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JUST IN TIME — MEANS OF IMPROVING PRODUCTION SYSTEM

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Проанализированы оперативные методы и средства организации производства и обеспечения его материалами, контролем качества под общим термином Just-in-time, его преимущества над традиционными решениями.

The objective of this project is to provide insight Just-in-Time (JIT) through its history, goals, limitations, benefits and requirements of implementation. I show several examples of successful applications of JIT, as well as other ideas, which are closely related to Just-in-Time and Kanban System.

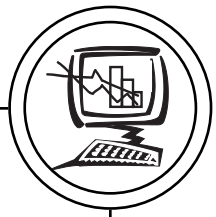
Introduction

Commercial success originates from the capacity to meet customers' requirements and demands. In global competition, nobody can afford to sit back and take it easy. Companies have to react faster to customers' demands for improved quality at lower prices. For engineers, this involves creative application of engineering principles. The challenge of engineering also features effective resources management in order to produce cost-effective solutions. Many organizations are involved in benchmarking and continuous improvement strategies that stress continual inventory reductions. These strategies usually include fewer suppliers, smaller lot sizes, shorter lead times, reduced set-up time, total quality programs, preventive maintenance, employee training as well as increased emphasis on customer satisfaction. The effective management of materials is crucial to the performance of many organizations. The new idea of lower production times and work-in-progress, continual inventory reduction have lead to the idea of incorporating JIT and Kanban System in manufacturing industries.

Just in time is easy to catch conceptually, everything happens just in time. For example, we have to leave our house just in time to catch a bus to the train station, walk into the office just in time to start the work. Theoretically, there is no problem about this, however achieving it in practice is likely to be difficult. So also in a manufacturing operation component parts should be picked up by a worker and used. So we would at a stroke eliminate any inventory of parts, they would simply arrive just in time. Similarly we could produce finished goods just in time to be handed to a customer who wants them. So, at a conceptual extreme, JIT has no need for inventory or stock, neither of raw materials nor work in progress or finished goods. This allows an organization the ability to adapt changes in demand, and therefore production more quickly.

1. Jit definition

We know some modern manufacturing concepts: flexible manufactur-



ing system (FMS) — aided design (CAD), computer-aided manufacture (CAM), and just in time production

1. Just-in-time production is a system, which ensures that each item is only made at the time it is required, or in the case of purchased items, delivered to the production line when needed. The system reduces inventories throughout the process but requires careful attention to scheduling. Its adherents believe that the system prevents problems from being hidden behind inventories so that they can be dealt with. JIT offers a low-technology approach, based on demand-pulling requirements. However, it requires some stability in demand levels and considerable effort to install and make effective[1].

2. JIT was originally developed to improve efficiency by reducing the cost of carrying inventory, but it also helps improve quality and delivery[2]. Where inventories are built up «just in case», they usually grow large enough to mask quality control problems. Good and bad quality output get mixed in inventory and the trail grows too cold to track down the source of quality problems. Producing inventory just in time means that so few items are in an inventory that quality is easily monitored. Delivery is improved because items are available to customers (either internal or external) just when they are needed and just in the quantities desired, without the added cost of carrying large inventories[3].

3. JIT is called a philosophy because it goes far beyond inventory control and encompasses the entire system of production. In a nutshell, JIT is an approach, which seeks to eliminate all sources of waste, anything that does not add value in production activities by providing the right part at the right place at the right time. Parts are therefore produced just in time to meet manufacturing requirements rather than by the traditional approach, which produces parts just in case (JIC) they are needed. The JIT system results in much less inventory, lower costs and better quality than the JIC approach[4].

2. Comparison of conventional and jit attitudes

It appears that JIT is gaining popularity as the chosen method for cyclical production. JIT has such a major impact that it is compared with Ford moving assembly line and the Taylor system as huge innovations in production management. The assumptions of JIT system are certainly opposed to most of traditional assumptions about repetitive manufacturing.

3. Elimination of waste

The Japanese have developed an aversion to waste. They view scrap and rework as waste and thus strive for perfect quality. They also believe that inventory storage wastes space and ties up valuable materials.

