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The Jit Gospel

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I. INTRODUCTION

"I believe, it (...JIT...) is truly the best option for Western companies and an option that should be explored by every company" Hay(1988)

Many textbooks, academic and industry magazines have been singing the praises of JIT (Just-In-Time). Since its "discovery" by western manufacturing companies, JIT has been attributed remarkable benefits. Statements like "20 to 50 percent increases in direct and indirect labor productivity, 30 to 40 percent increases in equipment capacity, 80 to 90 percent reductions in manufacturing lead time, 40 to 50 percent reductions in the cost of failure (scrap, rework, and warranties), 8 to 15 percent reductions in the cost of purchased material, 50 to 90 percent reduction in inventories, 30 to 40 percent reductions in space requirements" that made their appearance in the operations management literature (Hay 1988), have tempted many companies to jump on the JIT bandwagon. For many of its enthusiasts, JIT is no longer a production control system ; it has become a creed. The message that can be learned from both theory and practice seems to be that Just-in-Time manufacturing can work in any manufacturing environment, in any industry (Hay (1988)).

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All this did not come by surprise. The fundamental JIT-principles - elimination of waste, total quality creation, human resource involvement, continuous improvement, just to mention these few - are universally desirable results and have been so ever before the advent of JIT; and JIT appeared to offer all these desirable results. The purpose of this paper is not to criticize JIT as such and its underlying good principles. Our basic objective is to raise some warnings against blind adherence to JIT and against being carried away by its 'halo' effect, if any.

The origin of JIT lies in the Japanese automobile industry (Monden (1983), Ohno (1988a), (1988b)); i.e., repetitive discrete flow item manufacturing of relatively standardized products using rather standard mature technology. It was a pull system applied to simple assembly type of operations, resulting in lower inventory levels and a better operational flexibility (responsiveness), largely due to various improvements of the production environment and production parameters. However, it has now ballooned disproportionately and many attempts have been made to implement it in production environments which are completely different from the ones originally aimed for (Ohno and Mito (1988), Shinohara (1988)). There seems to be no excuse for not using JIT (Walleigh 1986). Thus, a word of caution is at place here. Blind adherence to a number of common JIT rules and beliefs may result in strategic damaging consequences, either because they are incorrectly implemented as such or are used in a wrong environment.

The analysis presented in this paper is mainly based on in-depth discussions with fifteen top-level managers operating in various manufacturing industries within Europe (automobile, textile, consumer electronics, steel, consumer products and the pharmaceutical industry). The reactions heard during these discussions ranged from "JIT is a necessity" to "JIT is utopia". This asks for some clarification.

II. JIT DOCTRINES AND BELIEFS

In this section we analyze some of the best-known "dictums", "do's and don'ts" and "beliefs" surrounding JIT. They are assembled in more general themes such as JIT and capacity, JIT and suppliers, JIT and employees, etc.

A. *JIT and capacity*

> *"Set-up time reduction leads to smaller batch sizes, shorter throughput times and consequently reduced inventories and increased market responsiveness. This finally results in lower costs." Hall (1983), Hay (1988), Monden (1983), Schonberger (1981).*

The argument is appealing. Reduced set-up times allow for smaller batches. This leads to reduced waiting lines, short material flow time, reduced throughput time, reduced customer order delivery times, increased market responsiveness. However, the fundamental question is: "How do we do it?"

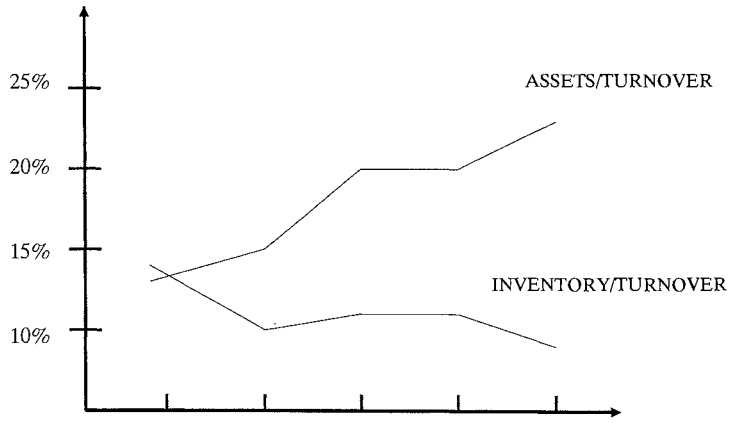
There is no denying that in a repetitive manufacturing environment of mature products and the use of rather standardized, conventional and mature manufacturing technology, effective set-up reduction on bottleneck facilities can be achieved at often low cost (Shingo (1985)). However, blind set-up reduction on non-bottleneck activities may be a pure waste of money (Goldratt and Cox (1984)). In addition, it should be appreciated that set-up reduction does not happen overnight but may take several years (Shingo (1985)). Very often, set-up reduction and its synergetic chain of benefits are achieved through process innovation. It may involve a heavy deployment of state-of-the-art manufacturing and tooling technology, heavy investments in (flexible) automation (flexible manufacturing (FMS) and assembly systems (FAS)), and capital intensive material handling systems (AGVS, AS/RS). Quite often it involves point-of-use manufacturing facilities and standby machines. Set-up time reduction comes at a price.

