Implementing lean manufactu

Imitation to innovation

By Quarterman Lee

Not much is written on how to implement lean manufacturing. Some firms stumble through with trial and error. Others rely on repeated Kaizen events. Another approach emphasises phases:

1. Stability
2. Continuous flow
3. Standardise work
4. Pull system
5. Level production
6. Continuous improvement

These phases are supposed to roll through the plant like tsunamis. For most firms this is unrealistic and likely to fizzle.

What guidance we do have is highly prescriptive. 'Do these things (followed by a list) and everything will be OK.' This is like a physician with a list of the top twenty drugs. He gives the same list to every patient, regardless of symptoms. Examining the matter more strategically raises several questions:

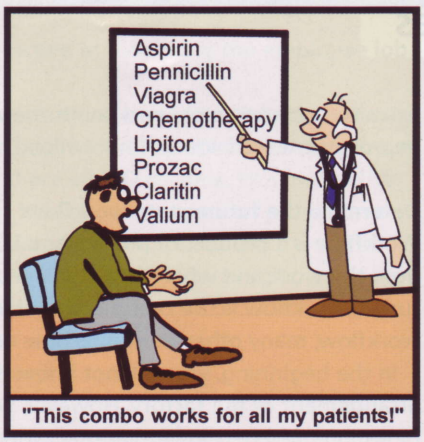
- Do we need the entire list of 'tools and techniques'?
- If not, which do we employ?
- Which elements come first?
- Do we implement plant-wide or in focused areas?
- How does Kaizen fit into the picture?
- How detailed should the plans be?
- How long will it take?
- How do we know when we are really lean?

The Toyota model

Wickham Skinner does not consider lean manufacturing to be an actual manufacturing strategy. He likens it to 'blocking and tackling' in football, a necessary skill but insufficient for consistently winning games.

Skinner's point is legitimate. However, many manufacturers cannot even 'block and tackle' and lean manufacturing is a good way for organisations to learn these basics. We will use the term 'lean manufacturing strategy' to refer to a lean implementation that is well thought out and rationally adapted to the company involved. This contrasts with 'lean manufacturing' that refers to blind imitation of Toyota, repetitive Kaizen events or 'list thinking.' 'Manufacturing strategy' refers to an approach that starts with corporate and marketing strategies and then designs a manufacturing system to support them. Understanding the history and background of lean manufacturing can help sort out your implementation approach. Taiichi Ohno and Shigeo Shingo developed lean manufacturing at Toyota over a period

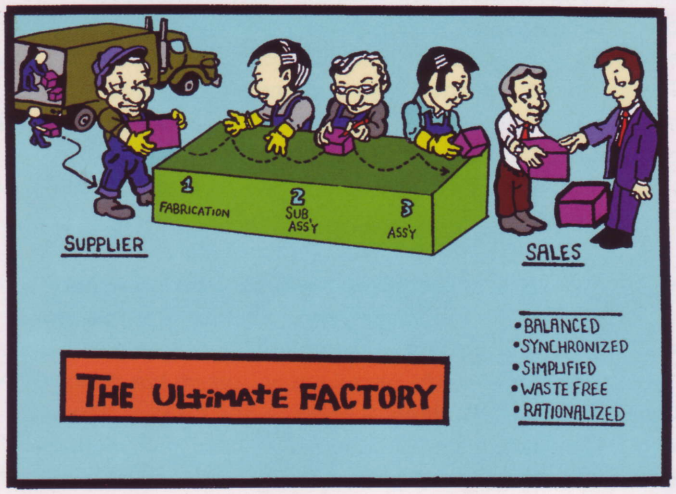
of 20-30 years. Their intention was not to develop some sort of 'unified field theory' for all manufacturing. They simply wanted to solve Toyota's specific problems. The solutions they chose, while broad based, do not necessarily apply in all situations.



Ohno first visualised an ideal production system, primarily in terms of workflow. Ohno's ideal production system, inspired by Ford, had a series of adjacent workstations, balanced and synchronised with no inventory between stations. It delivered finished product to the customer exactly when needed (just In time) and drew materials from suppliers, just in time.