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[1]David Hussey, *Strategic management from theory to implementation*, Butterworth Heinemann 1998, pp.415.

[2]R.H. Schmenner, The merit of making things fast. *Sloan Management Review*, Fall 1988, pp. 11—17.

[3]E. Hall, Just-in-time management: A critical assessment. The Academy of Management Executive 3, November 1989, pp. 315—318;

[4]Roger G. Schroeder, Operations management, Mc Graw-Hill 1993, pp. 662.

Conventional vs. JIT Attitudes:

Conventional	Just-in-Time
Some defects are acceptable	Zero defects are necessary and attainable
Large lots are efficient (more is better)	Ideal lot size is one unit (less is better)
Faster production is more efficient	Faster production than necessary is a waste (balanced production is more efficient)
Scheduling and queues are necessary tradeoffs to maximize output from equipment and manpower	Tradeoffs are bad; they trade one waste for another and prevent the paper solution of problems
Inventory provides safety	Safety stock is a waste
Inventory smoothes production	Inventory is undesirable
Inventory is an asset	Inventory is a liability
Suppliers are adversaries	Suppliers are partners
Multiple supply sources lead to safety	Fewer sources of supply lead to control
Breakdown maintenance[5] is enough	Preventive maintenance is essential
Long lead time is better	Short lead time is better
Set-up time is given	Set-up time should be zero
Management is by edict	Management is by consensus
Work force is specialized	Work force is multifunctional

Source: (compare) Richard J. Tersine, *Production/Operations ma-nagement, Concepts, Structure and Analysis*, second edition, PTR Prentice — Hall, A. Simon & Schuster Company, pp. 572. also Richard J. Tersine, *Principles of Inventory and Materials Management*, fourth edition, Prentice — Hall International, Inc. A. Simon & Schuster Company, 1994, pp. 417.

Waste is defined:

— as anything which does not contribute value to the products,

— anything other than the minimum amount of equipment, materials, parts, and workers (working time), which are absolutely essential to production (as defined waste in Japan Toyota's Fujio Cho).

Waste is defined as any activity that adds cost to a product without adding value. Such waste can occur in any area of a business, therefore the implementation of JIT requires a total systems approach, which will involve every employee and every area.

JIT is designed to eliminate waste, and waste is created by manufacturing problems. Thus, if these problems can be identified and attacked, waste can be reduced to the bare minimum[6].

An expanded JIT definition advanced by Fujio Cho identifies seven prominent types of waste to be eliminated[7]:

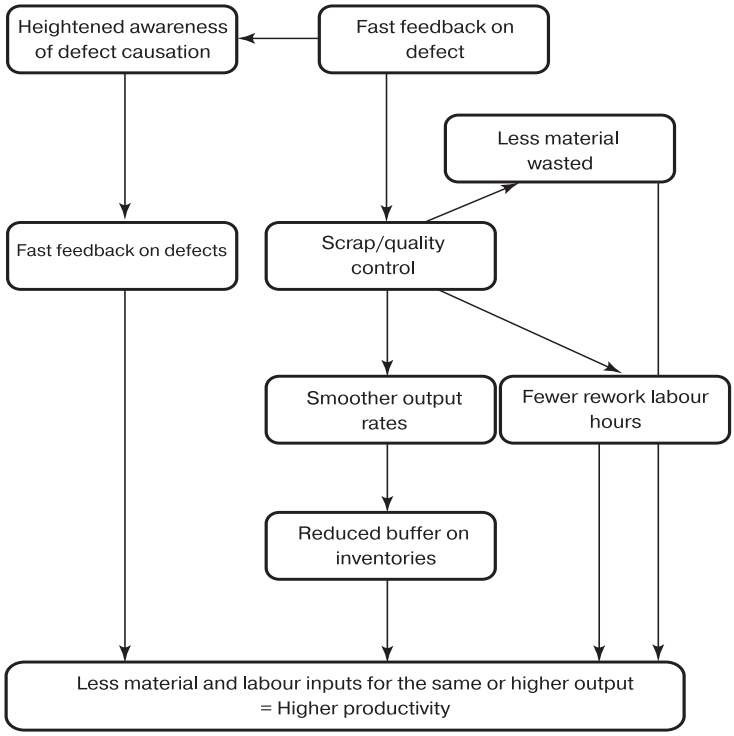
1. waste from overproduction,
2. waste of waiting time
3. transportation waste,

[5]*Breakdown maintenance* — remedial maintenance that occurs when equipment fails and must be repaired on an emergency or priority basic.

