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“Wastology”  
*The Total Elimination of Waste*

If you were to ask someone, “What does the JIT Production System mean?” and that someone were to reply, “It means making just what is needed, just when it is needed, and in just the amount needed,” that would indicate he or she has at least an intellectual grasp of the JIT Production System.

On the other hand, if the person’s response was something like, “It means the total elimination of waste,” that would suggest that perhaps this person has learned JIT physically as well as intellectually. I might add that the JIT Production System is a philosophy that seeks that point of truth where improvement activities and manufacturing activities become completely intertwined. But it is an empirical, hands-on philosophy that devalues any ideas that are not grounded in the factory.

Only people who have physically learned the JIT Production System can truthfully answer the question, “Why should we make just what is needed, just when it is needed, and in just the amount needed?”

Many people would answer this question with, “to better respond to customer needs” or “to reduce inventory.” However, making just what is needed, just when it is needed, and in just the amount needed first requires a flow in the factory.

The factory’s flow is what brings all of the waste to the surface, where we can apply JIT techniques to totally eliminate the waste. *JIT means ideas and techniques for the total elimination of waste.*
Why Does Waste Occur?

There are all kinds of waste in the world. People waste time, space, buildings, products, and so on. Even the way we dress can be seen as wasteful. After all, what useful function does a necktie serve? Or a collar? Or a crease?

Naturally, we can expect factory waste to exist in many forms. When waste becomes bad enough, the waste is no longer in the factory—the factory is in the waste. Finally, the waste may get so dense it strangles the factory.

Just how does waste occur in the first place?

First, we must reach a universal understanding of what waste is. Different people have different ideas about what does and does not constitute waste. Common definitions of waste include, “Whatever is not useful is wasteful,” or “Whatever does not contribute to profitability is waste.” These two definitions alone exhibit a significant difference in how waste is understood.

For example, let us suppose I consider neckties a form of waste. I argue that neckties serve no useful purpose whatsoever. But someone who uses his necktie to clean his eyeglasses might disagree with me. For him, neckties are quite useful indeed. Some people might even find their neckties useful after they have washed their hands and can find nothing else to dry them.

Definitions of waste are just as diverse in the factory. Let us take inventory as an example. When product sales are on the rise, inventory becomes a wonderful thing. There is nothing the sales department hates more than production shortages of hot-selling items. Consequently, it views inventory as “necessary.”

Once sales slow down, however, inventory changes from angel to devil. At such times, inventory appears especially diabolical to the managers who suddenly face cash flow problems. These managers might go as far as to say that inventory is “unnecessary” without really knowing what they are saying.
JIT production means removing waste. But when different people have different ideas of what waste is, their enthusiasm for joining together in improvement activities is bound to wane. For that reason, if for no other, we should all have the same idea of what waste really is.

So, let us think for a moment: What constitutes waste in the factory?

We can start counting specific types of factory-related waste, such as the wasteful use of telephones, vouchers, meetings, control work, conveyance, and the like, and we would probably never finish counting. Taking telephone-related waste as an example, we cannot say that all use of telephones is wasteful. Sometimes it is worthwhile.

It is not easy to find the essential meaning of waste, therefore, when waste appears in such variety and is often mixed with nonwaste. Indeed, how can we all agree on a common definition of waste when we cannot even clearly identify it? Perhaps we should approach this problem from the opposite angle by seeking to define what is useful, and then regarding everything that does not fit that definition as waste.

In a factory, “useful” is the same thing as “value-adding.” Machining and other types of processing done in the factory is what adds the most value to the products. So we can say then that everything that does not add value is a form of waste. Clearly, we can see the equivalence between adding “no value” (that is, valuelessness or worthlessness) and waste. We could further emphasize the wastefulness of everything in the factory that does not add value by noting that *waste does not process anything, nor does it add any value.*

Once everyone agrees upon this back-door definition of waste as “everything that does not add value” suddenly and mysteriously all kinds of waste becomes visible.

Where before we saw no waste, we begin to see waste in the way things are counted, waste in the way the workpieces are set on the operator’s table, in the way the operator picks up screws and a screwdriver, in the way he screws in the
screws, and in the way he puts back the screwdriver and passes on the assembled workpiece.

Thus, the simple task of fastening screws into workpieces suddenly becomes full of waste. The only value-adding part of this whole operation is the function of fastening two workpieces so that they will not become separated. Everything that does not directly serve this function is waste. (See Figure 3.1.)

In some cases, the entire screw-fastening operation itself is pure waste because there may be a cheaper way to fulfill the same function. Using a chemical adhesive instead of a screw may, for instance, serve the function of fastening two things together.

In any case, this one simple example of a screw-fastening operation should be enough to demonstrate just how full of waste factories are. It is an exaggeration to say that everything that goes on in the factory is wasteful. We should ask ourselves how waste could have been so successful in taking root in today’s factories.

All kinds of problems, large and small, crop up in factories on a daily—or even hourly—basis. We can safely say that no factory is without problems and that every factory finds itself
buried in piles of problems. How much waste a factory contains, however, depends on how well it responds to its problems.

These “factory problems” are the seeds of waste, and ineffective responses to these problems allow the seeds to germinate and grow. The following is my list of “waste-creating” moments that commonly occur in various factory departments.

1. Manufacturing
   a. This other guy is not busy right now, so I'll use him on my line for the time being.
   b. There's no place to put those things, so let's put them down there for the time being.
   c. This process has been turning out some defectives, so let's increase output for the time being to make sure we produce enough good ones.

2. Conveyance
   a. This stuff is heavy, so let's borrow a forklift for the time being.
   b. For the time being, we'd better count them to make sure we have the right amount.

3. Inspection
   a. We are receiving too many quality complaints, so let's add more inspectors for the time being.
   b. We need to reduce the number of defectives, so let's draw up some Pareto charts for the time being.

4. Equipment
   a. We need to increase our output, so let's bring in another machine for the time being.
   b. There's been a machine breakdown in production, so let's call in some maintenance people for the time being to do some emergency repairs.

5. Control/management
   a. Next month's production schedule has not been decided yet, so for the time being let's just do this month's over again.
b. We’ve been having an awful lot of late deliveries. We’d better make a list to keep track of them for the time being.

The fact of the matter is that the waste that fills up and destroys so many factories starts with such simple incorrect responses to problems.

Notice that I have been careful to include the words “for the time being” in all of the above instances. We tend to do things “for the time being” when we want to do something right away and do not want to take time to find a more permanent solution. In other words, we are temporarily avoiding the problem rather than solving it. Such stopgap responses imply that we do not understand what is really causing the problem.

Virtually all the waste that exists in factories originates in such “evasive” responses. This is particularly true of waste in inventory and conveyance.

Problems occur all the time in factories. People are kept busy finding “evasive” responses to these problems as they occur. The only way to solve the problems is to look directly at them to find the real root cause and then remove that cause. The important thing is to switch from makeshift problem-dodging to real problem-solving.

As shown in Figure 3.2, once a stopgap measure has been employed to “avoid” the problem, people start institutionalizing the stopgap measure by assuming it is the correct measure to take. Then they start making it a habit. Finally, after a few years, no one even questions the ways things are done, since they seem to be the “natural” way of doing things in the factory.

Once such erroneous responses become substantiated as the natural way of doing things, even people who intellectually recognize the inherent wastefulness will be hard put to make any improvements that actually root out the problem’s true cause. The only solution for getting rid of such deeply embedded waste is a truly radical one: the JIT factory revolution.
Types of Waste

In Japanese factories, one often hears of the need to “tighten the cost belt” or “Eliminate the 3 Mu’s.” The 3 Mu’s are the three main types of waste that improvement groups target in their improvement activities. Each of these types has a Japanese name that begins with the syllable *mu*. They are defined as follows:

- **Waste** (muda) = *Capacity exceeds the load.*
  This is a waste of capacity.
- **Inconsistency** (mura) = *Capacity sometimes exceeds the load and the load sometimes exceeds the capacity.*
  Here, the problem is one of variation.
- **Irrationality** (muri) = *Load exceeds capacity.*
  Capacity is overtaxed by an unreasonable load.
The goal is to arrive at a “rational” balance where capacity and load are about equal.