According to legend, Ohno then asked Shingo and others what prevented the realisation of this ultimate, no-inventory system. As the reasons for inventory surfaced, Ohno requested that his deputies 'eliminate the reasons.' All of the subsequently developed elements of lean manufacturing aim at eliminating (or at least reducing) the reasons for inventory. Ohno understood that inventory mirrors waste.

Understanding the history and background of lean manufacturing can help sort out your implementation approach



For Toyota (and many other manufacturers) the foremost 'reason for inventory' involved the intertwined issues of equipment scale, setup, batching and workflow. The causal diagram (below) illustrates.

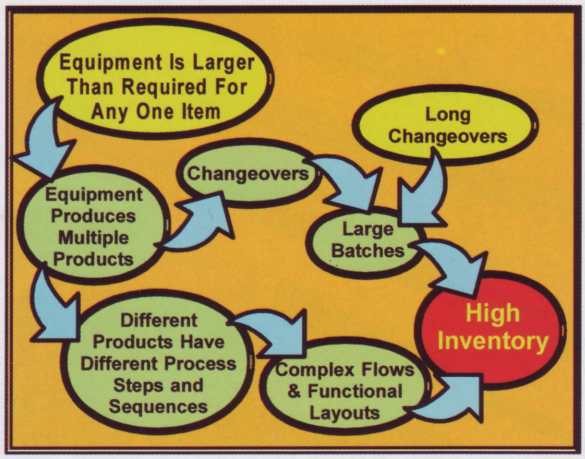
The problem starts with equipment that is larger and faster than required for a single product. This causes multiple products to run on the same equipment. Two effects ensue:

1) Changeovers become necessary
2) Different products follow different routes

Large-scale equipment often requires difficult and time-consuming setups. The combination of changeover and long setup forces large batches that bring high inventory. Different routes force functional layouts with their complex material flows that also increase inventory.

High inventory brings all sorts of waste in material handling, space and quality (not shown). This diagram is over-simplified. In reality, it has multiple, subtle reinforcing loops that exacerbate the problem over time.

Shingo attacked both root causes. First, he developed the SMED system that reduced changeover times and, thus, batch sizes and, hence, inventory. Second, he scaled down the equipment, where possible, thus enabling cellular manufacturing and its simplified workflow.



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Lean Manufacturing Laundry List

- Cellular Manufacturing
- Total Quality
- Teams
- Rapid Setup (SMED)
- Kanban
- Value Stream Mapping
- Process Mapping
- Work Balancing
- 5-S
- Autonomation
- Pokayoke
- Jidoka
- Elimination of waste
- Total Productive Maintenance
- Continuous flow
- One Piece Flow
- Standard work
- Visual management
- In station process control
- Level production
- Takt Time
- Point of use storage
- Kaizen
- Supplier Development

Few individuals or organisations cope effectively with more than 2-4 multiple, high-priority objectives

Ohno and Shingo were 'systems thinkers.' They visualised causes and effects, interactions and dynamic behaviours. This contrasts with 'list thinking' that is static, obscures cause-effect and treats elements of a system as independent.

SMED and workcells did not become part of the Toyota production system because they had cosmic virtue. They were employed because they reduced inventory and waste in the Toyota context. Other techniques addressed other issues. For example, some buffers at Toyota were large because of equipment breakdowns. Total productive maintenance (TPM) addressed this breakdown problem. If your machines do not breakdown frequently, there is no reason for TPM. The key point is:

- Do not copy specific tools and techniques; they are not universal
- Copy the thinking and analysis methods; they are universal

Developing a lean strategy

To develop a lean manufacturing strategy and implementation plan, we recommend five general steps:

1. Evaluate the current state
2. Determine the future state workflow (in principle)
3. Identify future state infrastructure (in principle)
4. Identify precedents and priorities
5. Develop the plans

Evaluate current state

Our lean manufacturing assessment is a good tool for this. It examines nine key areas and points the way to appropriate improvement techniques. To download this tool, visit our website.