The finance director of a large textile company, reputed for its widespread JIT efforts on the factory floor, figured out that the capital intensity has gone up, as the inventory to gross revenue ratio has come down. Almost all of our interviewees had the same experience. Moreover, some mentioned that profitability had eroded (which of course depends on many other factors). The point is that JIT asks for flexible capacity - sometimes overcapacity (Schonberger (1981)), not only for the sake of reduced inventories, but also to satisfy the need to be close to the customer as witnessed by increased direct foreign investments in smaller, focused plants near major customers. We clearly see a substitution of inventory by fixed assets. This substitution effect is clearly illustrated in the figure below (for a company in the computer industry). Goldratt (1984) defines inventory as all the mo-

ney that is invested in the system. According to this definition, the inventory increased in a number of JIT companies. A JIT advocate will claim that the efforts to improve the manufacturing process will automatically unfreeze the additional capacity required. We believe that this may not always be the case.

FIGURE 1

Substitution of Inventory by Fixed Assets.



INVENTORY DOWN CAPITAL INTENSITY UP
A COMPANY IN THE COMPUTER INDUSTRY

The increased capital intensity issue is a major concern to many managers. Fixed assets such as machines or buildings can quickly turn into "fixed liabilities" when the business takes a downward trend.

It cannot be sufficiently emphasized that inventory reduction can be achieved in many different ways. One way is to have flexible (over) capacity. For certain industries, for example those using rather inexpensive, conventional, standard machinery, this may be the ideal strategy. However, the story may be completely different for the inherently capital-intensive plants making use of very expensive machines available in limited supply. These plants have to face the reality of bottlenecks. In this case, the so-called load oriented planning systems may offer a better alternative to JIT. In a load oriented planning system we have to control the release of material, which cannot be at a higher rate than the absorption rate of the bottleneck. We refer the reader to the literature (Goldratt and Cox (1984), Jones and Roberts (1989), Wiendahl (1987), Karmarkar (1989)) for more details.

Managers of capital intensive plants in the steel industry for example, view inventory in a different way than their colleagues in the less capital intensive industry. As a Managing Director of a steel-transforming plant puts it: "having more inventory is not as bad as having to live with one investment decision that went wrong". In an assembly plant on the other hand, raw materials and components are often made up of high-value added items while the assembly process itself is a fairly simple process that does not require substantial capital investment and that does not add substantial value. Consequently, inventories constitute a major cost component that may be considered as "evil".

"Stockless production is more than a set of established techniques to be installed. It is a fundamental way of thinking." Hall (1983).

"Holding inventories, in particular buffer stocks, is evil. It is bad for the manufacturing process." Hall (1983).

"The balancing act. The importance of uniform plant load." Hay (1988).

Strive for a "levelled, synchronized production" says the JIT manual. Basically this means, "manage your demand function". In a stable demand environment - typical for repetitive manufacturing environments where 'a little bit of everything is made every day' - the driving force at the final assembly stage can be a mixed-model sequence which sprouts the various pulling cycles. The concept of mixed model production is not bad as such. The crucial point is that very often the underlying assumption of a stable repetitive demand which allows for deterministic, stable and often frozen master production schedules is not met. If there are wide fluctuations in product demand, holding inventories at effective levels in the production process might be a blessing.

