# ICT and Lean Management: Will They Ever Get Along?

Thomas Houy

Communications & Strategies

September 2005

# ICT and Lean Management: Will They Ever Get Along? (*)

**Thomas HOUY**
Department of Economics, Management and Human Sciences
ENST, Paris

***Abstract:*** In companies, Information and Communication Technologies (ICTs) accelerate the speed with which information is exchanged between employees, facilitate the processing of data and improve the quality of intra-company communication. As such, ICTs are powerful management support tools and can help to boost firms' performance. However, there is no consensus as to the way in which they should be used. The aim of this article is to contribute to the discussion on the various ways that ICTs are used in companies. Its empirical analysis is based on observations of the paradoxical practices and reasoning that dominate the lean manufacturing approach. Although the lean manufacturing approach considers that ICTs are useful to a degree for carrying out certain tasks, it emphasises the inefficiencies that can result from an inappropriate use of these technologies.
***Key words:*** Use, Information and Communication Technology, Lean Management, Information Systems, Toyota Production System

The contribution made by Information and Communication Technologies (ICTs) to productive organisations seems obvious: accelerated data processing and the improvement in the dissemination of information exchanged between employees suggest that ICTs make a significant and positive contribution to a company's performance. However, the correlation between a company's productivity and its level of ICT equipment remains unproven. Indeed, several researchers have highlighted the lack of a direct relationship between these two variables (GREENAN & MAIRESSE, 2000; JANOD, 2004). This apparent paradox is usually referred to as Solow's paradox.

(*) I wish to thank Michael Balle, Godefroy Beauvallet, David Bounie, Marc Bourreau and Michel Gensollen for their precious assistance in preparing this article. The Laboratory for Innovation Economics and the e-Company Program of France Télécom R&D funded part of this research through the Projet Lean Entreprise (www.lean.enst.fr).

The debate on the correct use of ICTs in companies remains open: if the integration of new communication tools, whose objective characteristics make them powerful management support tools, does not automatically result in improvements at an operational level in companies, this raises questions regarding the use and appropriation of ICTs in companies.

One argument is often advanced to try to explain Solow's paradox: in order to be effective, companies must accompany the implementation of ICTs with appropriate organisational changes (Askenazy & Gianella, 2000; Greenan & Mangematin, 1999). This thesis, supported by pertinent empirical research works (ICHIONIOWSKI, SHAW & PRENNUSHI, 1997; GREENAN & GUELLEC, 1998), has opened up a wide-ranging debate on the nature of the organisational practices that are suitable for the integration of ICTs within companies. Measuring the impact of ICTs on the performance of companies by trying to define suitable organisational models to accompany these new technologies undoubtedly contributes to a better understanding of Solow's paradox. A complementary approach to assess the relationship between ICTs and company productivity involves studying the way in which ICTs are used within each organisational system.

Two analytical approaches can be distinguished: the first is based on the observation of cases where ICTs have been successfully integrated into companies and sets out to identify organisational practices which have facilitated that successful integration; the second attempts, reciprocally, starting from organisational practices that have been successful, to observe which tools and ICT uses combine effectively in such practices. The first approach can be used to compare organisational practices from the point of view of their compatibility with ICTs in general; the second does not see ICTs as a whole, but sets out to precisely measure the balance at a micro level between specific technical tools and organisational practices. The analysis in this article is based on the second approach and studies ICT usage prevailing in a specific management paradigm, lean management.

An illustration of the way in which ICTs can be integrated into certain companies is intended to contribute to a better understanding of the scope and limits of ICT for management. Studying the lean management approach to clarify the normative debate on the correct use of ICT in companies will also provide an opportunity to address the relevance of the applications proposed by the new technologies in a specific organisational context. This examination will be particularly instructive as the reasoning of lean management advocates is supported by arguments based on management

and organisational efficiency principles, rather than being inspired by irrational conservatism.

The article begins with a brief presentation of the analytical method used, which is followed by a definition of the lean management approach. The lean informational paradigm is then discussed and compared with practices in the workplace. Finally, the role allocated to ICTs in these specific organisations, the ways they are used and their consequences from the point of view of controlling operators and sharing knowledge between employees are discussed.

## ■ The analytical method

To deal with the question of the use of ICT in a lean environment, I have adopted a twofold approach in this article based on an analysis of existing literature on the subject and the observation of practices in the workplace.

There is an abundance of prescriptive literature on how lean companies should organise the internal circulation of information. Numerous books, published mainly by consultants, concentrate on establishing informational rules that govern the way in which lean companies operate. Selecting several of these publications will facilitate an analysis of the content of the arguments in favour of lean manufacturing [1]. The aim is to use these texts as evidence of how lean companies view ICTs.