Upon hearing this, some JIT novices might nervously conclude that they not only have to look for plain old waste (muda) but must also make separate improvement efforts to deal with inconsistency (mura) and irrationality (muri). Fortunately, this is not so. These are just theoretical distinctions. In practice, irrationality shows up as inconsistency, which is always tied in with waste. In the practical-minded JIT production system, people involved in factory-based improvement activities are not asked to make distinctions among the 3 Mu’s but instead concentrate their efforts on eliminating waste in the broad sense, which includes inconsistency and irrationality. (See Figure 3.3.)

In other words, JIT’s “total elimination of waste” is intended to cover all of the strictly defined types of waste. In addition to the 3 Mu classification, there are many ways to organize waste into categories. Below are descriptions of three such classification schemes: 5MQS waste, production factor waste, and JIT 7 waste.

**5MQS Waste**

The 5MQS scheme identifies seven types of waste, five of which begin with the letter “M”: Man, Material, Machine, Method, and Management. The “Q” in the 5MQS formula stands for Quality and the “S” for Safety.
Figure 3.4 lists the specific forms of waste that are grouped under the 5MQS categories.

The following describes some of the main forms of waste illustrated in Figure 3.4.

**Walking Waste**

In JIT production, the basic policy is that everyone stands (or walks) while working, especially since most workers are handling several processes at once. But such multi-process handling requires that the workers “walk” at least a few steps as a kind of secondary operation to their main processing operations.

Walking and working are not the same thing. In factory workshops, walking usually takes about one second per step. These steps add up fast, resulting in considerable “walking waste.” The proper response to this situation is to ask, “Why does this worker have to take X number of steps?” and then...
see if an improvement can be made to reduce the required number of steps.

**Watching Waste**

This kind of waste is most abundant in factories that have brought in automated equipment, NC machines, and the like. At such machines, the operator sets up the workpiece, pushes a switch, and then watches the machine do its work. Whenever I’ve asked one of these operators why they are standing there watching the automatic machine work, he or she always has an answer ready, such as, “I’m watching out for flying fragments” or, “I’m making sure the shavings don’t cause problems.” Still, the fact is that these operators are “whiling” more than “watching.” They have some free time while the machine is working, so they “while” it away by being a spectator to the machine’s work. To avoid just this kind of waste, JIT’s “human automation” (jidoka) makes a point of clearly separating machine work from human work.

**Searching Waste**

In changeover procedures that require about 30 minutes, it is not easy to tell when five of those minutes are spent searching for jigs and tools. However, when the same five minutes of searching time goes into a 10-minute changeover, the “searching waste” is quite obvious.

Searching waste is especially common in subcontractor factories. The answer to this problem is the most basic of the “5S” basics: proper arrangement (seiri) and orderliness (seiton).

**Waste of Large Machines**

It often happens that people at processes where workpieces are being processed one at a time without any problems suddenly decide it is better to “maximize output” by gathering workpieces into lots of dozens or even hundreds before
processing them. This rapid boost in output also means a rapid increase in waste.

Large machines that are built for such large-lot processing are themselves manifestations of this kind of waste. I have seen many large presses, cleaning chambers, furnaces, and shotblasters that fit this description.

Figure 3.5 illustrates all the forms of waste that can be created by just one large cleaning unit. There are also some related forms of waste having to do with overall production that are not even listed, such as waste in overall lead-time and quality-related waste.

**Conveyor Waste**

In factories that produce home electrical and electronic goods, almost every assembly line operation uses conveyors. I have
been quite surprised at the extent to which these factories have seen fit to use conveyors. When I ask why, I am usually told that the conveyors help maintain a steady pitch.

I cannot argue with the benefit of a steady pitch, but we need to look at the price paid for that benefit in terms of waste, specifically waste related to moving things to and from the conveyor and “idle time waste” resulting from an imbalance among operations. When viewed from this perspective, conveyors are not so much a tool for maintaining a steady pitch as they are a materials-handling tool that links operators.

Factories such as these become dependent on their conveyors and fail to see all the waste the conveyors conceal. For them, the first step in JIT improvement is to go “cold turkey” by getting rid of the conveyors and their fixed ideas related to them.

**Waste in Machines That “Process Air”**

Often, after the operator presses the “start” button, the machine does nothing but “process the air” for a few seconds before actually machining or otherwise processing the workpiece. Cutter blades spin without cutting anything but air and presses move without pressing anything but air. (See Figure 3.6.)

To remedy this problem, we need to find out what the minimum required amount of space is between the blade,
die, or other tool and the workpiece, and then modify the machine to get as close as possible to that minimum space.

**Waste of Parts**

Here, we need to look at the basic functions of the parts and materials used in the product and then repeatedly ask “Why?” while applying value analysis (VA) and value engineering (VE) techniques to eliminate waste.

We can begin the questioning by asking: “Why is this part necessary?” or “What is this part’s basic function?” Once we have asked this of all the product’s parts, we can grasp what their basic functions are. We are then ready to ask questions such as: “Could these parts be replaced by this part?” or, “Is there some way we can reduce the amount of materials or number of parts?” or, “Could this function be combined with some other basic function in the same part?” This line of questioning will help us reveal and eliminate waste.

**Waste of Materials**

The need for proper arrangement (*seiri*) and orderliness (*seiton*) is just as great in management departments as it is in manufacturing.

First, we figure out which materials are really necessary and which are not, then we immediately toss out all the unnecessary things. Hanging on to nonessential materials fills up lockers and otherwise takes up space. It also contributes to time wasted in searching for necessary things amid piles of unnecessary things.

To do this, we need to find out where the management materials come from. For example, at least half of the material generated by computers is expendable. To find out which half, we can experiment by no longer outputting and distributing the materials. The departments that need certain materials will demand them. Judge all materials that are not in demand as superfluous.
Waste in Meetings

I can tell how efficiently and seriously a factory’s employees pursue their work by looking at two things: the cleanliness of their bathrooms and the efficiency of their meetings.

Meetings happen for all kinds of reasons; there are productivity meetings, advancement meetings, and quality meetings. At many of these meetings, the participants either meet without really discussing anything or discuss something without really making any decisions. In both cases, the meetings generate nothing but waste.

Shish-Kabob Production Waste

The more trouble it is to switch to new products and carry out the required changeover, the more people tend to opt for “shish-kabob” (lot) production. Shish-kabob production is a tempting option when one-piece flow becomes difficult. However, we should be mindful of its many disadvantages, which include the following:

- Diminishes production opportunities
- Lengthens lead-time
- Increases inventory
- Increases defectives
- Eats up space
- Consumes more parts and energy resources
- Slows capital turnaround
- Conceals waste and other problems

The list could go on and on, but I will stop with these eight drawbacks of shish-kabob production to avoid wasting space.

Waste in Picking Up and Setting Down Workpieces

This kind of waste is particularly prominent at factories that are not well organized for manufacturing. Often, workpieces
must be picked up, set down, and counted at each process in the line.

The people at such factories seem unaware of the fact that processing and assembling workpieces is a constant battle against material handling costs. The same value can be added to products even without all the “picking up and setting down.” All it takes to reach that point is human wits and energy.

### Waste in Making Defective Goods

It is not difficult to surmise that quality consciousness is generally abysmal when defective products are taken apart so that their parts can be recycled to build other products. I have seen this happen, especially with molded plastic parts and aluminum diecasts.

And it is not hard to find workers at such factories who shrug their shoulders at defective products and say, “No big loss. We can recycle the parts.”

Addressing defective products is too little too late. We need to find ways to prevent people and machines from making defect-causing mistakes in the first place. JIT’s essential techniques for doing this are human automation, *poka-yoke* (mistake-proofing), and company-wide awareness revolution.

### Waste in Disaster Prevention Measures

Accidents and injuries are a clear sign of truly excessive waste in the factory, and are the kind of “social waste” that people should regard as Public Enemy No. 1. Safety guidance and assurance must be a key underlying factor in any campaign to rid factories of waste.

### Production Factor Waste

This approach to waste takes the “flow of goods” in production as the basis for finding and eliminating waste. The flow of goods at a typical factory is characterized by:
1. Procurement staff ordering and accumulating materials, which they send to the materials warehouse as “retained” goods.

2. At the processing stage, a conveyor system carries the materials to the processes on the production line.

3. The conveyed materials to be processed are “retained” next to the processing equipment.

4. The materials next to the processing equipment are picked up and “processed.”

5. After being processed, the goods are set down and “retained” on the other side of the same machine.

6. The conveyor carries these goods to the inspection process.

7. The goods are retained at the inspection process, awaiting inspection.

8. The goods are inspected.

9. The inspected goods are set down again and retained on the other side of the inspection process.

10. The conveyor carries the inspected goods to the warehouse, where they are retained prior to shipment.

If we take just the four key flow factors (retention, conveyance, processing, and inspection) from these ten steps in the flow of goods, we get a pattern of:


Let us examine the function performed by each of these four main flow factors.