Determine the future state workflow

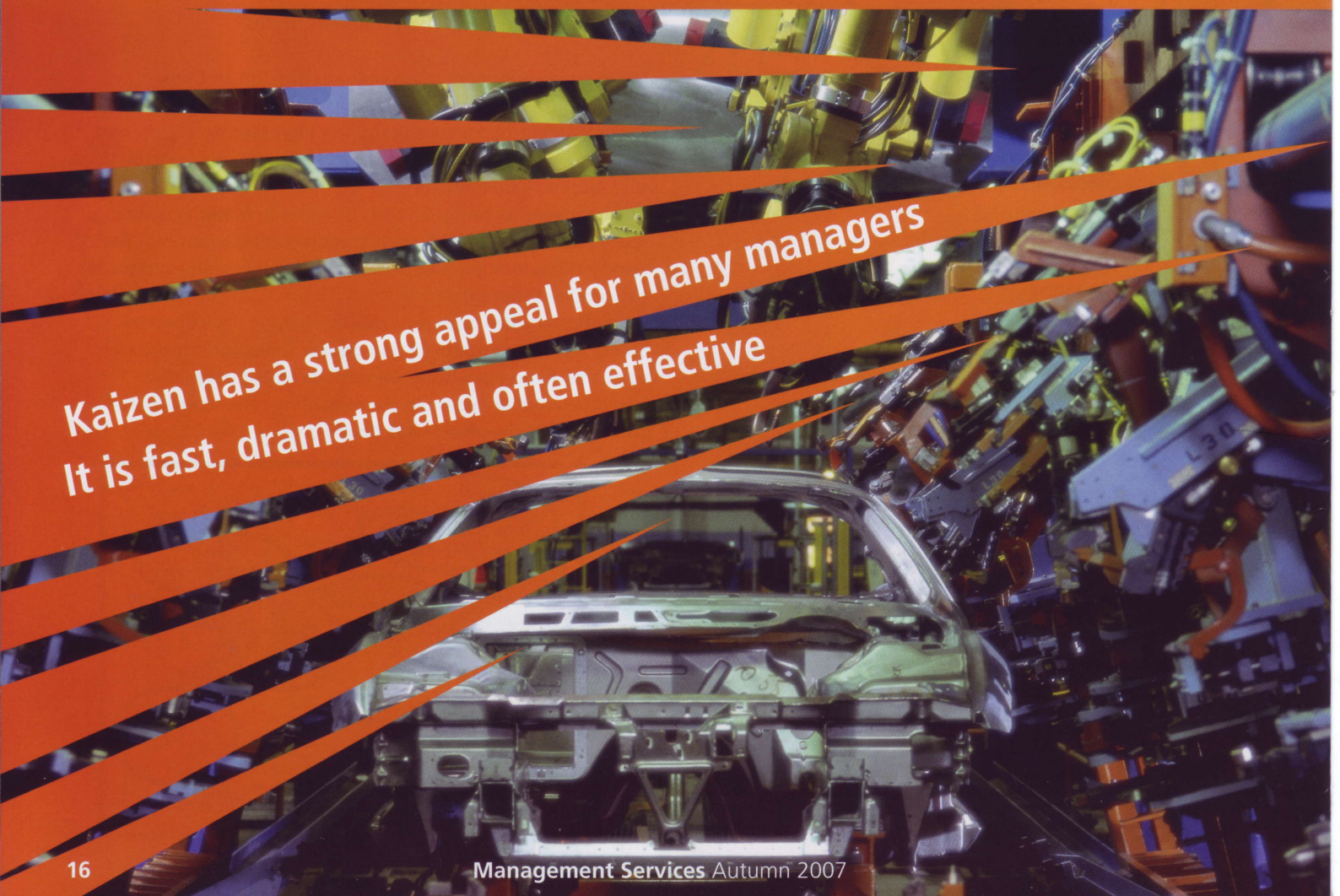
Workflow is a product of process and layout. What equipment does the work and where it is. For many (but not all) manufacturers, workflow is the best place to start. With a streamlined workflow, many other things become easier.