The observation of workplace practices will enable us to compare the arguments advance by advocates of the lean approach with the facts. The views expressed in this regard will be based on the in situ observation of several companies in diverse business sectors, as well as feedback from practitioners of the lean method during the "Lean en France" and "Lean et Systèmes d'Information" seminars organised by the Projet Lean Entreprise over the last year [2].

---

[1] Bounine, Bouzebouk, Choi, Drew, Liker, McCallum, Roggenhofer, Womack are lean authors chosen to analyse arguments of lean manufacturing advocates.

[2] The *Projet Lean Entreprise* provided me, via seminars and factory visits, with a “shop floor” basis for this article

## ■ The lean manufacturing approach

### Background

Although the lean approach is very much inspired today by Japanese management methods, and more particularly by the *Toyota Production System*, it may have originated in the United States. *Training Within Industry* (USA, 1940-1945) may have been the source of methods for improving productivity, such as quality circles or the Kaizen (HUNTZINGER, 2002).

After several years, the success of this approach in Japan, which was not yet called lean, but which had started to take shape, aroused clear interest among European and American industrialists. From the 1970s, attempts were made to export Japanese production methods. Unfortunately, these experiences were not as successful as expected. At that time, numerous analysts blamed the lack of success on a culturalist hypothesis, whereby Japanese management methods are difficult to export due to their close links to the unique social context of their country.

That hypothesis prevailed until the end of the 1980s. However, at the start of the 1990s, that argument was not so readily accepted and it was considered simplistic to explain the failure to establish Japanese methods in Europe and the United States with purely culturalist arguments. Several researchers studied the subject closely and engaged in precise empirical and theoretical research. Their work formed the basis for the first definition of lean management.

It is to be noted that the lean approach is now subject to a certain degree of criticism from academics. Most economics and management researchers point to the lack of empirical data on the economic trade-offs and the pronounced influence of consulting firms in publications on lean management. The lean manufacturing approach, as presented and studied today, is based on assumptions that have been insufficiently debated. These criticisms are justified in the light of the flagrant shortage of formalised economic articles on the subject (KOSKELA, 2004). This shortcoming sometimes discredits a method, which is nevertheless strongly supported by industrialists with direct practical experience of it (HOLWEG, 2005). However, the lean approach merits special attention since it offers a series of remarkably stylised facts, particularly with regard to the informational practices associated with it.

## Lean in France today

Measuring the development of the lean approach in a country is difficult since the term "lean" is used by numerous companies that merely apply traditional, just-in-time methods. However, the lean approach encompasses a large number of other dimensions. These difficulties undoubtedly explain the absence of empirical studies on the number of French companies that have adopted this management method. It is nevertheless possible to present a broad outline of several trends in the implementation of the lean approach by French industry.

The lean manufacturing approach is currently chiefly used in the automobile industry in France. Most carmakers, parts manufacturers and their first and second-tier sub-contractors are inspired by the *Toyota Production System*. Given the spectacular productivity gains achieved by the Toyota group over the years, it was logical for the lean manufacturing approach to spread within the automobile sector first of all. Moreover, over the past few years, the aeronautics industry has adopted lean production methods. The food-processing industry seems to have been using methods that are similar to the lean approach for a long time (without, however, employing the term to describe them) for structural reasons relating to the requirements of its sector (quality certification, traceability of products, etc.).

Therefore, the lean approach in France today mainly concerns industry. In the service sector lean management methods compete with alternative successful approaches based on "low cost" competition.

## Concepts at the heart of the lean approach

The two pillars of lean manufacturing are just-in-time and autonomation. Just-in-time includes the concepts of continuous flow and pull production, rapid tool changes and the integration of logistics. Autonomation is a term that groups together procedures for stopping the production line automatically in the event of a problem, methods for eliminating causes of error and problem analysis. Lean manufacturing practitioners emphasise the fact that these concepts must be seen as a consistent whole whose procedures cannot be separated.

## ■ The lean manufacturing informational model

### Proposals by lean authors

Drawing on existing literature on the subject, it is possible to outline the lean informational model.

#### *General principles*

Several key ideas emerge from the analyses of lean authors on the way lean companies should manage in-house information flows.

It is clear from the large volume of literature on lean management that the most widely advocated idea involves putting in place a simplified information management system. All the authors of normative books on the lean concept support the following argument: the reliability and performance of a company's processes must make it easier to minimise information management needs (WOMACK, 2004). According to them, ensuring that each stage of the company's process is capable and available [3] should limit the use of information alerts on the malfunctioning of a procedure. In other words, these authors maintain that it is preferable to eliminate the causes of malfunctioning than to automate reporting functions aimed at warning managers of the existence of the problem.