1. Retention

We can define retention as stopping the flow of goods without adding any value to them. Other words used for this are “stockpiling,” “warehousing,” and “temporary storage.”
Every time we have retention, we have some kind of inventory. Figure 3.7 shows how overall inventory can be broken down into different types of inventory.

In this case, retention occurs for several reasons, including:

**Capacity imbalances**—Figure 3.8 shows a container of waste overflowing as an analogy of what happens to in-process inventory when there is capacity imbalance between upstream and downstream processes.

In terms of capacity balance/imbalance, the relationship between upstream and downstream processes can always be expressed as one of the following three formulas:

- Upstream process = downstream process (Synchronized)
- Upstream process > downstream process (Inventory)
- Upstream process < downstream process (Shortage)
Goods flowing from several lines to one process (flow of goods). When goods flow from several processes in other lines to just one process, they tend to pile up at the point of convergence. Conversely, goods pile up when they are sent from one process to several others. (See Figure 3.9.)

Avoiding changeover and/or product model changes (anticipatory manufacturing)—Since the processing department hates having to replace dies, blades, and the like, it tends to minimize changeover in assembly, which causes retained goods to pile up.

End-of-the-month rush (anticipatory manufacturing)—When the factory people are told to follow a monthly production schedule, they tend to take it easy during the first half of the month and then “step on the gas” during the latter half, especially the last week.

Consequently, assembly parts tend to pile up during the middle and end of the month and product inventories pile up at the start of the month.

Opportunistic buying, policy-based buying (anticipatory buying)—This happens most often with raw materials. Manufacturers that buy materials whose prices fluctuate widely or that have long lead-times try to buy these materials a little more cheaply by entering annual procurement contracts or using other anticipatory buying tactics.

After-sales service part requests (anticipatory manufacturing)—This refers to the manufacturing of “service parts” or “spare parts” to be used in repairing the delivered
products. The manufacturer keeps an inventory of such parts to be able to respond quickly to service part requests.

After looking at the functions served by these different types of inventory, we can see that the two main causes for inventory retention are anticipatory manufacturing and anticipatory buying.

Inventory begins piling up when the upstream processes begin turning out more than the downstream processes can accommodate. This also happens when work-in-process gets bundled into lots to avoid changeover. Finally, it happens when required goods are produced before they are required. All of this adds up to increased inventory.

Retention adds to costs without adding anything to value. It is useful only as a “cushion” against problems such as shortages.

Now we have reached the crux of the problem. Because inventory acts as a cushion, people tend to think of it as a solution to production flow problems. The truth, though, is that inventory merely evades problems and does not solve them. No matter how much inventory we accumulate, the real causes for problems will not go away.

2. Conveyance

Conveyance can be defined as an occurrence whenever goods are being moved without having any value added. We also call such activity “transport” or “transferring.”

Figure 3.10 illustrates the functions of conveyance within the production flow.

“Conveyance” between two retention points is sometimes done by hand, but when there is enough volume to warrant it, we usually employ a conveyance machine such as a conveyor, cart, or forklift to do the work.

“Material handling” between a retention point and a processing point is only rarely used for processing of lots and is generally used for one-piece processing. In this latter case, the moving of materials is almost always done manually. When I analyzed the flow of production at a certain
electronic equipment assembly plant, I obtained the following breakdown of the four main flow factors.

- Processing points: 6
- Retention points: 24
- Conveyance times: 16
- Inspection points: 3

It is amazing how many retention points and conveyance times occur. These two factors, in fact, make up over 80 percent of the total. While it is true that retention does not itself require any labor, conveyance often requires a lot of worker hours. In fact, conveyance accounts for about 80 percent of the worker hours involved in the 16 times things are moved in this factory.

This curious fact deserves a little more thought. We have already defined conveyance as moving things in a way that raises costs without adding value. In view of the entirely negative effect of conveyance, we should not be content with just shortening conveyance distances and times. We need to make a radical improvement by getting rid of conveyance entirely.

To do this, we must abolish the specter of retention. Conveyance tends to happen wherever retention points occur.
If we can get rid of retention completely by linking processes together, conveyance will die a natural death. Doing this will entail the following:

1. Begin by having one person process workpieces one piece at a time. *This will teach people how poorly the equipment is laid out.*
2. Change the equipment layout to accommodate “one-piece flow.” *People will find out how mobile the equipment really is.*
3. Add casters to make hard-to-move equipment more mobile. *People will begin to understand what real improvements are.*

As shown in Figure 3.11, once we get the processes linked together, one-piece flow becomes possible for the first time. Now, if we can only get rid of the retention points, we can stop using conveyors. All that will remain is short transfers of workpieces between processes.

Note that we have *not* eliminated all transferring of workpieces between processes, but have only shortened their distances (and times). Why? Because in this case, completely eliminating all movement of workpieces—including material-handling movement—would turn all of the process stations into one all-inclusive process station. That might sound good in theory, but in practice it requires heavy equipment investment, much longer processing times, and lower output. To avoid all that, we opt for a three-station arrangement. This still means that a capacity gap is likely to
appear between one process station and the next. So, for the time being, this JIT-oriented production layout gives rise to shish-kabob production.

3. Processing

In the present context, processing means adding value to a workpiece as it proceeds through the production line. It is the work that goes into the workpiece.

Basically, two types of value-adding take place in production lines. One type is processing in the narrow sense, which means altering the shape or chemical makeup of the raw materials or parts that comprise the workpiece. The other type of value-adding is assembly, which simply means putting together materials and/or parts to add value. (See Figure 3.12.)

In improving processes, there are two main methodological models to choose between: the “ideal model” and the “analytical model.” If we choose the ideal model, we need to find out what the essential functions of the process are, then ask ourselves, “How can this process best fulfill those functions?” This “ideal model” calls for a deductive approach, an approach that lends itself to two kinds of improvements: VA/VE improvements and technology-specific improvements.

If we adopt the analytical model, we need to study the various processing operations and ask ourselves, “How can these operations be made more efficient?” Thus, the analytical mode requires an inductive approach. This approach lends itself to technology-specific improvements and to breaking up and combining processing operations.

![Figure 3.12 Two Types of Production Value-Adding.](image-url)
Figure 3.13 illustrates these models and approaches.

By definition, processing means adding value. In view of this, most production engineers think of processing as established and somehow beyond improvement. They aim their improvement efforts elsewhere and do not stop to think about improved processing. I call such production engineers “lateral improvement makers.”

By contrast, some production engineers take a more critical look at things. For example, they might ask, “Why are we drilling holes at this process?” when inspecting a drilling process or “Why are we putting in screws?” when viewing a machine screw-fastening process.

The more critical the engineer is, the more he or she is able to make improvements that reach into product functions or even into product design. These are “vertical improvement makers.”

Vertical improvements require the kind of inquisitiveness and wisdom seldom seen in the analytical (IE) approach, which accepts the current processing arrangement and then tries to make it work a little more efficiently.

4. Inspection

This last but not least of the four major factors in production flow can be defined as the identification and elimination
of defectives from the production flow. As such, inspection does not add any value.

Some people might take exception with the above definition of inspection and instead argue that inspection is “defect-finding behavior.” But this latter definition is far from accurate. “Defect-finding” sounds too much like “improving” or “problem-solving.” While it is true that finding defects is an effective way to reduce defect complaints from customers, it does nothing to reduce the number of defective goods being produced on the line.

Keeping a large inspection staff to minimize customer complaints gives the manufacturer a false sense of security while defective goods continue to be produced and inspection costs continue to climb.

We have to change the concept of inspection from “finding defects” to “reducing defects.” In JIT, reducing defects goes beyond recognizing them and doing something to make them a little less frequent. JIT declares all-out war on defects and calls on us to find ways of preventing their recurrence altogether.

Thus, JIT requires a three-step progression from “finding defects” to “reducing defects” and finally “preventing defects.” Naturally, this means inspectors must change their whole attitude toward their work. Figure 3.14 shows how JIT views inspection work.

![Figure 3.14: How JIT Views Inspection Work.](image)
Sorting inspection—In sorting inspection, defect-finding inspectors sort nondefective processed workpieces from defective ones and throw out the latter.