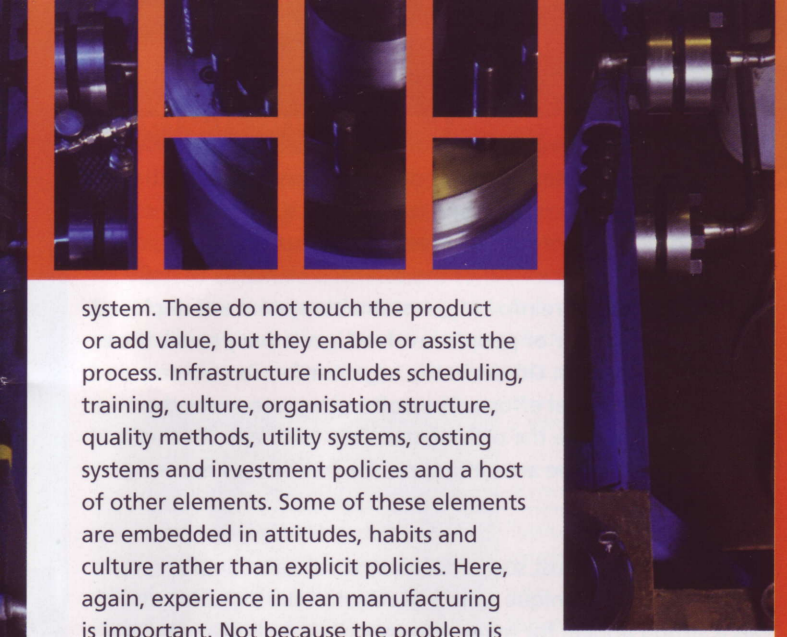
In the beginning, you will not know the final layout and arrangement of the factory. However, you should be able to determine where cellular manufacturing will probably apply and where it may not. You should be able to identify probable Focused Factories. You may be able to identify where a few new machines might untangle portions of a complex workflow. In addition, you can revise misguided equipment utilisation and ROI policies that discourage cellular layouts.

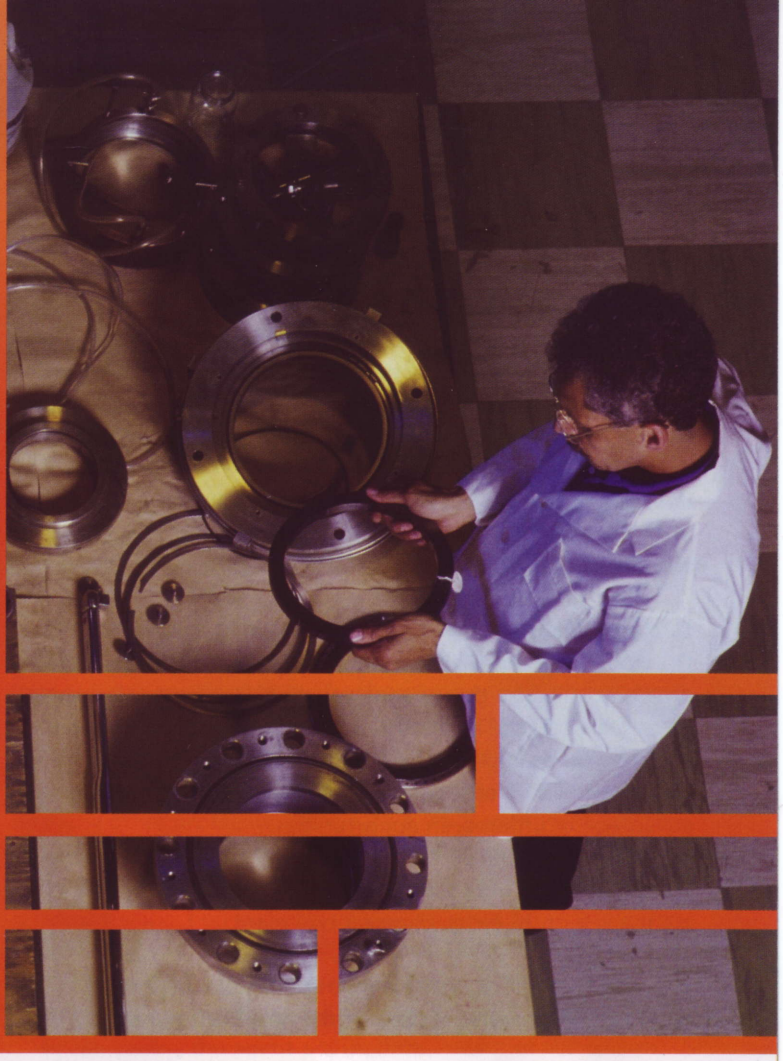
For shops with hundreds or thousands of parts and a functional layout, this requires considerable experience in group technology. Without such experience, it is difficult to see how cellular manufacturing can work. The paradox is that the larger the number of parts, the more likely it is that workcells will be viable and efficient. I have known many firms that had abandoned the idea of cells because of this apparent difficulty. It does take a lot of work to untangle the mess and identify the cells. It often requires sophisticated methods. Our web pages on group technology address this.

