>Standard efficiency</th>
<th>Work time/ Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material- come into production</td>
<td>feeding machine</td>
<td>18-24 T/ per H</td>
<td>5 H</td>
</tr>
<tr>
<td>Raw material - shatter</td>
<td>crusher</td>
<td>17-22 T/ per H</td>
<td>5 H</td>
</tr>
<tr>
<td>Raw material - grind</td>
<td>double-shaft pug mill</td>
<td>35-52 T/ per H</td>
<td>2 H</td>
</tr>
<tr>
<td>whisk</td>
<td>pulverizer</td>
<td>23-36 T/ per H</td>
<td>3 H</td>
</tr>
<tr>
<td>calcine</td>
<td>rotary kiln</td>
<td>13-16 T/ per H</td>
<td>6 H</td>
</tr>
<tr>
<td>Wrought material (finish goods) - grind</td>
<td>pulverizer</td>
<td>25-29 T/ per H</td>
<td>4 H</td>
</tr>
<tr>
<td>Package- leave production</td>
<td>Packaging machine</td>
<td>15-22 T/ per H</td>
<td>7 H</td>
</tr>
</tbody>
</table>

**Figure 8 production process and machine**

Source: Zhonggui, Ren, Scene manager of Operation department in Kerneos

**All information upon was supplied by production department.**

We have compared two main products of case company, named aluminates cement and bauxite. The time and techniques of these two products’ production was the same approximately, but they were different in raw material and adjustment of the equipment, we draw a chart of the adjustment as figure 9:
<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Adjust content</th>
</tr>
</thead>
<tbody>
<tr>
<td>crusher</td>
<td>Change the size of spare parts in crusher</td>
</tr>
<tr>
<td>double-shaft pug mill</td>
<td>Clean</td>
</tr>
<tr>
<td>pulverizer</td>
<td>Clean</td>
</tr>
<tr>
<td>rotary kiln</td>
<td>Clean and Adding fuel</td>
</tr>
<tr>
<td>Packaging machine</td>
<td>Change the size of packaging bag</td>
</tr>
</tbody>
</table>

**Figure 9 Changing Facility**

Source: Zhonggui, Ren, Scene manager of Operation department in Kerneos

Through this chart, we can see that company needs to spend much time on change in different production. Through talking with manger of production department, he told us that the change time is about 2 days in generally. 2 days means two days’ working time, in fact it will often cost about 13 or 14 hours, the facilities should be changed one by one because of limited human resources, and the daily work is not so busy that workers must get hold of every minute, so two days’ working time can be used for changing facilities. During the change time, production should stop its work till the change time finish.

### 5.2 production system

According to the literature review, we have summarized the contrasts of production types.

#### 5.2.1 Pull VS push

In a push system, the production order is scheduled and the material is pushed into the production line. In a pull system, the start of each product assembly process is triggered by the completion of another at the end of production line. Pull production or push production? It depends on their actual situation. In 90th century, it is said that the Pull Production is better than Push Production.

After discussing and analyzing by using the Theory of Constraints (TOC), no matter which production modes, they also have their conditions and scope. The mission of the manager is to choose the production mode agilely based on TOC, we cannot choose subjectively. Nowadays,
the mix pull-push production is the most used of by enterprises.

Other words, CONWIP is more and more popular. Through the theory learning and the goal researching upon, we found some problems about the production type in the company. From the view of compare among Pull, Push and CONWIP, the advantages of CONWIP are represented below:

5.2.1 CONWIP VS Push VS pull

CONWIP VS Push
1. CONWIP is better to Push when the process with high throughout;
2. Reduce the influence of “vicious circle of overtime” in Push Production;
3. Reduce the quantity of WIP;

CONWIP VS Pull& KanBan
1. Reduce the amount of WIP and easy to find the problems variously on the production line;
2. Reduce the congestion efficiently;
3. It is more universal way that used in various environments, especially for the production lines with variety of goods;
4. It is better to use CONWIP in a process with enough setup time than KanBan.

6. Analysis/Discussion

6.1 production mode

After we studied, researched and read many theoretical articles, we have summarized our views of production modes.