This type of inspection may reduce complaints from customers, but it will not do anything to reduce the number of defects.

Information inspection—This type of inspection reduces defects. When a defect occurs, the related data are used to find the process where it occurred and to correct the defect-causing problem.

Three ways to perform information inspections are:

- **Quality control method**
  This is also known by the acronym SQC (Statistical Quality Control). After taking detailed statistical data of the conditions at each process, any defect can be traced back to the process where it occurred and then can be corrected. (See Figure 3.15.)

- **Downstream process control method**
  To make inspections as objective as possible, the inspectors inspect every workpiece and use statistical data for feedback at each downstream process to check up on the previous process. (See Figure 3.16.)

- **Independent quality control method**
  Also known as “independent inspection,” this method requires process equipment operators to conduct their own quality inspections of goods processed at their own stations to provide faster information feedback for the downstream process control method. (See Figure 3.17.)

![Figure 3.15 Information Inspection Using the Quality Control Method.](image)
Back-to-the-source inspection—This is a defect-preventing approach in which we find the error leading to defects, distinguish among the resulting defects, and then make improvements that prevent defects from occurring even if the same error occurs again.

The two main methods used in this type of inspection are *poka-yoke* and human automation. (*Poka-yoke* is described further in Chapter 12.)

As you can see, “inspection” comes in all types, each based on a different approach to defects. Just the same, we must always remember that the basic act of inspection contributes *nothing* to higher added value. That is why we should be concerned to prevent defects in the first place, so as not to waste untold labor expenses on inspections.

In this brief discussion of the four major production flow factors—retention, conveyance, processing, and inspection—
we have seen why each factor occurs, what the functions of each are, and which methods can be used to manage them.

The important point of reference in thinking about these four main factors is their relationship to the adding of value to products. Remember—anything that does not somehow add value to the product is only waste.

More than anything else, the severity of our vigilance against waste determines whether our improvements will be revolutionary, incremental, or just empty gestures.

- **Highest severity**
  This means we look at all four factors—retention, conveyance, processing, and inspection—with a keen eye for identifying and eliminating waste. This is especially true of retention, conveyance, and inspection, which are nothing but waste, and is also true of processing. To bring critical inspection right to the heart of the process, we need to ask, “Why is this processing necessary?”

- **Second-highest severity**
  Here, we regard only processing as a value-adding factor and look toward retention, conveyance, and inspection as targets for waste-eradication efforts. This level of severity does not make for “vertical improvements” that overlap waste removal across factors, that eliminate waste from processing, or that carry waste-removing improvements all the way upstream to the design stage.

- **Second-lowest severity**
  At this level, processing is obviously above suspicion as a source of waste and inspection is indispensable for removing defective goods. Consequently, we aim our waste-removing efforts entirely toward retention and conveyance.

  When severity is at this level, our improvement efforts will probably not go beyond material handling.
Lower severity

If we adopt this level, we see not only processing and inspection, but also retention and conveyance as necessary to production. We would never go as far as to get rid of retention and conveyance. Instead, we “solve” retention problems by establishing new places to pile things or by building new shelves. Likewise, we “solve” conveyance problems by bringing in more carts or introducing an automated transfer system. All such improvements are actually nothing but empty gestures.

**JIT’s Seven Types of Waste**

In JIT, we classify waste into seven types. Each of these types has been identified by the highly critical waste-removing eyes of veteran JIT improvement staff.

Carrying out factory-based improvements on these seven types of waste can prevent waste from becoming institutionalized in the factory. The “production factory waste” described in the previous section is included in JIT’s seven types of waste. However, the JIT approach requires strongly motivated people who have developed an “instinct” for removing waste using IE methods. (See Figure 3.18.)

JIT’s seven types of waste are:

1. Overproduction waste
2. Inventory waste
3. Conveyance waste
4. Defect-production waste
5. Processing-related waste
6. Operation-related waste
7. Idle time waste

While these types of waste are found most commonly in the factory, JIT has seven additional types of waste that
can be effectively applied to management divisions. These management-related waste are:

1. Overkill waste
2. Work/material accumulation waste
3. Conveyance/walking waste
4. Human error waste
5. Waste inherent in management and clerical processes
6. Operation-related waste
7. Idle time waste

As you can see, the two sets of waste have many similarities, such that factory-based waste eradication efforts can almost be applied as they are to management divisions. This is because:

1. A keen eye for waste remains keen no matter where it looks.
2. JIT's seven types of waste are impartial.
3. Removing JIT's seven types of waste from the factory easily develops into removing all types of waste from all types of places.
The types of waste are actually almost limitless. There is waste in memos, in communication, in details...in everything. Once we’ve created some time for waste-eradication efforts, the thing to do is to go to the factory and start with JIT’s seven types of waste. At first, we should expect to find these seven types (and variations on these types) to be lurking in every square inch of the factory.

Just remember: No factory is without waste. If we can enter the factory with that thought on our minds, we are starting out just fine. Next, we need to get to the heart of waste by asking “Why?” at least five times. This should naturally lead us to the deepest roots of waste, after which we need only put our ingenuity to work in coming up with improvements to eradicate the waste.

The three essentials for starting out are: train the eyes to spot waste, remember that no factory is without waste, and start right in the factory.

Let us look at JIT’s seven types of factory-based waste in more detail.

1. **Overproduction Waste**

Overproduction waste can be defined as “producing what is unnecessary, when it is unnecessary, and in an unnecessary amount.” Does this sound familiar? It is a mirror image of the Just-In-Time definition.

Overproduction waste is the worst of all forms of waste. It contributes to retention and inventory waste. More inventory naturally leads to more conveyance. Overproduction waste is like a wedge that opens the door for various other kinds of waste.

So, we start asking “Why?” Why does overproduction occur? Simple: Workers and machines have excess capacity. They put this excess capacity to work in turning out excess products. Once we have reached the root cause of overproduction, we can immediately start making improvements. To begin with, we can use devices such as kanban and the
“full work system” to tie production processes together in a flow, after which we can synchronize the worker and machine cycle times with product cycle times. This may require some leveling, worker hour reductions, or equipment downsizing.

2. Inventory Waste

Originally, inventory strictly meant stock in warehouses. But in its broader definition, inventory means whatever is being retained at retention points inside or outside the factory. Some of these retained items are warehouse inventory and some are in-process inventory (see Figure 3.19). Generally, we refer to in-process inventory as one type of broadly defined inventory.

Therefore, “inventory waste” should be understood to generally include not only waste in the warehouse, but also waste related to all stock-in-hand, such as in-process inventory. This means materials, parts, assembly parts, and whatever else piles up at retention points located at or between process stations.

In JIT improvement, we regard this inventory in all its variety as “symptoms” of a “sick” factory. In other words, just as doctors look for such typical flu symptoms as fever, weariness, and dizziness, JIT “doctors” need to look at inventory as symptoms of ill health in factory operations. Inventory sometimes piles up as finished product inventory and other

Figure 3.19 Warehouse Inventory and In-Process Inventory.
times as in-process inventory. And defectives can lead to very big piles of inventory.

Behind the symptoms of inventory stacks we can find the causes of the illness. Once we have identified these causes, we are ready to begin therapeutic or surgical treatment. The treatment, of course, is JIT improvement, aimed at revolutionizing the factory.

The most important prerequisite for uprooting and sweeping away inventory waste is the awareness revolution. Inventory waste will stay put unless people firmly believe in *No Inventory*. People naturally tend to take the easy way out. Keeping inventory piles here and there is an easy way to avoid all sorts of problems. But we need to realize through and through that inventory avoids but never solves problems.

3. **Conveyance Waste**

Conveyance waste is another broad term covering everything from conveyance made necessary by poor layout, material handling (such as picking things up, setting them down, and stacking them up), and just moving things around. Sometimes the wastefulness of the existing conveyance system is due in large part to complexity involving excessive conveyance distances and heights, or underutilization of conveyor systems.

Conveyors and material handling systems not only take a heavy toll on productivity, but also eat up valuable space in the factory. Moreover, the more times an item is moved or handled, the greater the chance of its being dented or otherwise damaged.

The basic approach to correcting this situation is to first redesign the equipment layout, then take away the conveyors and minimize the amount of material handling.

4. **Defect Production Waste**

Human errors invite defects and defects are the watershed for a long cascade of events. Customer complaints increase.
Rising customer complaints lead to beefed up inspection staff. This usually results in fewer complaints.