Determine future state infrastructure

Infrastructure consists of supporting elements in a manufacturing







system. These do not touch the product or add value, but they enable or assist the process. Infrastructure includes scheduling, training, culture, organisation structure, quality methods, utility systems, costing systems and investment policies and a host of other elements. Some of these elements are embedded in attitudes, habits and culture rather than explicit policies. Here, again, experience in lean manufacturing is important. Not because the problem is difficult, but because the paradigm is different.

Identify your own lean elements

Based on the above vision of the future state, pick the appropriate elements of lean manufacturing from the lean laundry list. You may also identify other advanced manufacturing techniques that are not on the usual lists of lean manufacturing.

Identify precedents and priorities

Next, identify priorities and precedents. Precedence may require the use of certain elements to make some other element practical. For example, Rapid Setup (SMED) may be necessary to enable kanban and workcells make kanban simpler and easier. Workcells also function better with small lots. The precedence might therefore be Workcells + SMED + kanban. In reality, these are likely to be concurrent as much as sequential, but more on this later.

Priorities depend partly on precedence but they also depend on ROI. By giving priority to those elements, products and areas that promise the fastest and largest returns, the system transformation becomes self-financing.

For example, many companies want to start with 5S. They want to clean the place up. This seems like a good thing and Martha Stewart would surely approve. However, generally, cellular manufacturing is a better place to start for the following reasons:

- The return on 5S is lower, less immediate, and less obvious than the return for workcells
- If workcells are implemented after 5S, much of the 5S work must be redone after the rearrangement

The rearrangement into workcells will automatically entail much of the cleanup, fix up work of a 5S program

- Workcells are smaller, tighter and more focused than functional areas. As a result, they are easier to clean and keep clean. With workcells in place, 5S becomes easier, faster and more effective
- The inventory and material handling reductions from Cellular Manufacturing make the plant neater and easier to manage and clean

Another factor in setting priorities is the 'low hanging fruit' principle. For a variety of reasons, it may be very quick and easy to implement one or another of the selected elements. It thus makes sense to give such elements higher priority.

Develop the plans

With a broad overview of the situation and a vision for the future and knowledge of precedents and priorities, we can begin to plan our course of action.

Phasing

We suggest three broad phases for lean manufacturing:

I. Core disciplines
II. Consolidation
III. Continuous improvement

Phase I implements the minimum essentials necessary for the system to work effectively. These are often (but not always) the core disciplines on the home page. Perhaps 60- 80% of the benefits accrue from Phase I. The changes in Phase I are dramatic, the results immediate and the benefits clear. When people speak of a lean implementation, they usually think of Phase I.

Phase II builds on the core disciplines of Phase I. It includes the later, secondary techniques honed by Toyota and others. Examples include 5S and quick and easy Kaizen. Phase II fine-tunes and improves the initial system. It includes methods and training that inculcate basic values that sustain the system for years to come.

Continuous, incremental improvement is the hallmark of Phase III. Here, the changes are less dramatic, but more important. Phase III never ends; a core value at Toyota but unappreciated by most imitators.

Timeframes

The time required for Phase I varies significantly; It depends upon the size of the firm, the product-process mix, culture, leadership and many other factors. Let us assume a 'typical' factory of, say, 500 employees, 2000 or so manufactured parts, a dozen product lines, and competent leadership. Phase I will

probably require 3-6 months to see substantial results and 12-36 months for completion. 'Completion' is a rather vague term in this context and the transition between Phase I and Phase II is not always clear.