In addition, lean authors recommend that the processing of information within a company should be decentralised. They consider that organisations based on continuous flow should limit information needs to local communication between upstream and downstream production units. The processing of information, particularly when it concerns starting production mechanisms, must therefore be decentralised. It should not be communicated via a central system, but should be based on a labelling system that provides a direct, single and automatic link between the department that wants to obtain a piece and the department that produces it. James Womack uses the term "reflex controls" to characterise the decentralised, direct, automatic relationship that must prevail between upstream and downstream production units. Lean companies must give

[3] Available means to be able to produce a piece whenever it is needed.

priority to a decentralised approach, based on the transmission of selected local information. Only a small amount of information must be stored.

> "Piling up information in a large inventory is as bad – maybe worse – than piling up large inventories of products." (WOMACK, 2004)

According to lean authors, the aim of an information system is to indicate at all times and to each operator what type of piece to produce, when to produce it and in what volume (BOUZEBOUK, 2002). This definition of the role of information within a company leads authors to discuss the updating of data and the size of "information batches". Since the information should inform each operator what he should do at a given time, lean authors conclude that information must be updated frequently. This updating requirement of information has consequences for the quantity of information contained in each message. In their view it is preferable to send information in small batches at a high frequency than to send it in large batches infrequently. This requirement for updating data laid down by lean authors supports them in their view that digitized, centralised, integrated information systems are unsuitable.

> "Centralised systems fail to take into account variations quickly enough. They are based on a small number of basic assumptions, which whenever they are called into question (by events as common as a late delivery, a series of defective pieces or a machine failure) can quickly go wrong". (DREW, McCALLUM & ROGGENHOFER, 2004).

Another idea that can be gleaned from the views of authors of normative works in this area is that the management of information must be transparent and intuitive. In their view, one of the keys to the lean system is its emphasis on making system failures immediately visible, so that they can be treated immediately.

Another recurring argument is that too much information kills information:

> "Sharing a lot of information with everyone ensures that no one will have the right information when it's needed" (LIKER & CHOI, 2004).

This argument leads lean authors to claim that it is preferable to make all information easily accessible and to leave it to operators to find information themselves, instead of transmitting information to them. In this way, the right information will reach the right person at the right time.

The views of lean authors on, "what constitutes an efficient information system" naturally has an impact on the nature of information and the use made of it.

*The nature and use of information*

According to lean authors, the nature of the information exchanged between employees must relate to the design of products. Information exchanged must concern production processes, work standards or suggestions for improving productivity. The approach advocated by lean authors is therefore similar to a design to cost approach where little use is made of market information. Design information, on the contrary, is seen as indispensable to achieve production objectives.

Lean authors also want companies to give priority to succinct progress schedules thanks to which they can produce ad hoc precise and detailed quantitative analyses. Moreover, these authors distrust abstractions from reality and reporting solutions offered by integrated management software packages. In their view, it is preferable for employees to search for the information they need, as and when they need it, rather than configuring software to provide them with information that is repeated at predetermined times.

Given the nature of the information exchanged within lean companies (operational information), information mainly circulates horizontally. The nature of the information exchanged directly shapes the way in which it circulates. Since the information exchanged within lean companies tends to be more operational, it is only useful between operators that need it.

In terms of information systems, lean authors emphasise the relevance of a "multi channel" system that is only partially digitized, since access to information must never be restricted. In their view, only the most frequent cases must be digitized, with exceptions managed manually.

Finally, the lean approach, as advanced in the works of numerous authors, reveals an atypical informational reasoning model. What is the situation as regards workplace practices?

## Tools used and views of practitioners

Practitioners of the lean method put in place original tools. Many of these communication tools are visual. Here are several examples:

***Visual communication tools***

*The labelling system*

The labelling system is known, in lean companies, as "Kanban". Companies that adopt this system place a label on each batch of pieces. This document contains various pieces of information: the article's reference, the quantity of articles in the container, the destination of the container (downstream machine or storage), a plain description of the piece, the number of containers in the batch treated, its location in the storage area, information concerning the route of the piece in the production unit or information on the packaging of pieces. Other information considered useful by the company can be recorded on the label.

The aim of this label is to send a signal that enables the company to produce only parts to replace parts which have just been used and in the order of their use. This system is therefore a tool which determines the way in which production is initiated by orders based on product output. In practice, a production unit may have to produce several items and the rate at which items are used can vary. In such cases, the labelling system becomes slightly more complicated in order to manage production priorities.