However, the reduction in complaints does not in any way mean a reduction in defective goods (except shipped defectives). To reduce the occurrence of defects in the first place, we need to go all the way back to their original causes. Defects produce waste in and of themselves and give rise to the waste produced thereafter until someone finally gets around to correcting the defect. In addition, they disrupt the normal flow of goods and have a big impact on productivity. That alone is good reason for switching from sorting inspection that just separates the defectives from the nondefectives to back-to-the-source inspection that builds quality in at each process. It is also a good reason for adopting defect-prevention methods, such as poka-yoke and human automation, to prevent equipment malfunctions, as well as better training and more standardized work methods to help minimize human errors.

5. Process-Related Waste

Once people get the hang of performing a particular job, they lose sight of the job’s function and simply “do the job.” For example, I have seen cases where a factory worker, whose job includes drilling machine screw holes, continues to drill the holes even after design changes call for welding to be used as the fastening method instead of machine screws.

I have also seen workers aggressively drive numerous screws into exterior casing as if they were trying to win a boxing match with the casing. They were certainly putting in far more screws than required to serve the casing’s function. They were putting screws in where none had been needed in earlier models. I’ve even seen this sort of thing happen in cases where an adhesive or welding process had already fastened the casing firmly enough.

Obviously, we need to ask, “What is the basic function of this work procedure?” and “What is the basic function of this
part?" The conservation-minded approach is taken not only by JIT experts, but also by experts in industrial engineering (IE) and value engineering (VE).

6. Operation-Related Waste

Not everything that happens in a day’s work adds value. In fact, the vast majority of the typical worker’s labor is “movement” and very little indeed is actually “work.”

Movement is waste. More precisely, movement that does not directly add value is nothing but waste. Work operations are the movements workers make while they are working.

Operation-related waste can be created by poor equipment layout or by poorly placed parts, jigs, and tools. To improve such situations, we begin by asking, “Why is this operation necessary?” to see if the operation might not be eliminated altogether. If it turns out that the operation does serve a legitimate function, we then get to work in reducing the amount of movement required by the worker to do the operation. In order, we start with feet movement, then proceed to hips, shoulders, arms, hands, and fingers.

7. Idle Time Waste

“Idle time waste” is a broad term that includes both human idle time and machine idle time and covers a wide variety of cases. Idle time is generally time spent waiting for something. However, the causes for such waiting can be broken down into causes originating from the “waiting side” and those originating from the side that makes the waiting side wait. In many cases, the causes come from both sides.

The main causes on the side that makes the idle time occur include people, machines, workpieces, and conveyances devices. An even wider variety of main causes exists on the waiting side, but the biggest factors there are human- and machine-related factors. For example, if the workpiece is causing the idle time to occur, the causes and required improvements might be similar to those shown in Figure 3.20.
Figure 3.21, found on page 182, provides a table listing JIT’s seven types of waste under the categories of description, contents, causes, and responses.

**How to Discover Waste**

I have heard many complaints arising from cases where people have set out to remove waste from their factory only to be disappointed at the results. They say they have genuinely worked hard to make improvements, but their efforts do not seem to be leading anywhere. Naturally, they want to know why. Generally, the reasons for such slow progress are not so much the expected reasons—such as faulty improvement plans or difficulty in implementing the improvement—as they are factors such as:

1. Being unable to recognize waste as it occurs in the factory.
2. Waste remains hidden within abnormal conditions or problems in the factory and is thus not readily apparent.
3. Even when waste becomes evident in connection with abnormal conditions or problems in the factory, people do not know enough to recognize the waste.

If an inability to see the waste as it occurs is the reason, the previous section of this chapter should help them get at least a theoretical understanding of the types of waste. Once they have gained such an understanding, the people concerned...
must head straight into the factory and gain a practical grasp of waste by actually identifying it and dealing with it.

This section explains how to develop a “sixth sense” for discovering waste in the workplace. This explanation has three parts, which are listed below in order of their appearance.
Finding waste according to its “back-door definition.”
- Bringing latent waste to the surface with one-piece flow under current conditions.
- Analyzing current conditions to discover waste.

Finding Waste according to Its Back-Door Definition

No matter how many books we read or how many video programs we watch to build up our knowledge of what constitutes waste, when we go to the workplace prepared to start eliminating waste, we find it hard just to find the waste in the first place. In such cases, we tend to think, “I must have misunderstood the book” and we go back to the office to study. But then the next time we give it a try in the workplace, we run into the same failure and frustration.

People who have little or no experience in making improvements have a particularly hard time identifying waste in the factory. When faced with the complex nuts-and-bolts operation of a factory, an understanding of waste based on a few hours of book-reading is hardly enough to inspire confidence toward making changes.

But that is just the way it goes at first. We have to take a cold, hard look at the current situation in the factory. It may take hours of standing and observing before we begin to get a “sense” of the waste that lurks in the operations performed by the factory’s workers and machines. Discovering waste is a hands-on activity, and to develop our skill in that activity we need experience in the real things: the factory, the facts, and the work-in-process.

Every operation that occurs in the factory is chock-full of waste. Waste is so common that its own ubiquity makes it hard to see. We sense that we are losing our ability to distinguish what is wasteful from what is not. When this happens, we desperately rely on our instincts and start blindly looking
for waste. This makes waste even harder to find. This is a dilemma that many JIT novices fall into.

At times like this, the thing to do is take a deep breath and start thinking differently. In fact, we need to take an opposite, “back-door” approach to finding waste by ceasing to look for waste. That’s right: If waste is too hard to distinguish, then just stop looking for it.

Instead, go around to the “back-door” and look for waste’s opposite: work. (Remember, work is defined as whatever adds value to the work-in-process.) In most cases, whatever operation we study will be full of waste in all its confusing variety. It may, however, also include one or two small value-adding functions that we may rightfully identify as “work”—“work” that is much easier to identify than waste.

To do this, we need to continually ask ourselves, “What is this operation doing?” We need to closely inspect the entire process.

For instance, if the process is an assembly process, we even need to look at how the machine screws are fastened. Once we have realized, “Oh, this is a screw-fastening process,” we are ready to repeatedly ask ourselves “Why” questions, such as, “Why do they need a screw-fastening process here?”

This line of questioning brings us to the realization that the function of the process is to fasten two parts together, and the fastening agents in this case are the machine screws.

We are now ready to get to the bottom of the function we have just identified by looking at the “work” (value-adding) involved. In this case, the “work” is the second or two during which the final turn of the machine screw is made to actually fasten the two parts together. Now that we have identified the “work,” we automatically know what the “waste” is: everything else—picking up the screw and screwdriver, inserting the screw, and so on.

Believe it or not, if we have come this far, we are already halfway there in making an improvement. To make further progress, we need to continue asking “Why?” For example,
why must the operator take a step each time he picks up a screw? Let us suppose the answer to that question is that the box of screws is kept three feet from the operator’s work position. Now we ask “Why?” again: “Why is the box of screws kept three feet away from the operator?”

This series of “Why” questions should continue for at least five questions. This is the “5W” portion of the 5W1H procedure that is further discussed at the end of this chapter. Asking “Why?” at least five times will take us from the surface phenomenon of the problem through successively deeper levels of causal factors until we reach the real cause or causes that form the crux of the problem.

If we start making improvement plans (in other words, if we jump to the “How to make an improvement” question) after asking “Why?” only once or twice, our improvement plan will be as superficial as our inquisition. I call such improvements “empty gestures” or “surface improvements.”

This book will emphasize the 5W1H (five “Whys” and one “How”) method again and again because it is an extremely important tool for digging beneath “surface waste” to discover the “true, deep-down waste.”

Figure 3.22 summarizes the five main points concerning the most effective way to discover waste.

**Bringing Latent Waste to the Surface with One-Piece Flow under Current Conditions**

Factories come in all kinds. At some factories, people have learned to make deep-reaching improvements while other factories are still making surface improvements or do not wish to make any improvements at all. Some factory workers are making rapid progress in carrying out improvements and others are moving at a yawn-inducing pace.

Fortunately, I know just the thing to wake up drowsy workers at factories whose improvement campaigns are either
sluggish or nonexistent: one-piece flow. (Chapter 5 describes one-piece flow production in more detail.)

Most people get a highly inaccurate first impression of what one-piece flow is all about. They imagine one-piece flow production as something that first requires a new equipment layout to follow the process sequence, a worker trained in multiprocess handling skills, and various other time-consuming preparations. When such people hear me suggest switching to one-piece flow, they tend to say something along the line of, “Sounds good, but the present layout is all wrong.” As usual, the person is theorizing instead of being practical.