[6]Richard Burman, *Manufacturing Management — principle and system*, Mc Graw-Hill, 1995, pp. 272.

[7]Kiyoshi Suzuki, *The New Manufacturing Challenge: Techniques from Continuous Improvement*, New York- Free Press, 1987, pp. 7—25.

RELATIONSHIP BETWEEN JIT AND QUALITY



Source: Richard J. Schonberger, «Some Observations on the Advan-tages and Implementation of Just-in-time Production Systems», *Journal of Operations Management 3*, no. 1 (November 1982), pp. 5.

4. inventory waste,
5. processing waste,
6. waste of motion,
7. waste from product defects, shortages of tools, materials, or information.

3.1. Quality control at the sourse

It means do it right the first time. Each worker is the quality inspector of his or her tasks. Every individual is responsible personally for the quality of the work that he or she produces. If quality problems develop, the work is stopped and everybody in the area concentrates on resolving the problem. Work is not started again until the problem is corrected. Workers are responsible for feeding only good quality parts to the downstream operations they supply. Unacceptable quality is not tolerated; the emphasis is on quality instead of quantity.

Some Japanese firms look at a defect as a treasure because it can reveal a way to improve the production system. This is the positive approach that a company should encourage to gain full cooperation in improving quality. Workers and managers are on the same team, trying to improve the system. Quality circles frequently are used to improve quality and productivity. Quality circles of volunteer employees meet weekly to discuss their jobs and problems. These small group improvement activities attempt to devise solutions to problems and share the solutions with management. They are led by a

supervisor or production worker and typically include employees from a given production area. Others are multidiscipline teams led by a trained group leader.

Quality at the source is predicated on three principles:

— defect free output is more important than mere output;

— defects, errors and breakdowns can be prevented,

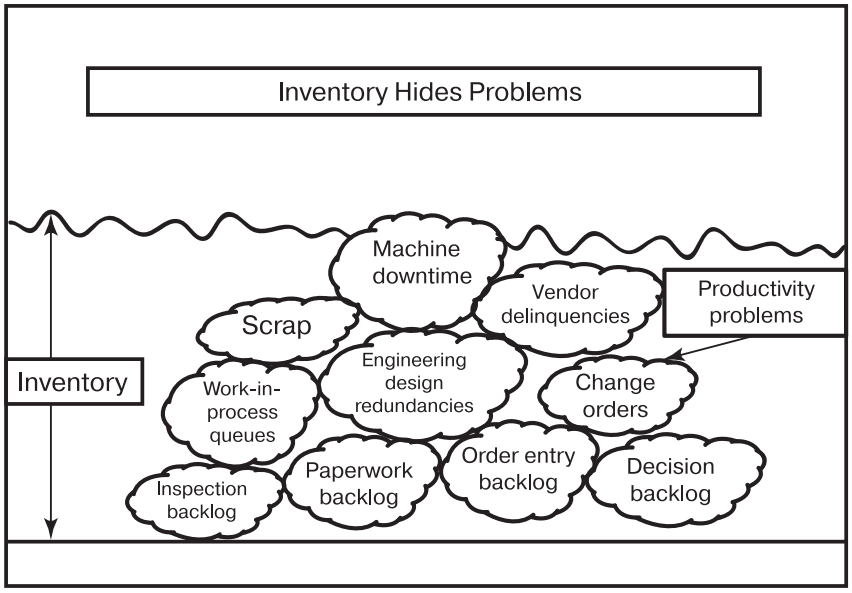
— prevention costs less that doing things the second time.