Practitioners who use this tool consider it to be ideally suited to working on pull production flows. In their view it has several advantages: the labelling system enables them to inform each operator about what he or she must do, when this must be done and the volumes required. Practitioners also like this method for its simplicity.

*The andon cord*

The andon cord, generally located above each operator's head, enables the operator to send a visual and/or sound signal to the line supervisor to warn of a problem on the production line. This cord can also be used if the operator wants to speed up the supply of inputs. This method of signalling problems lies at the heart of the problem solving approach of lean companies. When an operator takes the initiative of pulling the andon cord, it is the supervisor's responsibility to go to the workstation involved and resolve the problem. If the supervisor cannot solve the problem, the production line is stopped at the next workstation.

This cord automatically triggers a warning signal that can be seen by everyone and requires action to be taken at the source of the malfunctioning. Lean practitioners believe that the most effective way of dealing with

problems is to identify the source in the production area and believe this system to be ideal for that purpose. It is very expensive for a company to stop the production line, but stoppages in this context are justified by supporters of this method, who argue that it is preferable to bear this direct cost at the time the production line is stopped, rather than to have to bear the indirect cost that the company will face if it allows a problem to persist. The logic is to make problems visible so that they can be treated immediately, even if the direct cost of solving the problem may seem high.

In practical terms, this warning method has a major drawback with regard to the possible interpretation of the message sent by the operator to the line supervisor and other team members. By activating the cord, the operator announces that he or she has a problem. However, operators often prefer to hide their problems, rather than send out a negative signal on the quality of their work. In order to ensure the smooth functioning of this system, practitioners emphasise that it is important to educate operators, so that they understand the company's approach to identifying anomalies. This requires an ongoing effort by plant managers to educate operators and make them understand that triggering the warning does not mean that the employee has made an individual error, but indicates a collective failure, which must be treated collectively for the general good.

*Video*

Lean industrialists are generally obsessed by eliminating waste within their production processes. They distinguish seven types of waste: overproduction, waiting, needless transportation and handling, needless machining, inventory, needless movements and faulty products. According to them, experience has shown that such waste needs to be eliminated on the shop floor. In their opinion, it is far more difficult to detect inefficiencies in their office than on the shop floor. For decision-makers this means operating on the basis of concrete observations. Lean practitioners believe that a detailed/statistical analysis of the operator's work would not enable them to detect any waste in the operator's work process as readily. Although statistics may provide information on the operator's results, they cannot provide managers with information about ways of improving those results. Therefore, in their view, the only way of identifying sources of waste which handicap productivity and the well being of workers is to analyse practices (assisted by video). This management method contrasts with "management by figures". It is therefore common for lean companies to use video and make a visual analysis of the gestures and movements of operators on the

production line in order to identify ideas for improvements and potential productivity gains.

Moreover, using video also enables them to identify best practices, which can then be shown to other operators, thereby facilitating their acceptance and adoption by all team members.

This approach, whereby lean managers observe the work practices of operators, is similar to a traditional Taylorist approach. Therefore, lean manufacturing is not a management system that contradicts Fordist or Taylorist production methods. The lean approach draws considerably on these practices to create a paradigm, which must be seen as an extension of previous methods. There are numerous similarities with Taylorism: for example, the lean approach advocates a rigorous standardisation of work practices, since, according to lean practitioners, such standardisation is an indispensable prerequisite for continuous improvement.

The attention paid to an operator's every gesture, is not, in the eyes of lean practitioners, a secondary approach. Several industrialists have obtained spectacular productivity results using this practice. The use of video has, for example, enabled a leading global car parts manufacturer to achieve productivity gains of more than 40% upon several workstations. By observing all its operators, that company was able to identify numerous inefficiencies. For example, by observing the operators whose task was to fix springs to car seats, it noted continual delays as a result of irregular supplies of inputs and inappropriate scheduling of the collection of outputs from the workstations by forklift truck operators. By way of an example, this disorganisation in the supply and production processes was responsible for lost time of 22 seconds for a task that took the operator 65 seconds to complete.

*The A3 report*

Lean industrialists use a widely codified document to communicate information on process defects observed by operators on the production line. When a team member observes defects in a process, lean managers ask him or her to draw up a precise report on an A3 sheet (297 x 420 mm). This report is designed so that (1) the malfunctioning is analysed in great detail, (2) the causes of the inefficiency are established, (3) countermeasures are proposed (4), information on the way in which the company could measure the gains resulting from implementing a new process are given, and finally (5) the results of the new process must be observed and compared with the

old results. There is a place reserved for these five recommendations on the A3 sheet.