JIT means the total elimination of waste. But we cannot eliminate waste unless we first identify it. One-piece flow offers an effective technique for manifesting the waste that is latent within current conditions.

Instead of thinking up reasons for not giving this technique a try, we should simply switch to one-piece flow using the current conditions. Suddenly, we notice some amazing things:
The conveyor movement that used to bring 100-unit lots of workpieces to the process now must make 100 movements to bring 100 single workpieces. This hundred-fold increase in conveyor use makes conveyor waste noticeable, to say the least. It also helps us realize what kind of waste results when machines are placed farther apart than they need to be. Or, if carts were used to move the 100-unit lots a few feet to the next process, one-piece flow shows us that the workpieces can also be moved one at a time by hand. The vast cleaning chamber that cleans the 100-unit lots seems like massive overkill when the workpieces come through for cleaning one at a time. One-piece flow also shows us how unnecessary the in-process stock shelves and carts are and how poorly balanced the processes are in terms of their relative capacities.

One-piece flow also brings up some big problems, such as how to efficiently transfer workpieces one at a time. Applying our “shop smarts” to these problems is how we can go about solving them. Remember, one of the ten “Basic Spirit” principles for improvement is: “Problems give you a chance to use your brain.”

Even people who have an impossible time trying to understand waste intellectually will gain sudden enlightenment once they have tried out one-piece flow in their own workshop.

**Analyzing Current Conditions to Discover Waste**

JIT does not follow the traditional IE approach to improvement, which emphasizes analysis of current conditions. This is because JIT improvement is a deductive approach wherein we begin with recognizing the “ideal” of JIT production and the gap between current conditions and that ideal, then we get to work to bring conditions as close as possible to the ideal.

By contrast, with IE improvement, we begin by analyzing current conditions and then see what we can do to improve their efficiency. As such, IE improvement takes an inductive approach. The advantage of this approach is that it reliably
leads to higher efficiency. IE improvement of the conveyance system will likely result in a more efficient conveyance system. However, the conveyance system will always be there since IE does not question the existence of current systems, but just tries to make them run better. In addition, analyzing current conditions takes time, and this creates the disadvantage of a long lead-time for improvements. Meanwhile, the production diversification trend continues to accelerate, the size of individual orders continues to shrink, and the marketable life of new products is getting shorter and shorter. The way things are going, there may soon be many cases where IE improvement teams complete their analysis of current conditions and are finally ready to make the improvement, only to find that the product has been discontinued or the staff changed.

In response to these trends, we need a type of IE that dispenses with the emphasis on time-consuming analyses without losing effectiveness. The following describes a method for analyzing current conditions that does not take a long time, but produces good results.


When we look at production processes from the perspective of the flow of goods, we can broadly divide these processes into the four major flow factors of retention, conveyance, processing, and inspection. Obviously, various kinds of waste can be found within processing alone, but the places within the flow of goods where waste is found in greatest abundance are at the retention and conveyance points.

Arrow diagrams do not take a lot of time or labor to create, but they are very good for flushing out the major types of waste in production. As such, arrow diagrams can be applied against the factory’s equipment layout diagram by marking the major problem points in product flow in the diagram based on the arrow diagram’s analysis of the four major flow factors. Once the big problem points have been identified and illustrated this way, it is easier to make improvements.
Process Analysis Factors and Corresponding Symbols

1. Retention: Retention is when work-in-process of any kind is held or stored somewhere without being immediately involved in processing, conveyance, or inspection.

2. Conveyance: Conveyance is when the position of work-in-process is changed. Conveyance occurs most often between retention points.

3. Processing: Processing means altering the shape of chemical makeup of the work-in-process in a way that adds value to it.

4. Inspection: Inspection means checking the amount, size, shape, and quality of products to see if the product fulfills its functions and meets the relevant standards.

Figure 3.23 shows the graphic symbols that correspond to these four factors.

How to Create Arrow Diagrams

1. Recognize the analytical purpose: The purpose is not to create an arrow diagram. The purpose of the analysis is to discover major forms of waste. To actually remove the waste, the equipment layout will have to be changed, superfluous operations eliminated, and other improvements made. Arrow diagrams facilitate such improvements.
by making the current flow of goods more obvious and comprehensible in graphic representation. Everyone in the improvement team needs to recognize these points. (See Figure 3.24.)

2. **Select the product to be analyzed:** P-Q analysis (described in detail in Chapter 5) is an analytical method that compares products (P) and quantity (Q). It is very useful when applied to products for which a large output is needed. It also is useful with products that tend to encounter a lot of problems along the production flow.

3. **Prepare a factory layout diagram:** This diagram should contain the entire factory’s layout, and should indicate the positions of all machines, work tables, and other equipment. Since these diagrams are referred to again and again for each product, the original should be kept in a safe place and photocopies should be made for writing in remarks based on specific analyses.

4. **Do a flow analysis:** Flow analysis is not something to be done at some desk using a mental picture of the factory. The ways things are done at the factory are beyond what anyone can mentally picture or remember. Instead, we must go to the factory and make the flow analysis while watching what actually goes on there. Use the four flow factor’s symbols (triangle for retention, small circle

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**Figure 3.24  Acknowledging the Purpose of Arrow Diagrams.**

<table>
<thead>
<tr>
<th>Purpose: Cost reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Maintain quality while removing major forms of waste</td>
</tr>
<tr>
<td>- Measure the results</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Improvement: Carried out immediately at the workplace</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Change the layout and flow pattern of goods</td>
</tr>
<tr>
<td>- Get rid of superfluous operations</td>
</tr>
<tr>
<td>- Create a summary chart of flow analysis (after improvements)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis: Create an arrow diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reveal current conditions</td>
</tr>
<tr>
<td>- Make waste recognizable (and actually recognized) by everyone</td>
</tr>
<tr>
<td>- Create a summary chart of flow analysis (before improvements)</td>
</tr>
</tbody>
</table>
for conveyance, large circle for processing, and diamond for inspection) when drawing the arrow diagram for flow analysis. Connect these factor symbols with lines containing arrows that indicate flow direction. Feel free to use other numbers and symbols, such as those that appear in the example shown in Figure 3.25, to describe the contents of the various processes.

5. Write up a summary chart of flow analysis: After completing the arrow diagram, we should draw up a summary chart of the flow analysis and enter the relevant volume and distance information under the “before improvement” columns. (See Figure 3.26.)
Arrow diagrams such as the one in Figure 3.25 are one of the simple analytical tools developed by conventional IE that can provide very useful results. However, most of IE’s other statistical tools take a lot of time and labor to achieve similarly effective results, and much of this work is usually done at a desk and away from the factory.

JIT improvement’s emphasis of eliminating waste leaves no room for playing around at some desk with analytical symbols and numbers. The whole point of JIT improvement is to make every judgment in the factory, in our actual work environment.

2. Operations Analysis Table: Finding Waste in People’s Actions

Not everything workers do adds value to the workpiece. On the contrary, almost everything the typical worker does is mere “movement” that adds no value at all. Operations

Figure 3.26 Summary Chart of Flow Analysis.
analysis tables are analytical tools that help us bring the waste inherent in worker operations to the surface.

To fill in an operations analysis table, write down the operator’s actions in the order they are performed. This will help later in finding the major manifestations of waste within these worker operations.

There are five key points to remember when using operations analysis tables.

- **Point 1: Fill it out at the factory.** Do not use, “I know that job like the back of my hand,” as an excuse for filling out the table anywhere but in the factory. Look at the real situation in the factory as you fill out the table.

- **Point 2: Everything that is not work (value-adding) must be counted as waste.** Always look as critically as you can to distinguish work from movement as you observe the worker’s actions. Start by trying to identify the value-adding aspects of the operations.

- **Point 3: Look for the nitty-gritty details.** Look for as much detail as you can spot, then write all those details on the table. Detailed understanding requires detailed observation.

- **Point 4: Once you finish filling out the table, set an improvement goal.** Go over all of the observation-based data you have written in, including “work” actions and “movement” actions, movement of goods and the time required for that, idle time, and inspections. Then set an improvement goal.