Inventory is neither evil nor good. Inventories do often play a strategic role. A manufacturer in the electronics industry uses the concept of *Strategic Driven Inventory. Inventory is not the root-cause of all production/logistics problems; bad planning and thoughtless application of narrow theories and dogmas are.* In many practical settings holding inventories is necessary because of uncertainties, process time variabilities, capacity limitations, process decoupling, etc. (Conway et al.

(1987), Jackson (1991)). The JIT philosophy asks us to eliminate that need. In many practical settings, however, the favorable conditions of the repetitive automobile industry (modular approach, stable demand patterns, etc..) are absent. Manufacturers often have to deal with more product variety, unreliable processes and/or unpredictable yields (e.g. chip production), utterly new, advanced and immature technology. As a consequence, uncertainty and instability are unavoidable, at least during the burn-in years of the manufacturing process. JIT-ting in unstable process technology environments may present problems that may effectively kill the throughput of the company.

B. *JIT and Suppliers*

> *"In the Japanese style of manufacturing, two things are vital: the elimination of waste in production and stocks by 'just-in-time' delivery of parts; and close co-operation with parts suppliers over quality as well as R&D. Both require proximity." The Economist, February 23, (1991)*
>
> *"Stockless production has much larger goals than just inventory reduction. The intent is to strengthen the production capabilities of both customers and suppliers. Inventory may temporarily be shifted to suppliers in the course of doing so, but the long-term goal is to reduce inventory everywhere."*
>
> *"The objectives with suppliers, in order, are (1) eliminate safety stocks, and (2) eliminate incoming inspection and sorting."*
>
> *"There are many instances in which one part is found only in one place."*
>
> *"Another misconception about stockless production is that companies merely push their inventory onto their suppliers. That is not true of the large suppliers. It is not true of the small suppliers either." Hall (1983)*

Subcontracting companies occupy a rather peculiar place in Japanese industry. The big repetitive manufacturing firms (e.g. Toyota) rely largely on subcontracting for what seems to be good reasons (Herroelen (1984), Juckler (1984), Van Wassenhove (1984)). They refrain from vertical integration and *produce only their key (strategic) parts*. Their

real know-how is in handling a large number of parts, i.e. in an efficient organization to assemble these parts into a final product over and over again. Toyota receives several advantages from subcontracting *a large number of relatively simple parts*. Small subcontractors can produce these parts a lot cheaper since they do not face the large overhead costs which big companies such as Toyota have to face. Big firms can put several subcontractors in competition for the same relatively simple parts, which helps in cutting prices. Big companies like Toyota impose learning curve tactics on their subcontractors forcing them to reduce their costs (and prices) every year. Most small subcontractors are entirely dependent upon one big firm and are therefore in no position to object (Van Wassenhove (1984)). This view is also confirmed by Moritani (1982) who states that "The component subcontractors bear the brunt of price competition. The big manufacturers, in fierce competition with each other, try to beat down the price of parts as much as possible in order to maintain competitiveness of their export products. The subcontractors are in no position to refuse".

Ask any so-called Western JIT company and they will tell you that they became very demanding with respect to their suppliers. A strong JIT supplier network seems to be a must, resulting in 'strengthened production capabilities of both the customer and supplier'. Without any doubt, there are many situations where "the supplier has learnt to manage its operations more efficiently and it has cut down the costs". Nevertheless we would like to raise some warnings against blind faith in the supplier network.

Before we dig into our main arguments, we should be aware of the following. *Subcontracting may have a number of reasons and subcontractors may be of different types*. In a MITI report (1982), it is stated that Japanese mother companies mainly subcontract because subcontracting companies have specialized technology and specialized equipment, because subcontractors have the capacity that the parent company is lacking, because subcontracting provides them greater flexibility towards lot size fluctuations, lower costs of personnel and equipment. From the outset we must realize that the Japanese word "subcontractor" (actually they have different words for the several types) can cover a wide variety of situations. Some subcontractors are simply subsidiaries created and owned by the mother companies. Their activities are completely tied to the main company. Some are independent companies, which became authorized suppliers, often not allowed to supply other mother companies. Some companies are

independent and supply to many companies (Hall (1983), Juckler (1984)).