This method was introduced by lean practitioners to oblige operators reporting a malfunctioning to reflect at length on the shortcomings of the existing processes and ways of improving them. In addition, this approach is intended to help team members understand the environment in which they work. Lean industrialists emphasise another advantage of this method: the A3 report helps to establish a direct link between the report's authors and its readers. This system thus facilitates the communication and sharing of knowledge between managers and operators.

*The workstation instruction sheet*

Lean industrialists use another visual communication tool: the workstation instruction sheet. This sheet is placed on every workstation where it can be seen by the operator. It defines precisely the best way of carrying out a task so as to ensure that quality, productivity, safety and planning requirements are met.

This document is useful for standardising the work of operators; standardisation is one of the pillars of the continuous improvement of lean companies.

The workstation instruction sheet is a visual tool intended to remind operators of the tasks to be accomplished. Practitioners stress that it is particularly useful in cases where the frequency at which operators rotate at different production workstation is high.

In short, numerous visual communication tools are used in lean companies. Computerised systems and detailed statistical analyses are given low priority by lean practitioners, who prefer immediately visible information that is accessible to everyone. My own practical experience has shown that lean practitioners are chiefly concerned about reaction times in the event of problems on the production line. As the cost of production line stoppages is high, managers want to be advised immediately of problems. Therefore, they give priority to visual and sound warnings that can be seen and heard by everyone. They consider that the use of figures leads inevitably not only to longer reaction times in the event of a problem, but also limits the dissemination of information concerning alerts.

The sharing of information by all employees, facilitated by the presence of visual communication tools, makes it possible to communicate information

openly and encourages a collective management approach. According to practitioners this system encourages the participation of all employees in actions to achieve improvements and resolve problems.

***Computerised communication tools***

Lean practitioners do not use only visual communication tools, they also use software tools, containing digitized information. As regards these computerised communication tools, the lean works expounded in the various books on the subject differ from the practices on the shop floor observed by this study. This difference can be accounted for by the fact that lean companies have only recently adopted lean production methods in France. Consequently, most of these companies suffer from an inertia that keeps old information systems in place. It is difficult for a company to get rid of its old integrated management software package given the disruption that could follow the implementation of the lean informational approach, as described by relevant literature on this subject. Accordingly, whereas advocates of lean manufacturing are resolutely hostile to Enterprise Resource Planning (ERP) solutions [4], they are nevertheless still widely used in just-in-time manufacturing plants.

An ERP solution has several key functions. In terms of production management, an ERP solution can deal with production scheduling, product receipts/deliveries, as well as inventory movements. In terms of planning, ERP solutions manage problems of capacity and supplier needs. Finally, as regards finance, an ERP solution can manage invoicing and value products and inventory.

An ERP solution has a twofold advantage. It facilitates the transversality of information recorded on the one hand, and the integration of all the company's functions on the other.

The arguments used against ERP solutions by lean practitioners do not concern all the possible applications of these integrated management software packages. It is therefore necessary to distinguish between their

4 "The reductionist and abstract character of software packages, which are extremely precious for anticipating and organising the plant's future production, can be disadvantageous when it comes to organising and managing production. The necessary processing of information via an abstract phase and the tendency of computerised solutions to see workplace realities only in terms of their own abstractions seem, on reflection, particularly incongruous." (BOUNINE & SUZAKI, 1994).

views on production management applications and those on planning applications.

With regard to production management, an ERP solution can be used to assess inventory levels, issue production schedules and manage automatically receipts/deliveries of parts.

Lean advocates are particularly harsh in their criticism of applications for assessing inventory levels. Their case is based on the idea explained above, whereby it is better to focus on processes, rather than spending time on communicating information on the results of such processes. In other words, lean authors believe that the use of an ERP solution to obtain a permanent, continuous assessment of inventory levels is pointless, since lean companies must succeed in ensuring that inventories are kept at a stable and minimum level. Not only is this reasoning open to argument from a theoretical point of view, it is also strongly contested by practitioners who claim that they cannot do without an ERP solution for inventory management purposes. Furthermore, these practitioners add that the combination of an ERP solution and the labelling system enables them, when the number of items involved is high, to avoid "chasing after all the labels to have information on the company's production rate and inventory levels".

As regards production schedules and receipts/deliveries of parts, numerous practitioners are content with the labelling system. This method seems adequate to satisfy the company's needs and the use of software in this area is considered pointless. Moreover, ERP solutions seem to create logistical complications that do not exist with the labelling system.

In terms of planning applications, we distinguish between problems related to smoothing out orders and those related to forecasting supplier needs.