- **Point 5: Thoroughly eliminate waste from everything except “work” operations.** After making an analysis to distinguish “movement” operations from “work” operations, carry out improvements to eliminate as much of the “waste” as possible. Write down the improvement results on the operations analysis table and then confirm them. Figure 3.27, on the next page, shows how the operations analysis table might appear at this point.
## Operations Analysis Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Work</th>
<th>Movement</th>
<th>Transfer</th>
<th>Idle</th>
<th>Inspect</th>
<th>Description of operation</th>
<th>Time</th>
<th>Distance</th>
<th>Work</th>
<th>Movement</th>
<th>Transfer</th>
<th>Idle</th>
<th>Inspect</th>
<th>Description of operation</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Load castings onto cart</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Develop small shotblaster and install in U-shaped cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transfer to press</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Press</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unload with workpieces to be pressed</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drill</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transfer to drill press</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shotblast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drill workplaces (lot size: 100 units)</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Load drilled workpieces onto cart</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transfer to shotblaster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wait until shotblaster is empty</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Suspend workpieces in shotblaster using crane</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shotblast workpieces (lot size: 100 units)</td>
<td>3'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Load shotblasted workpieces onto cart</td>
<td>5'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transfer to inspection station</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inspection (lot size: 100 units)</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td>15</td>
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<td>16</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Before Improvement (date: 10/28/88)**

**After Improvement (date: 12/07/88)**

*Figure 3.27 Operations Analysis Table: Aluminum Casting Deburring Operation.*

Standard operations serve a very important function in the realization of JIT production in that they provide a method for finding the most efficient operational combination of people, goods, and machines to safely produce high-quality products at low cost.

To establish this type of standard operations, we must first analyze the current operations to flush out their inherent waste and impracticalities. Things cannot be standardized unless they are first identified.

Figure 3.28 shows how a combination chart for standard operations might look prior to making an improvement.
Looking at the chart shown in Figure 3.28, we can see that the basic problem is the need to produce 600 door jambs per day when one day of operation time equals 450 minutes (7.5 hours). To do this, we need a cycle time of 54 seconds, whereas the current cycle time is 89 seconds. Obviously, a production shortage is inevitable unless we bring in extra equipment or resort to overtime work to make up the difference.

However, there is another option: We can use this combination chart to discover waste in the current combination of people, goods, and machines, and then we can make improvements to realize a more efficient (cycle time-reducing) combination.

4. Waste-Finding Checklists

Waste-finding checklists are a good tool to have when inspecting workshops for waste. We can record the types and magnitudes of waste that we find at each process to make such waste readily apparent. There are two kinds of waste-finding checklists: workshop-specific ones and process-specific ones.

We should use a workshop-specific waste-finding checklist when looking for types and magnitudes of waste within a certain workshop’s processes. This type of checklist works best for finding major forms of waste. Next, we should use a process-specific checklist when probing deeper into the major forms of waste that have already been identified at certain processes in order to discover smaller, more subtle forms of waste. (See Figure 3.29.)

A more casual name for this checklist would be “the major waste checklist.” Figure 3.31 shows an example of this checklist form, which, as mentioned, we carry with us while inspecting the types and magnitudes of major waste in a particular workshop.

When filling out this checklist form, first enter the number and name of the process concerned, then rank the magnitude of the seven types of waste (each type has its own column in the form) according to Figure 3.30’s five levels of magnitude.
Find major forms of waste at each process
Note the types and magnitude of such waste

Determine ranking of improvements.
Observe the first process to be improved.

Find small (subtle) forms of waste within the process
Observe the types of and magnitude of such waste

Brainstorm improvement ideas and carry them out.

Figure 3.29  How to Use Waste-Finding Checklists.

Figure 3.30  Five Levels of Magnitude.

Figure 3.31  Waste-Finding Checklist (Workshop Specific).
After that, it is very simple: We just add up all these level numbers and enter the sum in the “Waste Magnitude Total” column. After we have done this for each process, we will be ready to rank the processes according to their waste magnitude totals and thereby obtain a priority-based sequence for improvement. Finally, we need to brainstorm some improvement ideas, which we should enter in the “Improvements Ideas and Comments” column on the right side of the form.

**Waste-finding checklist (process-specific).** We can also call this the “Minor Waste Checklist.” Here, we are looking for detailed, subtle forms of waste that lurk within each process. Figure 3.32 shows how the form for this checklist appears.

When filling out this form, fill in every minor manifestation of waste you can find and enter it under the most appropriate of the seven types. Next, check up on your waste observations by having another look. If you see the waste again, check the YES column to confirm it. If not, check the NO column. Both of these columns appear in the form under the “Confirmation” heading.

For example, let us suppose we have discovered that there are no production schedules or control signs posted at the process. If a second look confirms this, we check the YES column. If we find the allegedly missing items are present after all, we can check the NO column.

Any items that receive a check in the YES column need to be rated for magnitude (under the “Magnitude” column). Here, we have only three magnitude levels. (See Figure 3.33.) This second form includes both negative and positive waste-related statements. Naturally, the magnitude rating is different, depending upon the type of statement (See Figure 3.34).

**Example 1:**
- No production plan or control board
- Few control boards
- Almost no control boards
- No control boards at all
1. No production schedule or control boards
2. No leveling of production schedule
3. Production not in sync with production schedule
4. Items missing
5. Defective goods produced
6. Equipment breakdowns
7. Too much manual assistance
8. Too much capacity
9. Lots grouped into batch
10. Using push production
11.
12.

Workshop name: Wastology

Waste-finding Checklist (process-specific)

<table>
<thead>
<tr>
<th>Description of waste</th>
<th>Confirmation</th>
<th>Causes and improvement plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No production schedule or control boards</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>2. No leveling of production schedule</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>3. Production not in sync with production schedule</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>4. Items missing</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>5. Defective goods produced</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>6. Equipment breakdowns</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>7. Too much manual assistance</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>8. Too much capacity</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>9. Lots grouped into batch</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>10. Using push production</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

Process Name: Waste-finding Checklist (process-specific)

<table>
<thead>
<tr>
<th>Description of waste</th>
<th>Confirmation</th>
<th>Causes and improvement plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complaints from next stage</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>2. Defect in previous stage</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>3. Defective during transfer</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>4. Defective due to wear</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>5. Defective due to wet</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>6. Omission in process</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>7. Defective due to wear</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>8. No human assistance</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>9. No human due to work</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

Overall improvement points:

Figure 3.32 Waste-Finding Checklist (Process-Specific).

Figure 3.33 Three Magnitude Levels.

<table>
<thead>
<tr>
<th>Level number</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>A little waste</td>
<td>Considerable waste</td>
<td>A lot of waste</td>
</tr>
</tbody>
</table>

Figure 3.34 Negative/Positive Statements.
Example 2: Missing item(s)
   Only one or two missing items
   A few missing items
   Many missing items

Once we have used these forms to elucidate the types and magnitude of waste, we need to go back to the processes concerned with the people who work there and start looking for the causes of all this waste. Only then are we ready to start brainstorming for improvement ideas.

**How to Remove Waste**

We have seen how forcibly switching over to one-piece flow under current conditions can bring underlying waste to the surface and how analyzing current conditions using waste-finding checklists can help clarify problem points.

Now we must recognize the important fact that identifying and elucidating waste does nothing to eliminate it. So far, we have only identified the targets, and we still do not know what kind of improvement measures to aim at them.

Our next step is to develop an “intuition” for waste and the “courage” to call it what it is. This step is necessary if we are to develop the “strength” we need to enter the workshop and start cutting waste out by the roots.

Things that have always seemed just fine suddenly become discernible as waste when the competition in market prices or deliveries gets fierce. A switch to a new product or a modified design tends to create lots of new waste. Latent waste also suddenly becomes apparent when certain methodological or staff-related changes happen. *Waste undergoes transformation with astounding ease and multiplies with alarming speed.*

If factories are to maintain minimal waste under such circumstances, waste elimination must somehow keep pace
with waste proliferation. To do that, we need to have just the type of intuition, courage, and strength described above.

In this section, we will discuss the work of removing waste in five main parts, which are listed below in order of their discussion.

- Basic attitude for removing waste
- Removing waste from the movement of goods
- Removing waste from the actions of people
- Removing waste from the movement of machines
- Removing waste from the combination of people, goods, and machines

The Basic Attitude Needed to Eliminate Waste

JIT improvement has many enemies. When we find waste and attempt to eliminate it, we usually run into all kinds of enemies.

We run into the enemy called “Resistance.” This enemy grumbles such things as, “If we do it your way, we’ll never be able to produce enough!” Then there is the enemy called “Intimidation,” who warns, “OK, but you’re to blame if there are any defectives!” Finally, there is “All’s Well,” who pleads, “Can’t we just leave well enough alone?”