Genuine JIT means *synchronized manufacturing*: the supplier makes the required item just-in-time for the mother company to use it in its own manufacturing operations. Even in the repetitive discrete item manufacturing environment where true JIT was born - the car industry - *achieving JIT supplies may be a tremendous task*. In a study of car-parts makers in the European Community, carried out for the European Commission by the Boston Consulting Group, it is discovered that only nine firms succeeded to implement examples of genuine JIT operations (The Economist (1991)). *In most cases, the parts-makers have simply invested in 'buffer-stock' warehouses close to the car maker's plant from which frequent deliveries are made.*

In addition, there are good reasons for not *relying solely on real JIT supplies*. Even Japanese companies do not have JIT supplies for all the items they need. It seems logical to rely on JIT supplies (small lots, frequent deliveries just-in-time) for relatively high valued, high quality items which can be delivered over short distances with low transport costs by a reliable transportation system.

Given all the good reasons for and side remarks on subcontracting, there is, however, a key problem which can be summarized as follows. *Where a mother company may be operating in a perfect JIT production environment (e.g. repetitive assembly of standard products), this may not be necessarily the case for its suppliers*. A good example is provided by the assembly plants of personal computers vis-à-vis the supplier plants where the semiconductor chips are made. *Both clearly operate in a different production environment - the well established flow line versus the yield-suffering job shop, but they are both part of the same network of mutual dependency*. As a result, the supplier company - forced to operate in what could be called a non-JIT biotope - may be forced or deliberately opts for JIT supplies. How does it cope with that ? One large steel company mentioned that they had to increase the stock of finished products by an equivalent of four weeks. Another steel company was forced to set up a separate focused plant, in another continent, close to their customer. This dedicated plant does not offer the full scale of steel products, but only a limited range. The question is whether the return of such a heavy investment is sufficient to offset the diseconomies of multiple plant locations. When the economy is booming, not many may feel the pinch ; but when the economy goes bust, it would spell disaster.

Many companies decide to *outsource components for the simple reason that producing them in their own JIT environment is too problematic*. Can we expect that the supplier will do better ? A car assembly plant for example, may decide to outsource the production of painted car bumpers because matching the car body sequence on the assembly line with the bumper sequence creates nightmares. Will the bumper supplying company be capable of doing better in the sense of making just-in-time mixed-model bumper deliveries along the final assembly line ?

The General Manager of Purchasing and Materials Supply of a large computer company states that the purchasing lead times of several class A items, such as discs and semiconductors, remains a serious problem. Similarly, power supplies, plastic mouldings and chassis for the mainframe computers are far from being supplied just-in-time. For these items, the lead times are running in several weeks or months. For some of the items, the lead times have in fact increased, due to special customer specifications.

In addition, *supplier chains may go several levels deep. Suppliers do have their own suppliers. In a supplier chain, the weakest link determines the chain's performance*. Moreover, an improvement induced in one link of the chain does not necessarily lead into an improvement of the entire chain. A recent study of the supplier networks in Belgium (Plouvier and Ramioul (1990)) revealed that the small to medium sized companies cannot always assure the required capacity and the necessary investments in information technology.

Another issue of deep concern is the fact that a number of well integrated companies run the *risk of loosing their engineering basis due to the increased emphasis on outsourcing*. A well-known computer processor chip maker, had to call in Malaysian experts from its Penang factory to help set up the chip assembly line at an automated chip-making factory it started building in Arizona some years ago. None of its U.S. employees had that expertise any longer (Business Week (1986)).

Another point of major concern related to close supplier networks has to do with the *possibility of a potential business conflict*. The idea behind a sole-supplier relationship is that you share information with the supplier, discuss design issues, participate in product development and research, exchange information on production plans, future needs, etc. Suppliers should know the mother company as an insider, and should behave like one. Most of our interviewees were concerned

about this issue. An important company supplier may also be a supplier to the mother company's major competitors. Mother companies do not appreciate that a number of company secrets (product and process innovations, advanced production process technology, just to name a few) are "supplied" to their competitors. The problem is not necessarily typical of JIT-marriage relationships. But given the close relationships required by the JIT supplier chain - including joint research - the problem has become acute. Some companies try to protect themselves through legal contracts (rules of conduct); others are forced to go as far as monopolizing the supplier.