Phase II is evolutionary. It will probably require an additional 1-3 years.

Many firms who do well in Phase I never progress further. They are so proud of themselves that they sit down to contemplate their own greatness and never arise. The supreme wisdom of Taiichi Ohno was that he never fell victim to this self-delusion.

Implementation project plan

With the elements, precedents and priorities identified, it is time to work out a project plan with tasks, assignments and costs.

Strategic flexibility

Our knowledge at this point is very incomplete. Unexpected problems will arise that change any plan. Unexpected opportunities will also arise and this is where master strategists excel. Rommel, for example, was successful in the North African desert because he often deviated from his original plans to take advantage of unforeseen opportunities.

The only sure thing is that the plan will change. However, tasks in the near future are less likely to change than tasks that are many months away. I suggest two plans:

- A short term, detailed plan for the next 3-6 months
- A long-term, general plan for the next 6-36 months

The long-term plan sets direction and plans budgets. The short-term plan tracks specific tasks, activities and accomplishment. When problems and opportunities develop, it is easy to change these dual-plans.

Concentration

One of Von Clauswitz' principles of war is concentration: concentrate the maximum force in the smallest area. Business strategy has a corresponding principle, but for a different reason.

Few individuals or organisations cope effectively with more than 2-4 multiple, high priority objectives. As the number of objectives increase, efforts are scattered and people flit from one task to another. Everything slows down and the work that is done is half-baked. Most importantly, new practices fail to become institutionalised.

In developing an implementation plan, ensure that no more than 2-4 major initiatives occur simultaneously. In addition, particular individuals or groups should not be heavily involved in more than one or two of these objectives. Maintenance and engineering are the groups that most frequently become overwhelmed.

The Beachhead strategy

Many elements of lean manufacturing depend on and mutually reinforce one another. Individually, most elements make a modest performance contribution. Together, they interact and their effects multiply.

Implementing a particular element can take a long time. The larger the organisation, the longer it takes to migrate knowledge and experience. Consider that it took Toyota 30 years to do it all. Professors Kevin B Hendricks and Vinod R Singhal estimate that five years is required for an average company to completely implement TQM. If we attempt to implement and migrate one element at a time through an entire firm, it takes forever to get significant results. Moreover, it is difficult to sustain one initiative until the next wave comes along to reinforce it.

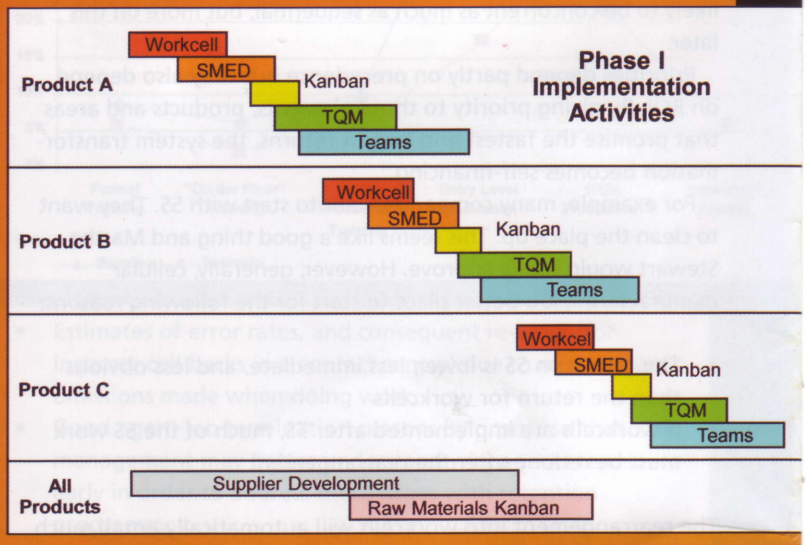
A beachhead strategy overcomes this by focusing on a small area or a product. All of the essential elements that are necessary for a self-reinforcing, sustainable system are deployed. Because the number of people involved is relatively small, it can happen very quickly. Others in the organisation can observe and learn from the initial efforts. They often begin to make their own changes before the official plan calls for them. Gradually, one product and one area at a time, the beachhead expands.