This quality at the source includes *automation or automated inspection*. Japanese prefer to have quality inspections performed by automation or robotics because it is faster, easier, repeatable, and suitable for jobs too redundant for worker to perform.

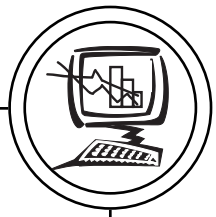
The most important thing is that problem-solving activities by management and workers drive to the whole system. These problem-solving activities are driven, in turn, by removing inventory, which is viewed as the «root of all evil». The JIT production system is, therefore, built on a philosophy of constant improvement.

An analogy for JIT is illustrated by Figure.

Production is viewed as a converging system of streams. The water level in the streams is viewed as inventory. At the bottom of each stream are rocks, which represent problems relating to quality, supplier, delivery, machine breakdowns, etc. The traditional approach is to hold inventory high enough to cover up the rocks and thereby keep the stream flowing. The JIT approach is the opposite; the water is lowered to expose the top of the rocks. When these rocks have been pulverized (e.g. the problems solved), the water is lowered again and more rocks are exposed. This process is repeated until all rocks are turned into pebbles and the stream flows smoothly at a low level.



Source: Chase Aquilawo Jacobs, *Production and Operation Mana-gement*, Mc Graw-Hill, 1998, pp. 328.



This analogy is very good because it highlights the problem-solving approach, which is at the heart of JIT[8].

Tools used to identify and resolve problems:

— management commitment and employee involvement;

— deliberate inventory lowering;

— reduction in batch sizes and set-up times;

— reduction in number of suppliers;

— development of customer / supplier partnership;

— better forward visibility of demand;

— improved manufacturing layout;

— total quality management (TQM);

— improved planning information[9].

By using the above-mentioned tools and meeting capitulated requirements, a company can greatly improve its manufacturing environment and thus become more efficient and competitive.

It is apparent that the JIT approach to repetitive manufacturing can be a very powerful competitive weapon. It achieves a synchronized flow of the desired product mix with very little in-process inventory. It gives opportunity for quality to be more easily improved and provides superior company flexibility. Both less plant floor space and a lower plant investment are required. JIT further improves a plant's competitiveness by speeding up product throughput so the company is quicker to introduce product innovations or to respond to customer demand. The JIT philosophy and many of its elements can be applied in job shops and intermediate volume manufacturing companies. Certainly all companies can benefit from an accent on quality, participation, and teamwork. Some JIT elements must be adapted if they are to be applied in job shops. Effective preventative maintenance and quality programs are also important in job shop factories, just as in others. Even service companies can make do of many such concepts.

3.2. Minimized set-up time

Because small lot sizes are the norm, machine set-ups must be quickly accomplished to produce the mixed models on the line. To achieve such set-up time[10] reduction, set-ups are divided into internal and external activities:

— internal set-ups must be done while a machine is stopped;

— external set-ups can be done while the machine is running.

Other timesaving devices such as duplicate tool holders are also used to reduce set-ups. It is not unusual for a Japanese set-up team to spend a full Saturday practicing change-overs.

Reducing lot sizes, set-up times, and lead times is the key to decreasing inventories in a JIT system. The objective is a lot size of 1 unit. This is done through small-group improvement activities and management and labour cooperative efforts.

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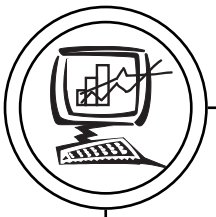
[8]Roger G. Schroeder, *Operations management*, Graw Hill. 1993, pp. 668.

[9]Richard Burman, *Manufacturing Management — principle and system*, Mc Graw-Hill, 1995, pp. 273.

[10]Set-up time — the time required to prepare a machine or process for manufacturing an order.



Recently, there has been much interest in the idea, that companies can compete on time (beyond JIT to Time-Based Competition), as well as on flexibility or costs.