6.1.1 Analysis of push and pull system

Push Production can not match “Just in Time” in modern production process. If a company selects Push Production, and ensures delivery on time in the whole process at the same time, it must calculate exactly the time of all the production in every step and the date of finished goods. And this is very hard work which costs much manpower and material resource. If there is any exceptional situation or mistake in production process, the MRP has to be reconsidered and transformed, such as working overtime, which also costs much manpower and financial
resource. Because of the various complexity and uncertainties in Push Production such as defective, damaged equipments and so on, the company has to keep much inventory to ensure the delivery on time. In the JIT concept, keeping much inventory will impropriate much capital, and cause much cost on moving, placement and maintenance.

6.1.2 Comparison of advantages and disadvantages

As we can see from the theoretical framework, we summarized the advantage and disadvantage between pull and push as figure 10:

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull production</td>
<td>Zero inventory</td>
<td>1. increased rate of idle machines</td>
</tr>
<tr>
<td></td>
<td>Overstocking of products with low-stress conditions.</td>
<td>production at a high rate of update frequency</td>
</tr>
<tr>
<td></td>
<td>production at a high rate of update frequency</td>
<td></td>
</tr>
<tr>
<td>Push production</td>
<td>high utilization of equipments</td>
<td>high level of inventory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>high-stress conditions from the market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>low rate of update frequency for market requirement</td>
</tr>
</tbody>
</table>

**Figure 10 advantages and disadvantages between pull and push**

To avoid these disadvantages of Push Production, the concept of Pull Production has been developed. Pull Production is a way of production that all the work in the production process should be pulled by market demand, that means production depends on market demand. In this production process, every step should satisfy the demand from the next step, and send demand to the previous step. In Pull Production, planning department just makes the final production plan according to the market demand.
6.2 case company and our proposals.

6.2.1 Nowadays, the Kerneos exerts a not very appropriate production way -

Push Production.

Push Production in Kerneos.

During the phone visit to some managers in Kerneos, they told us Kerneos is a large-scale production company with Push Production as their production mode. So we should analyze the parts incarnate characteristics of Push Production first. 1. Kerneos is a big company that produces two kinds of building materials, aluminates cement and bauxite. Based on characteristics of these two productions, there are a many of market order demands, and the production processes are very heavy and complex, such as big raw-materials, big machines, etc. 2. Long lead-time. Because of big raw-materials and big equipments, the whole production process spends much time on production. As we have marked upon, the lead-time for aluminates cement is 38hours, and the lead-time of bauxite is 32hours. Due to the complexity of production and the size of equipments, changing machines for different products production is also a process spends much time. 3. High level of inventory. We have showed the data of inventory of two productions in finding part. We think the amount of the productivity is too heavy to this company based on analyzing their productivity, and the total costs for inventory are also great. 4. Some details in the production line. In the production line of Kerneos, a warehouse for storing safety-stock is settled after the calcinations’ stage. Although there are some connects between production schedule and order demand, the production will not follow the order demand. There are two standard lines in the warehouse to control the production. One is the normal storage line; it is a standard that the quantity of the production can be satisfied with order demand as usual. This standard line is established in company’s SOP by other department of Kerneos, such as marketing department, logistic department, etc. Another standard is the amount of safety-stock; If the order quantity is small it will not affect the quantity of safety-stock, and the production line will not do production any more; if the order quantity exceeds the standard of safety-stock, the company will produce to full fill of the normal storage line.

For example: The stock of the company is 1300T, and the normal storage line of the company
is 1500T, the safety stock-line is 1000T. If the company gets an order for 500T, the company should delivery 500T production from warehouse. And the storage now is 800T, it is lower than the safety-stock line, then the company will produce until getting the normal storage line. So the quantity of production is 700T.

Because different equipment has different productivity in different stages in the production line in Kerneos, a buffer is set at every stage in the whole production line. The function of buffer is to balance the productivity of every stage in the whole production line and avoid congestion or over productivity during production. Calcine is the “bottleneck”, because the efficiency of rotary kiln is the lowest of the process, the company has to spend much time, which we can see clearly in the following chart. The warehouse is set behind calcinations.

For example: The productivity of the machine at the stage of raw material mill is bigger than the productivity of machine at the stage of calcinations, so the output of first machine is more than the second machine in the same time, and the rotary kiln can not treat with all output from double-shaft pug mill, so a buffer is necessary here to pile up the output that the rotary kiln can not treat. These 4 points are the most representative parts that full fill of characteristics of Push Production.