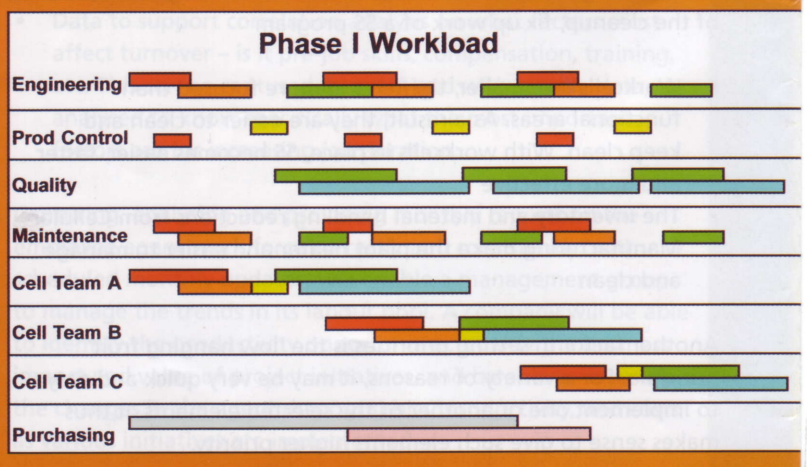
The Kaizen blitz

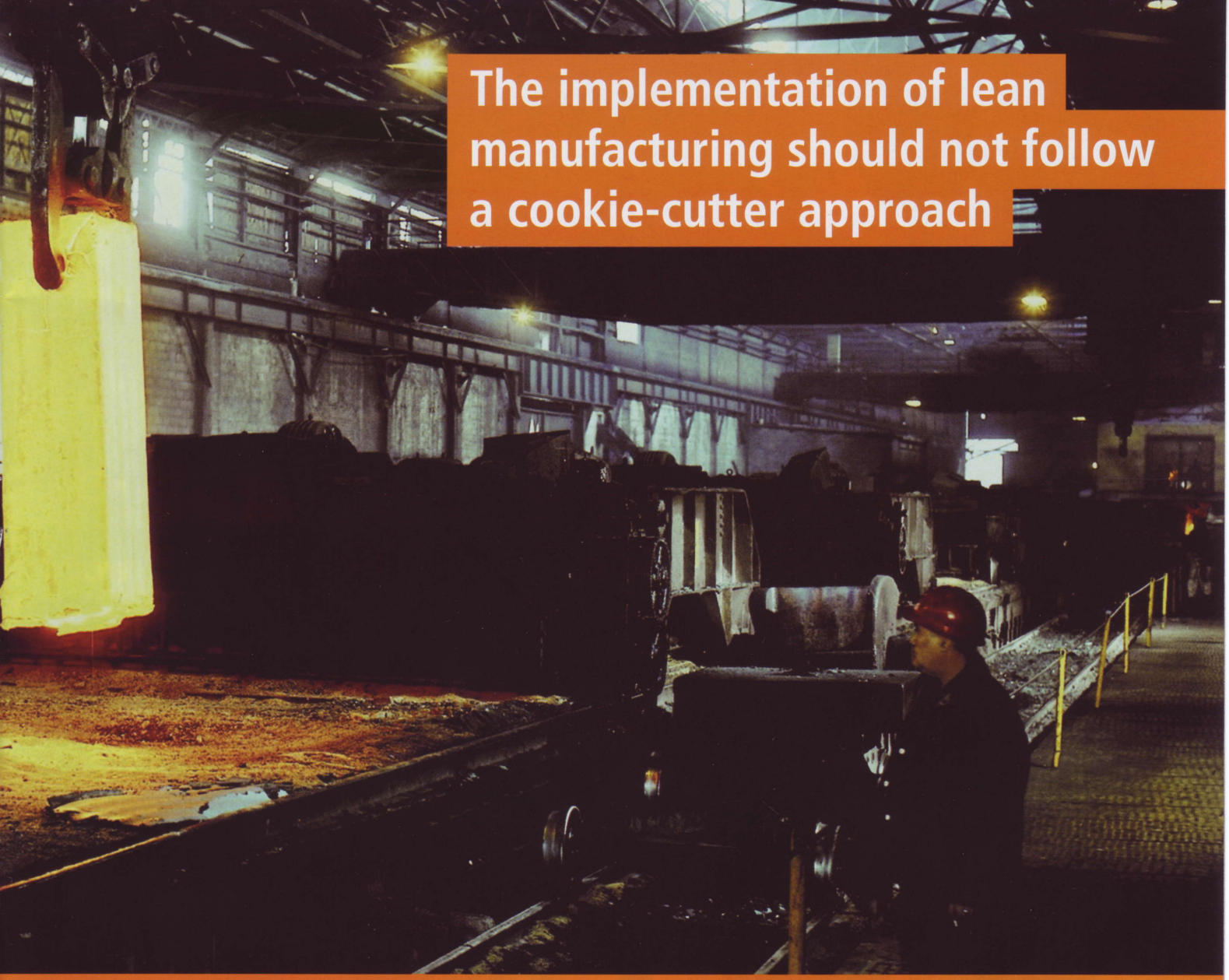
The Kaizen blitz is just such a focused, accelerated implementation and the technique suits a beachhead strategy. Kaizen has a strong appeal for many managers. It is fast, dramatic and often effective. Kaizen is used to implement workcells, reduce setups and also for 5S.