C. *JIT and employees*

> *"The responsibility for quality rests with the makers of the part. The only affordable way to control quality in all processes is for workers to do it themselves. Production foremen should be the quality experts. Total involvement means a sharing in the quality control responsibility by all plant employees." Schonberger (1982).*
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> *"The attitude of management toward the workers is also critical- ...The Japanese say 'What workers are doing today is only tapping their capability. We must give them an opportunity to do more'." Chase and Aquilano (1989).*
>
> *"The culture of employee involvement, of teamwork, must be developed in a company in order for JIT to work. There are three main areas that need to be explored: (1) Work force flexibility (job descriptions, work practices, cross training, working in teams rather than individually), (2) Employee involvement (self-inspection, problem solving, continuous improvement, (3) Teamwork (risk taking, willingness to experiment, cooperation across departmental lines)." Hay (1988).*

No system depends on the employee as much as the JIT (pull) system, and, perhaps, no system takes the employee for granted as much as the JIT system. JIT-workers are expected to be multifunctional, are expected to solve quality problems, are expected to work in groups, are expected to be set-up reduction masters, are expected to kick on quality circles, are expected to use their brains. How are we so sure

that this type of super-employee exists ? How are we so sure that JIT-employees like the requirements imposed on them ?

The first assumption we want to relax is that JIT workers are the single source of quality. We do not argue that quality involvement should not start at the workplace, nor that quality achievement is not part of the worker's responsibility. We only want to stress that employees on the floor alone, will not get the job done. Jungi Noguchi, General Manager of the Union of Japanese Scientists and Engineers (JUSE) states that "Workers and foremen can solve only 15 percent of all quality control problems. The rest must be handled by management or the engineering staff" (Noguchi (1981)). Juran himself (Juran (1981)) is quoted for saying that "There is no possibility for the workforce to make a major contribution to solving a company's quality problems".

Moreover, JIT dictates the management system should provide every worker with an opportunity to display his or her maximum capabilities. It is imperative that the management system should believe that workers can do much more than they are now given the opportunity to do. Of equal importance, however, is the question whether the workers welcome this. *Working in a JIT environment may be demanding and stressful.* To quote Klein (1989): 'Now they (employees) have targets every day, now you're under the gun all the time'. Indeed, JIT requires strict adherence to rigid methods and procedures ; floor discipline is a must. At the same time management fully exploits the possibilities offered by the flexible labour time systems (shift systems) and new forms of job content (multifunctionality). It is crucial that managers should have a clear idea of workers' expectations.

During our interviews, managers admitted that the JIT implementation is still very much a top-down approach and that it has not yet taken up at the grassroots level. It requires a great deal of trust and this is a two-way street. How can an employee be expected to remain faithful to whatever 'more' is asked when the company had to reduce the number of employees, while company sales went up. Faithfulness is a two-way process. You cannot ask what you cannot give.

Saying that JIT is still much of a top-down approach, however, is not denying that bottom-up gathering of information is crucial. One of the competitive advantages of Japanese manufacturers seems to be their way of gathering information within their own firm and using it to take decisions. Compared with the stereotyped western firm, they seem to operate from the bottom up rather than the top down. In-

formation flows freely up the organization, and decisions are taken at, or at least initiated, at relatively low levels. 'The generals rarely send orders to the troops. The troops send orders to the generals, for their approval' (The Economist (1991)).

D. *JIT and strategy*

> *"Just-in-Time (JIT) production systems are changing the way manufacturing organizations do business. Like MRP in the 1970s, JIT systems are at least contemplated by virtually every major manufacturing organization." Chase and Aquilano (1989).*

As we mentioned in the introduction of this paper, the origin of JIT lies in the Japanese automobile industry; i.e., repetitive discrete item flow manufacturing of relatively standardized products using rather standard mature technology. Repetitive discrete item manufacturing - production systems that make the same basic product over and over again - is the *natural biotope of genuine JIT*. This biotope is where the genuine JIT tree grows best: a repetitive environment (make a little bit of everything every day) which allows for stabilized, levelled master production plans which sprout mixed-model final assembly plans aimed at keeping the usage rate of components and subassemblies as level as possible and which create the *necessary* conditions for a relatively simple system of production control - the pulling cycle. A levelled production plan, however, is not enough. *Sufficient* conditions are created by very simple mechanisms and procedures for authorizing production and transportation (the Kanban control system), small lot sizes, set-up reduction and/or elimination on bottleneck machines, physical reorganization on the production floor exploiting as much as possible the benefits of line or cell layouts, and just-in-time supplies. This synergetic chain of necessity-sufficiency relationships goes several layers deep, culminating at the kernel of total quality creation.