Time-based-competition[11] has moved the application of JIT outside of the factory walls into sales, accounting, and order entry. Often the process for entering orders, or collecting account receivables, takes longer than production of the product. As a result, JIT is now being introduced into white collar and clerical areas. The principles of application are much the same:

1. faster set-up times,
2. reducing queues,
3. cross-training of the white collar work force,
4. elimination of non-value-added-activities.
5. the basic approach is to apply the ideas of JIT and quality to office work and to knowledge work.

The principles of time-based-competition have also been applied to the service\industries with great success (e.g. Fed Ex is one of the premier time–based competitors. It promises not only fast delivery, but on time delivery. Federal Express strategy is to focus on the international marketplace with two days delivery almost anywhere on the globe. Some banks have engaged in time-based competition by promising 15 minutes to process a loan request, versus the normal week or two).

There are two ways to compete through time[12]:

— through faster introduction of new products – it can be accelerated through special methods and concepts. These include simultaneous engineering, design teams, quality function deployment and use of information technology (CAD, CAM, networks);

— through faster throughput of existing products — various techniques can be applied to achieve the JIT ideal, which requires elimination of all work (time) that is not-value adding:

TOTAL QUALITY MANAGEMENT:

TQM is essential part of any JIT system, since JIT does not make allowances for quality failures, whether in processes or supporting services.

TQM — management of an entire organization so that it excels in all aspects of products and services that are important to a customer.

TOTAL QUALITY CONTROL:

TQC is the practice of building quality into the process and not identifying quality by inspection. When employees are responsible for quality, JIT works at its best because only good-quality products are pulled through the system. When all products are good, no «just-in-case» extra inventory is needed. Thus, organizations can achieve high quality and high productivity.

A component of quality is improved product design. Standard product configurations, fewer parts, and standardized parts are important elements in JIT. These design modifications reduce variability in the end item or in the materials that go into the product. Besides, improving a product's efficiency's, product design activities can facilitate the processing engineering changes.

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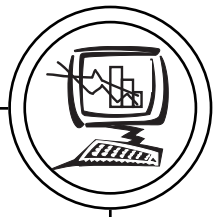
[11] Time-based-competition — competition based on time; make take form of rapidly developing products and moving them to market or rapid product or service delivery.

[12] Roger G. Schroeder, *Operations management*, Graw Hill. 1993, pp. 664—668.



JIT potential paybacks

Manufacturing lead times reduced	80—90 %
Productivity increases	(direct 5—50 %); (indirect 20—60 %)
Purchase price reduction	5—10 %
Inventory reductions: raw materials, work-in-progress, completed goods.	35—75 % 35—75 % 30—90 % 50—90 %
Set-up reduction	75—95 %
Space reduction	40—80 %
Quality improvements	50—55 %
Material stock-outs reduction	50—95 %
Scrap reduction	20—30 %

Source: Richard Burman, *Manufacturing Management — principle and system*, Mc Graw-Hill, 1995, pp. 275.

TOTAL PRODUCTIVE MAINTENANCE:

TPM is a part of the total quality concept, due to the need for the process capability of a machine to be maintained to match the design requirements.

All plant and machinery suppliers should be included in the TPM process, and be prepared to submit their equipment to reliability and risk analysis check. They should also be able to recommend preventive maintenance schedules for their products, and be able to supply full maintenance manuals with diagnostic, fault–tracking charts[13].

4. Jit advantages and disadvantages

Just in time has many pros, the most important are[14]:

— better quality products quality the responsibility of every worker, not just quality control inspectors;

— reduced scrap and rework;

— reduced cycle times;

— lower set-up times;

— smoother production flow;

— less inventory, of raw materials, work-in-progress and finished goods;

— cost savings;

— higher productivity;

— higher worker participation;

— more skilled workforce, able and wiling to switch roles:

— reduced space requirements:

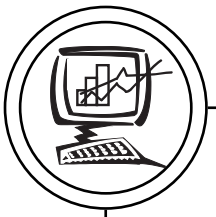
— improved relationships with suppliers.

When we want to implement just in time we should be absolutely sure that implementing of JIT system is a task that cannot be undertaken lightly. It will be expensive in terms of management time and effort, both in terms of the initial implementation and in terms of the continuing effort required to run the system overtime.