Smoothing out production involves smoothing out actual customer demand so that the production day tomorrow is as close as possible to that of today on the one hand, and mixing production volumes to part by part on the production line on the other. By smoothing out its production and creating small inventories, companies can satisfy the diversified needs of their customers and thus reduce their inventory of finished goods [5]. Lean authors tend to consider that it is pointless using an ERP solution to smooth

[5] It is to be noted that this reasoning is tenable when the company has invested sufficiently in its capacity to change tools rapidly.

out orders. The size of batches and, accordingly, the breakdown of the mix is determined by a formula which, linked to storage costs and the cost of changing the production run, determines the optimal size of the batches to be produced. Practitioners often use software such as Excel to help smooth out their production.

As regards forecasting supplier needs, lean authors and practitioners agree that software applications can be useful. The apparent hostility of lean companies to the use of a software solution to assist in the management of production does not extend to tools used to forecast suppliers' needs. This positive opinion on forecasting applications may seem incompatible with the set up of a pull system (labelling system) in the company. In fact, the use of labels is intended to satisfy the needs of a pull production system, whereas the use of medium and long term planning instruments to anticipate/simulate future consumption/needs is more of a push production approach. Lean practitioners and authors justify this contradiction by pointing out that it is difficult for a company, even if it operates on a lean basis using a labelling system, to forgo information on future needs. Therefore, lean practitioners and authors agree that it is logical to combine a labelling system with forecasting applications.

As regards the use of ERP financial applications, they are recommended by lean authors and used by lean practitioners. The invoicing of products (supplier and customer invoicing) does not run against any lean principle and is very useful for industrialists.

In lean companies, the information system must be closely adapted to the principles that form the cornerstone of the productive organisation. According to lean authors, and management researchers in general, the relationship between information system and organisation must be understood in that way. This argument is relatively well understood by lean practitioners.

In general, lean practitioners agree that the presence and use of software tools must not encourage employees and managers to disregard what happens on the shop floor and/or to manage the company by figures. Moreover, such software solutions must not facilitate the circulation of information that the company does not need. Subject to these conditions, if a software solution can assist the company's employees and processes, then industrialists can consider adopting it.

In addition, lean practitioners often stress the fact that the availability of a tool is not sufficient in itself and it is necessary to use that tool appropriately. For example, putting in place a labelling system does not, in their view, guarantee the success of its just-in-time organisation. Likewise, putting in place mechanisms to stop the production line automatically does not guarantee the correct application of problem solving methods. They consider it important to point out that there can be no guarantee that an operator will use correctly a given tool. The availability of all the tools used by these practitioners is therefore only an indispensable prerequisite for the successful implementation of the lean approach. Accordingly, it seems evident that, for lean practitioners, the managerial dimension is clearly essential to supplement the availability of these tools.

Lean practitioners add that each tool or type of behaviour associated with that tool, would not be effective if not combined with others. The lean approach combines a series of tools and types of behaviours that cannot be separated. In their view, a partial application of the lean principles would be inconsistent and ineffective.

## ■ ICT and the lean manufacturing approach

### Reticence regarding ICTs

A study of literature on lean manufacturing and an observation of practices on the shop floor highlight considerable wariness, if not hostility, on the part of lean companies towards ICTs. Lean companies use ICTs only for the global processing of planning and prefer to adopt traditional methods such as labelling for local management. In other words, the lean manufacturing approach gives priority to the local processing of information rather than a global, model-based management approach.

#### *Prioritising information and making it immediately visible*

The lean manufacturing position with regard to ICT relies on a twofold argument based, on the one hand, on the wish to make useful information immediately visible and, on the other hand, on the determination to give production information priority over other types of information. According to practitioners, the andon cord alert signal illustrates this idea. It is a signal

that is visible to everyone and obliges managers to act on the shop floor in order to identify the causes of the malfunctioning observed. Advocates of the lean approach consider that an alert signal generated by a computer software programme would be ineffective, since it would only be visible to the people receiving the message. The obligation to take action in response to a computer message is, in their view, far weaker. In addition, lean practitioners consider that an alert based on a sound signal constitutes a priority call for immediate action ahead of other tasks. Conversely, they believe that receiving an alert via a computer message can encourage the people receiving the message not to act or to delay taking action.

Making information immediately visible for everyone and prioritising production information are among the reasons cited by both lean authors and practitioners to justify the use of visual tools. However, these two objectives could be achieved by using computer software. Therefore, these arguments are not completely satisfactory, but they are nevertheless accepted by lean practitioners and upheld resolutely by lean authors.