The apparent productivity and competitive success of the Japanese repetitive manufacturing industry shook the western manufacturing industry. As the various links in the above mentioned synergetic chain of genuine JIT penetrated in the western manufacturing world, each individual branch of the genuine JIT tree was discovered, studied, pampered and cultivated by its own. Many of the branches were used as cuttings to grow unhealthy JIT trees in unnatural biotopes,

many of them were severely mistreated, others ballooned disproportionately with the result that the cultivators no longer see the wood for the trees. "Full-fledged JIT" was born and became a new management philosophy, became a must. The point is, blind adherence to the individual branches of the JIT tree may have strategically damaging consequences.

Flexibility, product variety, short lead times, operational speed are sound branches of the JIT tree, but need not always be the top priority items in a company's strategic basket. In addition, all of them might come at a cost. *Flexibility* is not easy to achieve and comes at a price. Very often, it is pursued through capital intensive investments with high exit barriers. A steel company may be tempted to *advertise* themselves as a tailor-made short lead-time supplier of a variety of rolled steel products. Making small tonnages of orders with *conventional* technology originally aimed at mass production, may lead to increased operating costs and rising finished goods inventory. The company may be trapped in an image position with no return, while their main competitors are found to supply neither tailor-made products nor JIT. Companies may seek speed and *flexibility* through the process of setting up dedicated plants next-door to their customers which may be located at the other side of the ocean. As such, they have to live with the constant danger of overlooking the elementary problems of scale. *Economies of scope may be real, economies of scale are not evil.*

Careful studies of a company's internal strength, its market and costs are natural predecessors to the deployment of flexibility strategies. *Blindly following the precepts of speed and flexibility may be the speedy way of inviting disaster.* As stated by one of our interviewees: "As long as you have a new and useful product, the reaction times and costs, although important, are secondary considerations".

Continuous *step-by-step improvement* - often quoted as one of the JIT fundamentals - should be an important management concern. It is of prime importance, however, in that type of industrial environment where products and production processes are in the maturity stage of the life-cycle. The JIT system itself, with its emphasis on manufacturing efficiency, manufacturing speed and some degree of product-mix flexibility was created in response to a particular situation. The situation being that of a product which is not going to change in its basics and, therefore, will suffer from a gradual set of changes 'step-by-step'. However, there is nothing virtuous and universal about step-by-step changes.

For several industries, the real strength lies in their research and development. Long-term oriented research and technological breakthroughs is what they really thrive on. Product innovation - launching new products in the burn-in phase of their life-cycle - is their business. As we mentioned before, *having a real useful innovative top quality product may be the primary issue; flexibility and low costs may be secondary matters.*

Total quality and company wide quality creation was the necessary oil for the JIT engine to run smoothly. It is the fertile soil that pampers the root of the JIT tree. The eminent successes of Japanese manufacturing, carrying the top quality label in its banner, created a total quality awareness in the western manufacturing world. Company wide quality creation became the standard-bearer of full-fledged JIT, and rightly so. For many companies, JIT ***is*** *total quality creation.* The constant strive towards total quality may be the soundest branch of the JIT tree, with guaranteed survival outside the original JIT biotope. Again, however, some sound realism is desirable. As Ishikawa (1983) puts it: "Japanese intellectuals and journalists have just begun to take interest in quality control, because they have been stimulated by overseas newspapers, weekly magazines and broadcasts. At this point, I think that it is more important to continue the quality creation practices than advertise them, since I am afraid that careless journalism may make a kind of noise that prevents company wide quality creation from making a healthy development". *Company wide quality creation is much more than the simple introduction of a set of quality circles (Inaba (1981), Ishikawa (1983)).*

JIT is not a must. Deploying a blind JIT strategy in a non-JIT environment may be dangerous. Desperately seeking flexibility through heavy capital intensive investments may play havoc with a company's profitability. Blind adherence to outsourcing may create corporations which have lost their crucial engineering basis. Reducing JIT to the process of shifting stocks to suppliers, rather than getting them out of the system altogether, may help but not that much. *Deploying an effective corporate strategy is much more than paying a simple lip-service to Japanese management techniques.* The many JIT tree branches are sound, but may suffer if they are transplanted out of their natural biotope. Coping with the many cornerstones of JIT in their sound natural environment itself, may be a heavy task. One of the reasons why JIT yields are not that big an improvement as expected may lie in the fact that companies have tried to grow JIT trees in 'enemy' soil and/or in

the fact that, living on the 'friendly' soil, they have failed in the implementation stage. JIT does not and cannot reduce the need for overall strategic planning and building the systems accordingly.