A steady and persistent campaign over several years, using continuous improvement process should be noted as «payback figures».

[13]Richard Burman, Manufacturing Management — principle and system, Mc Graw-Hill, 1995, pp. 288.

[14]http://www.dal.ca/~qhe/ie113398/jit.html



Conclusions

JIT is concerned with producing and/or stocking only the necessary items in the necessary quantities at the necessary times. Such a concept requires:

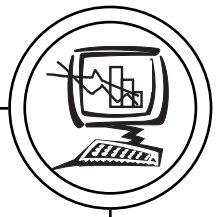
1. minimizing inventory investment;
2. streamlining material flow;
3. shortening production lead times;
4. exposing manufacturing problems to resolve them permanently
5. reacting faster to changes in demand.

The goal of JIT philosophy is to be getting better, and the way to measure a company's concept is to see how little work in process is required to operate. Since inventory protects a plant against problems, in heart of the matter it hides the problems, so they go ignored and unsolved. Problems must be pinpointed before they can be solved, and the way to do so is to drain off some work-in-process inventory.

JIT implementation is intimately related to the overall goals, vision, and objectives of the company.

JIT should be thought of as a means to achieve a desirable objective. With the extensive delegation of what used to be top-management concerns to the employees, the top management is involved in long-term strategic consequences of JIT implementation that affects the future of the company. Simple delegation of concern and common commitment of resources are not enough. The success of JIT implementation lies heavily in the hands of employees. In the long run, the success of JIT implementation hinges heavily on the cycle from top management obligation to employee involvement and back to top management commitment. JIT cannot be implemented without full worker understanding and cooperation. Management must ensure that workers understand their new roles and accept the JIT approach to manufacturing. So many changes are required, as indicated above, that JIT can not possibly succeed without the active and passionate support of all managers and workers. JIT is not simply another program but a whole new near to manufacturing.

1. Burman Richard, Manufacturing Management — principle and system, Mc Graw-Hill, 1995. 2. Dess G. Gregory, Alex Miller, Strategic management, Mc Graw-Hill, 1993. 3. Freeman-Bell Gail, Balkwill James, Management in engineering principles and practice, Prentice Hall International (UK), 1993. 4. Hall E., Just-in-time management: A critical assessment. The Academy of Management Executive 3, November 1989. 5. Hitomi Katsundo, Manufacturing Systems Engineering, Tylor&Francis, 1996. 6. Hussey David, Strategic management from theory to implementation, Butterworth Heinemann 1998. 7. Jacobs Chase Aquilawo, Production and Operation Management, Mc Graw-Hill, 1998. 8. Schonberger Richard J., Some Observations on the Advantages and Implementation of Just-in-time Production Systems, Journal of Operations Management 3, no. 1 (November 1982). 9. Schonberger Richard J., World class manufacturing: The lessons of simplicity applied, The Free Press, a Division of Macmilan, Inc., 1986. 10. Schroeder Roger G., Operations management, Graw Hill. 1993. 11. Schmenner R. H., The merit of making things fast. Sloan Management Review, Fall 1988. 12. Schmitt Tom and Connors Mary, «A Survey of Suppliers» Attitudes Toward the Establishment of JIT», Operations Management Review, 3, no. 4 (Summer 1985). 13. Spearman M. L., CONWIP: A pull Alternative to Kanban, Int. J. Prod. Res., 1990. 14.



Torrington Derek & Hall Laura, Personnel Management — HRM in Action, third edition, Prentice Hall, 1995. 15. Tersine Richard J., Production/Operations management, Concepts, Structure and Analysis, second edition, PTR Prentice — Hall, A. Simon & Schuster Company, 1994. 16. Tersine Richard J., Principles of Inventory and Materials Management, fourth edition, Prentice — Hall International, Inc. A. Simon & Schuster Company, 1994. 17. Womack James P., Jones D. T. and Roos D., The Machine That Changed the World, New York — R. A. Rawston Associates, 1990.

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