***Managing the company on the shop floor***

Lean practitioners and authors also see ICTs as tools that promote "management by figures" whereas, in their view, it is preferable to act on the shop floor. They justify their approach by pointing out that the quality of managerial decisions is even higher when the manager is fully aware of the reality on the shop floor. Whereas ICTs submit to decision-making bodies abstractions from reality which, by definition, cannot correspond exactly to reality. In fact, lean practitioners and authors are ready to support a high opportunity cost for the company, by asking managers to collect correct information directly from the shop floor, with a view to ensuring the quality of the information that will influence the manager's decision. Naturally, such reasoning does not leave much scope for the use of ICTs.

***The use of ICTs in controlling operators***

The attitude of lean companies towards ICTs and global centralised information systems poses an obvious problem as regards controlling operators. ICTs are tools that enable companies to supervise employees indirectly through a posteriori controls (Benghozi & Cohendet, 1999). As the micro-optimisation ensured by lean operators at their workstation is not based on a model, it is not controlled by the management. Operators are therefore in a position to extract value from this micro-optimisation. The risk

incurred by the lean company consequently lies in the fact that employees can choose to take advantage of the situation to hide information that might be prejudicial to them. As operators cannot be controlled by ICTs since such technologies are not mobilised by the lean manufacturing approach, the agency problem has to be addressed in another way.

More specifically, it is important to point out that lean managers require production line operators not only to execute their production tasks in compliance with work standards, but also to reflect on possible improvements that could be made to the process. Managers therefore have a twofold requirement as regards operators. Knowing whether operators comply with working standard seems easy (though in practice it often is not so simple) when the company uses ICTs to control operators a posteriori. On the other hand, ascertaining the level of effort made by employees to improve the production process seems more difficult. The communication of information on this task is vain and the use of ICTs in this area therefore seems pointless.

A study of literature on this subject and an analysis of the way in which lean companies operate suggests two ideas that merit further consideration in the attmept to understand how lean managers can exercise control over their employees without ICTs and information on the micro-optimisation achieved by operators on the shop floor.

***Control via inventory levels***

The optimisation of the elementary stages of the production process requires operators to take account of local micro-details that cannot be modelled. The common sense of the operators who accomplish such tasks is sufficient to ensure their improvement. It is nevertheless necessary for lean managers to implement a system based on incentives or constraints in order to encourage or oblige operators to implement their production tasks correctly. That poses the problem of the traditional principal-agent model, where the principal (the manager) does not have the information that is available only to the agent (the operator). The moral hazard here concerns the level of effort made by the operator. The principal seems to be in a position to resolve this problem of information asymmetry by controlling inventory levels. In an organisation operating on the basis of just-in-time, the lack of stock puts pressure on the operator, which obliges him or her to be more observant and act creatively to improve operational reliability and yields. Low levels of stocks give workers the incentive to improve the

production process because lower inventories place tight constraints on inputs, making it impossible for output targets to be attained using standard production techniques (ALLES *et al*., 2000). Managers can then play on the level of "shop stocks" of inputs to exercise a form of managerial control over employees. This idea, whereby the lack of stock enables or obliges the agent to maximise his or her efforts, is debatable. It was nevertheless used to construct a model in an article in the Management Science review of 2000 "Information and incentive effects of inventory in JIT production" written by Alles, Amershi, Datar & Sarkan.

***Control via the organisation's transparency***

With a view to understanding the way in which operators are controlled in lean organisations, it may be worthwhile to look at the ways in which such organisations work. To use the words of Konosuke Matsushita [6], lean management is similar to managing a glasshouse. The information is shared by all the company's workforce. This emphasis on openness could be a way for managers to control operators more easily, thereby reducing the problem of information asymmetry referred to above.

The two arguments used (control via inventory levels and via transparency) to try and understand how operators are controlled in lean organisations are questionable. However, the fact that lean companies refuse to use the method of digitized information invites further reflection on this subject. Existing literature has not really addressed this aspect of lean management. It would, however, be worthwhile to do further research on subject in the future.

**ICTs and the sharing of codified knowledge**

ICTs systematise the accumulation of knowledge in databases and codify the knowledge of operators (ARCHAMBAULT, 2004). New technologies consequently facilitate the sharing of codified knowledge between a company's employees. Lean companies make little use of the digitization of data. They therefore do not use ICTs to transform the codified knowledge of operators into collective knowledge.

6 Industrialist (1894-1989), President of Matsushita Electric Industrial Co. Ltd.

Lean companies have processes whose aim is, for the company, to integrate the knowledge of employees: continuous improvement exercises. Operators are, for example, encouraged to propose to their line manager ideas for improving their workstation. In most lean companies, this process is translated by a suggestion box made available to employees. The best suggestions are generally rewarded by a financial bonus. At Toyota Valenciennes-Onnaing, an event is organised every quarter to reward the employees whose suggestions are considered the best. Therefore, in lean companies, knowledge is shared among employees through channels other than ICTs.