Push production can not meet the requirement of JIT production. If the company chooses Push production, the exact calculation of delivery time for all production and semi-manufactured goods is necessary to ensure delivery on time. But this is a heavy work; it needs much data for instance time for equipments exchanged and repaired. This calculation needs much human resource and material resource. On the other hand, if any exceptional situation occurs, the whole production plan has to be revised to ensure finish the demand in time. But these revises also need much human resources and financial resources.

Secondly, because of the complexity and many uncertain factors like defective, equipment broken etc. production department would keep high level of safety stock. But from the view of JIT, high level of stock will occupy much money, and caused many other costs like moving, maintaining and so on.
6.2.2 We don’t support Pull Production to be used in this company.

In Pull Production, there is a very important manage tool—KANBAN. As the KANBAN is used in the whole production line, the interactivity of each step increased, and it also reduces the block on production line.

If the company chooses the Pull Production, they could control WIP better than Push Production, and reduce the amount of stock and stock costs. It can seemly satisfy better JIT than Push Production. But, it is not a perfect one. Because it will sacrifice the high rate of output and reduce the rate of utilization. That is to say if the company chooses Pull production, the productivity of the company can not to be exerted maximize.

Aluminates cement is one of building materials, and the requirement is very large. So, if the company chooses Pull Production, the step time for production will not be enough, and it is not easy to control this system with long production period.

6.2.3 Our suggestion

We make a proposal for our case company that they should use CONWIP system to production in the future, why?

According to the characteristics of aluminates cement, the demand of product is unstable. The market demand will be increased suddenly when the natural disasters happened (e.g. earthquakes, tidal wave) or some sudden incidents (e.g. factory explosion, traffic accident). However, the demand will be general when the sudden accidents do not happen. Therefore, the company should be set up the appropriate safety stock to aim at these sudden accidents, and make sure that it can be satisfied with the demand when the demand increase suddenly.

Production mode selected is based on TOC method, and it should think about these three questions:

✓ Where can it be improved?
✓ What is the result of improvement?
✓ How to implement improvements?

In general, the order of company should not be very large, and it is flexibility. After we have analyzed the disadvantages of pure-push and pure-pull production, we have already known that it would cause the situation of overproduction and the waste of
production if the company uses the pure-push production all the time. If the company uses Pull Production, it would cause the production capability decreased, the prepare time will not be enough, and cannot satisfy the order. Further more, the company can not satisfied with the demand increased suddenly. So, in our opinion, we suggest the company to use CONWIP. The primary period of production line will start to work when the storage of WIP decreases to the planning standard. And the other processes of production lines will work according to Push Production. Like the CONWIP process in figure 3.

7. Conclusions

Through our research and study in this thesis paper, the pull production can describe in a simple sentence “make-to-order” and push production is “make-to-stock”. (Christopher, M, 2005, P.152-P.154) We proposed to use “push” in the enterprise which has large quantities, less variety, and the production cycle is powerful. In the small quantity, variety, and short-cycle, we proposed to use “pull”. In our case company, a branch office of Kerneos in Guiyang, Guizhou, China, they use the pure-push production in their production process. After our analyzing and discussing, the reason why the production mode is not suit to them is the push production is complexity, inflexible to the unstable market demand. It is difficult to find the problems in the process because of much of WIP on the line.

Compared with push production, we think the CONWIP system is more suitable for them depending on the changes of market demand. Whether the order is large or small, production cycle is long or short, and variety of production is large or small, it can ensure their productivity to work efficiently. If they choose CONWIP system, the production process of company will be easy to control so that it can decrease the waste of cost.

With the booming of the economy, the market demand will change all the time, and the technology will be more and more advanced. Therefore, there will be more and more new products coming out. Meanwhile, more new theories and methods of production management will be researched. In our future study, we still have a long way to go. Finally, we hope our proposals will be useful in our case company.
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W. J. HOPP² and M. L. ROOF (1998), *Setting WIP levels with statistical throughput control (STC) in CONWIP production lines*, vol. 36, no. 4, 867± 882

**Internet:**


**Interview:**

Zhijie, Hu, Production department manager,

Zhonggui, Ren, Scene manager of Operation department,

Luo P, HR department manager of Kerneos, mail:luoping8848@163.com.

An interview by chat more than 5 times during July-Nov 2011, totally 3 hours.