Use Kaizen with caution; there are significant dangers; among them are:

- Kaizen, by itself, is tactical, not strategic. It does not substitute for a well-thought-out manufacturing strategy. Nor can it substitute for overall planning of things such as sites and macro-layouts. At some point, we must step back for the big picture.
- Kaizen requires experienced and knowledgeable facilitators. Usually these facilitators are consultants with wide-ranging experience. Unfortunately, some Kaizen consultants, both internal and external, know only the Toyota rules. Their knowledge is detailed, dogmatic and shallow. They do not grasp Ohno and Shingo's underlying philosophy as opposed







The implementation of lean manufacturing should not follow a cookie-cutter approach

to superficial rules and regulations.

- The learning in a blitz is superficial. There is simply not time to explore all possible solutions or delve deeply into issues. Much of this learning is through slogans, rules and edicts, not the fundamental reasons behind them. It works because the facilitator makes (or encourages) many decisions, often instinctively, that avoid serious errors.

Implementation project example

Here is a very simple example of a Phase I implementation that illustrates the principles. It anticipates three workcells. Each workcell will require rapid setup (SMED), kanban production control, total quality and team development. In addition, the plan anticipates a more general supplier development effort that will eventually bring suppliers into a kanban system.

The Gantt chart shows the timeframe for each activity. The workcells will be implemented sequentially. The more general supplier development and kanban is essentially separate. This schedule limits the number of tasks that a particular department must undertake at any one time. Chart 2 shows, for each department, tasks that require their heavy involvement. Note that no group has a heavy involvement with more than two simultaneous tasks. The implementation of lean manufacturing should not follow a cookie-cutter approach. Every factory is different and these differences require unique approaches. The elements chosen, their sequence of implementation and many other details differ from factory to factory. The originators of lean manufacturing, placed in different circumstances, would have developed different solutions.

The keys to success include: a fundamental approach, systems thinking, leadership, a flair for strategy and recognition of the practical limits on resources.

References

Hayes, Robert H and Wheelwright, Steven C, *Restoring Our Competitive Edge*, John Wiley & Sons, New York, 1984.

Hill, Terry, *Manufacturing Strategy*, Macmillan, London, 1985.

Skinner, Wickham, *Manufacturing In The Corporate Strategy*, John Wiley & Sons, New York, 1978.

Skinner, Wickham, *Manufacturing: The Formidable Competitive Weapon*, John Wiley & Sons, New York, 1985.

Stalk, George And Hout, Thomas, *Competing Against Time*, The Free Press, New York, 1990.

Wrennall, William, and Lee, Quarterman, *Handbook of Commercial and Industrial Facilities Management*, McGraw Hill, August, 1993.

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