However, there are no reasons why ICT could not be used in lean companies to support the continuous improvement philosophy, not only to facilitate the sharing of codified knowledge between operators, but also as a way, as suggested above, of controlling private information in the possession of employees.

## ■ Conclusion- extension

ICTs have been widely adopted by industry over the last ten years (BRIANT & HEITZMANN, 2003). Most companies see ICTs as useful tools for improving the performance of their organisation. Those companies generally use ICTs to process information in a centralised way, thereby enabling managers to access information collected on production, human resources and logistics.

On the contrary, lean companies give priority to the local processing of information. They thus make little use of the digitization of information and adopt chiefly visual tools for communication purposes.

Nevertheless, it would seem that the wish expressed by lean companies to process information locally is not inconsistent with the adoption of ICTs within their organisation. It is, in fact, possible to envisage introducing technological tools that would be adapted to the lean informational approach. The introduction of new technologies, whose characteristics would contribute to supporting the decentralised management of the information system, could have positive effects on the functioning of lean companies. The digitization of information, made possible by ICTs, would, for example, facilitate knowledge sharing between employees.

In addition, the adoption of new technologies consistent with the lean approach may possibly help managers to control operators on the production line.

The integration of new technologies consistent with the lean manufacturing approach inevitably calls for a study on the diversity of ICTs, with a view to ascertaining whether the characteristics of use and the technical properties of the new technologies can make ICTs compatible with different industrial approaches. Such research would appear to be valid in order to supplement this article.

**References**

ALLES M., AMERSHI A., DATAR S. & SARKAR S. (2000): "Information and Incentive Effects of Inventory in JIT Production", in *Management Science*, no. 46, pp. 1528-1544.

ARCHAMBAULT J. P. (2004): "Les TIC, la formalisation et le partage des savoirs. Vers une économie de la connaissances ?" in *Médialiog* no. 49.

ASKENAZY P. & GIANELLA C. (2000): "Le paradoxe de productivité : les changements organisationnels, facteur complémentaire à l'informatisation", in *Economie et Statistique*, no. 339, pp. 219-242.

BENGHOZI P. J. & COHENDET P. (1999): "L'organisation de la production et de la décision face aux TIC", in E. Brousseau & A. Rallet (sld), *Technologies de l'Information, Organisation et Performances Economiques*, Commissariat Général du Plan.

BOUNINE J. & SUZAKI K. (1994): *Produire juste à temps*, Masson.

BOUZEBOUK S. (2002): *Produire vraiment sans gaspiller: l'après juste à temps*, Editions d'Organisation.

BRIANT P. & HEITZMANN R. (2003): "Les technologies de l'information et de la communication : en marche vers l'entreprise numérique", in *Le 4 pages* (SESSI), no. 184.

DREW J., McCALLUM B. & ROGGENHOFER S. (2004): *Objectif Lean*, Editions d'Organisation.

GREENAN N. & GUELLEC D. (1998): "Firm organization, technology and performance: An empirical study", in *Economic of Information and New Technologies*, no. 6, pp. 313-347.

GREENAN N. & MANGEMATIN V. (1999): "Autour du paradoxe de la productivité", in *Innovations et performances*, Editions de l'Ecole des Hautes Etudes en Sciences Sociales.

GREENAN N. & MAIRESSE J. (2000): "Computer and Productivity in France: Some Evidence", in *Economics of Innovation and New Technology*, no. 9, pp. 275-315.

HOLWEG M. (2005): "Beyond Mass and Lean Production - on the Dynamics of Competition in the Automotive Industry", in *Economie et Société*, no. 15, pp. 245-270.

HUNTZINGER J. (2002): "The Roots of Lean", in *Target,* no. 18.

ICHIONIOWSKI C., SHAW K. & PRENNUSHI G. (1997): "The Effects of Human Resource Management Practices on Productivity: a Study of Steel Finishing Lines ", in *American Economic Review*, Vol. 87, no. 3, June, pp. 291-313.

JANOD V. (2004): "L'impact des innovations technologiques et organisationnelles sur les performances des entreprises : une évaluation non paramétrique", Working Paper.

KOSKELA L. (2004): "Moving On – Beyond Lean Thinking", in *Lean Construction Journal*, no. 1, pp. 24-37.

LIKER J. & CHOI T. (2004): "Building Deep Supplier Relationships", in *Harvard Business Review*, vol. 82, pp. 104-113.

WOMACK J. (2004): "Lean Information Management", e-letter from the Lean Enterprise Institute, November.