E. *JIT and business culture*

> *"One of the sources of Japan's technological power is nothing else than the uniform attitude within an entire Japanese company, from president to the rank and file, of desiring to make the company better, working at their jobs with an unflagging sense of purpose." Moritani (1982).*
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> *"Japanese and American management are similar for 95% but differ in all important aspects." Takeo Fujisawa, Co-founder of Honda Motor Company.*
>
> *"Employee involvement is a given in the Japanese culture, something Japanese manufacturing managers didn't even have to think about when they were working with JIT. But in the West, the culture of employee involvement, of teamwork must be developed in a company in order for JIT to work." Hay (1988).*

It is an almost impossible task to summarize the work of so many researchers who claim that the social and cultural background of the Japanese is different from the western world. That cultural background is reflected in the "Japanese" management style, the "Japanese" industrial organization and the "Japanese" production philosophy. Without dwelling into detail into the real meaning behind concepts such as *Amae* (dependency), *On* (the obligations every Japanese has to fulfill to the group, the family and the community), *Iemoto* (authority in management), *Ringi* (consensus management), it can be said that *stability and security* rank among the primary objectives of Japanese management. The idea of the group as a family within the larger family (company) is very 'helpful' in that respect. *Many JIT attributes basically boil down to two basic concepts: discipline and loyalty.*

A *successful implementation of JIT requires discipline* (repetitive schedules, perfect quality, tight process control, line stop procedures, correct timing, transfer of information, predictive maintenance,..). One of the tools in the Japanese magic JIT box is to transform - whenever feasible and effective - the production organization into an

almost deterministic environment, because of what is often explained to be their lack of "talent" to deal with uncertainty.

A successful implementation of JIT requires loyalty; loyalty with respect to the group, the company, the suppliers and mother companies, the nation. As already suggested, loyalty is subtle and may appear through different forms : obligation and the sense of guilt (Bolle de Bal (1983)), dependence, the acceptance of authority, the will to contribute. The management style, the organization of labor unions, the industrial structure (Keiretsu), the so-called "Japan Inc. feeling", may all be the simple consequences of a fundamental feeling of loyalty.

The JIT tree has grown in its own cultural environment. When applying JIT in the western world, we cannot discount its Japanese social and cultural roots. Restraint or discipline, and loyalty are part of the Japanese culture, and JIT fitted in very well with this background. The fact that it took the Japanese ten to twenty years to implement JIT, proves that there is more involved than culture. It is also a question of organization (incentive system, carreer planning, training, lifetime employment,...). The key issue is whether the western companies can also develop an organizational structure that fits the JIT approach, knowing that the culture is different. It will be necessary to find other management styles, other ways to motivate people, another balance between cooperation and competition, and ways to incorporate aspects of reciprocity.

III. CONCLUSIONS

The basic purpose of this paper was to raise some warnings against blind adherence to JIT precepts, so that managers should not misunderstand both the scope and context of a JIT implementation. Genuine JIT requires a very specific production environment. Many, if not all, branches of the JIT tree are sound. But, their natural biotope is repetitive discrete flow item manufacturing of relatively standardized products using rather standard mature technology. Transplanting JIT trees out of their natural biotope may cause them to suffer and run into several problems. In extreme cases, JIT may become dangerous and may result in misguided strategic signals.

Managers have to be aware of the impact of JIT on capital intensity, the dangers of zero inventory production and levelled master production schedules in those situations where (demand) uncertainty and in-

stability are unavoidable, the danger of undesirable transfers of technological information, the danger of de-emphasizing the importance of basic research and innovative capacity, the danger of simply transferring inventory to suppliers which in the long run will come at a price, and the fact that JIT may result in focusing on short term, pure efficiency performance measures. The biotope analogy we used in this paper not only refers to the production environment but also to the social and cultural environment.

The whirlpool of buzzwords and slogans we are confronted with these days give some people the impression that JIT is the only way out, which is not true. In fact, in a large majority of cases, the judicious use of the variety of powerful production planning and control tools and techniques may offer the solutions to efficient, effective and flexible manufacturing systems. Many components of the full-fledged JIT picture are very often strongly related to efficient and effective common sense management practice. This does not mean, however, that the important lessons we learned from implementing powerful production planning and control systems should be thrown overboard. Let us not throw out the baby with the bath-water.

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