No matter how many outside seminars on JIT production a company’s managers attend, no matter how many in-house guest seminars and training courses they hold under the banner of the Awareness Revolution, the enemies are still there, lying in wait. People do not really take waste elimination personally until it zeros in on their own workplace.

During the waste-finding stages, people who were filled with enthusiasm at awareness revolution seminars suddenly start donning the armor of, “I can’t do that!” or the helmet of, “That’s just impossible!” whenever the waste to be removed has some personal connection. It is amazing how fast people
can change from progressive to reactionary when they are asked to change their work habits.

In the final analysis, many people are willing to embrace the awareness revolution and analyze current conditions to discover waste because these things will not put any real heat on them or prescribe any painful medicine. But when the time arrives for removing the waste, suddenly they feel as if they had been doused with gasoline and set afire or forced to drink poison. It is the same old story: People tend to agree on generalities and disagree on particulars. Resistance and defensiveness can generally be counted on to raise their ugly heads at every workshop the waste removers visit. Figure 3.35 lists what I have found to be the ten main arguments against JIT improvement.

If I had to choose the three worst arguments, I would select the following.

Third worst: “Costs are already as low as they can possibly get!”

People who have labored long and hard just to get costs down to their current levels tend to regard JIT’s demands for further cost-cutting as unreasonable, if not downright impossible. Not
only is this attitude presumptuous, but it is also clear evidence of basic ignorance about waste. At the average factory, every activity that actually adds value to the product is accompanied by several thousand (even tens of thousands) of wasteful activities that enhance nothing but costs. But people still tend to judge by their sweat, and think that their cost-cutting efforts have done everything possible. There seems to be some idea that when the going gets hard, the job is finished.

Factories will not improve unless the factory people keep two things in mind: Improvements are limitless, and there is no end to cost-cutting.

Second worst: “Everything is going just fine now. Why change it?”

This is the argument I hear first at factories that are currently making some kind of profit. As long as the profit/loss balance is in the black, people do not concern themselves with such issues as fast-changing markets and growing customer complaints. People get complacent thinking, “Why should I work any harder when we’re doing fine as it is?” But do such people really think the business world will always be kind enough to let them “coast” and still make money? How soon people forget that what goes up must come down. To keep things up takes effort, and the amount of effective effort continually committed to keeping profitability up is directly proportional to how long it will indeed stay up.

The complacent question, “Why change?” can remain a common refrain for years, until people start noticing how tough things are getting and...ooops, they have slipped into the red! Then, suddenly, they start asking a new question: “How can we change?”

Worst of the worst: “It sounds like a good thing, but we still don’t want to do it!”

The reason why this is the absolute worst argument is very simple: It is the one I hear most often, and at all kinds of factories. Here are just a few examples:
At a home electronics manufacturing company: “Yeah, well I’m not surprised JIT worked at Toyota. But I’m afraid this company is just not in the same league as Toyota.”

At a kitchenware manufacturing company: “JIT is suited for automakers and others that do a lot of machine processing. It wouldn’t work at a factory like ours that works mainly with natural wood materials.”

At a farm equipment manufacturing company: “We’re different than other manufacturers. During the busy season, our sales jump four or five times higher than during the slow season.”

At a typical manufacturing subsidiary: “JIT might work at our parent company, but there’s no way it would work here. Maybe if our parent company got into it first, we could follow suit.”

At a long-established European automobile manufacturing company: “Are you kidding? JIT is based on a Japanese way of thinking. We think differently in this country.”

Unfortunately, these kinds of remarks are to be expected. I doubt there has ever been a factory where none of the above arguments have been launched against the specter of radical improvement. Everybody thinks they are somehow a “special case,” an exception to the rule. This idea alone is taken as a good enough excuse for evading all the difficult aspects of improvement.

In recognition of the seriousness of this problem, a Japanese watch manufacturer posted a list of “taboo phrases” on signs and posted the signs at various conspicuous places. (See Figure 3.36.)

Thus, there is no end to the variety of arguments one runs into when attempting to carry out improvements at factory workshops. I suppose factory workshop people are conservative by nature. If the current way of making things seems to be paying off, they are just not interested in making any big
changes. This is especially true of those in charge, who tend to be especially stubborn about maintaining the status quo. Shop veterans who have been on the job for 10 or 20 years are alarmed by the prospect that all their years of accumulated production know-how will be reduced to nothing by the JIT revolution. They are afraid, and they worry whether they would even be able to become the type of worker that JIT demands. Resistance is therefore a natural instinct for such people.

However, JIT leaders have neither the time nor the energy to deal with each individual’s resistance. The only alternative is for the workers themselves to become aware of the reasons for their resistance and to overcome that resistance. It is not enough to accept the JIT awareness revolution intellectually, for then we get the type of “agreement in general, disagreement on particulars” problems described above. Our revolutionized awareness must also be a physical and emotional commitment to change.

Figure 3.37 above illustrates the Ten “Basic Spirit” Principles for Improvement. These statements are explained further below.
1. **Throw Out All of Your Fixed Ideas about How to Do Things**

As soon as we scratch the surface of workshop resistance to change, we discover all kinds of fixed ideas about “the way things are done.” It is fair to say that the majority of the waste in the workshop is originated in these fixed ideas; fixed ideas about equipment layout, about manufacturing methods, about machine selection and operation, about manual work operations—the list is endless. One gets the impression that the workshop’s present condition is just one big, solid heap of fixed ideas and preconceived notions.

As long as that big heap of fixed ideas is there, there is no room for improvement to gain even a foothold. So we have to start by throwing out the entire heap. To do this, we must drop our die-hard “professional expertise” and return to a beginner’s mind, the novice who carefully and conscientiously works to make products one at a time. This is a basic principle of manufacturing.

2. **Think of How the New Method Will Work—not How It Won’t**

I have many times pointed out a needed improvement only to hear comments that invariably include words such as “but”
or “so it won’t work.” These should be among the “taboo phrases” in improvement activities. When we can hear people singing the “But...so it won’t work” song all over the factory, it is a sure sign that the factory’s days are numbered.

3. Don’t Accept Excuses—Totally Deny the Status Quo

When workers start coming up with “reasons” why something will not work, all the JIT leader hears is excuses. Unwelcome excuses, at that. I have been to workshops where the resident “expert” has gone on and on for 20 or 30 minutes—some have babbled on for hours—to inform me of the myriad different “reasons” why the status quo must be preserved. After a while, people stop listening. Once a bored co-worker even pulled out a pillow and took a nap!

Rather than embarking on the long and winding road of excuse-making, we need to start fresh by totally abandoning our attachment to the status quo and turn wholeheartedly toward contemplating positive action.

4. Don’t Seek Perfection—A 50-Percent Implementation Rate Is Fine as Long as It’s Done on the Spot

The intellectual types that run some factories are generally characterized by their perfectionism. When it comes to making improvements, their inclination is to gather some paper and head for their desks, where they immediately start drawing layout schematics and calculating economic lot sizes. As soon as we try to discuss some specific improvement plans with such people, they launch into long-winded discussions of the ramifications, and so forth. Meanwhile, factory-based improvement activities get put off for later.

For example, when I once suggested that a certain workshop should switch from sitting while working to standing while working, the person in charge decided that an analytical study must first be done to determine the ergonomic impact of such a change. He also wanted to seek the opinions of
every worker concerned before designing a new, higher work
table at which to stand.

But it did not stop there. Since the workers were of various
heights, he thought it necessary to include a height-adjustment
function in the new work table. But the difference in height
was so great that he thought it would also be prudent to
install a pedestal for the shortest worker. Then he figured
that the cement floor needed to be covered with wood to
reduce fatigue caused by standing on hard surfaces. After
that, he figured he should eliminate the labor and hassle of
adjusting the table's height manually by installing an elec-
tronic control device. The end result was a plan that entailed
spending gobs of money and extending the improvement
implementation period for years.

A key thing about improvements is that they must be done
right away. An improvement does not need to be completely
planned out in advance, just do 30 or 40 percent of it, then
take a look at it and figure what needs to be done next to
complete it. Improvements dreamed up on a piece of paper
in an office rarely work as planned in the factory. Unless
an improvement's implementation is begun right away, we
will find ourselves spending all kinds of money to get it the
way we theoretically want it. But the fact is that most of the
improvements that cost a lot of money are failures.

There have been many, many sad and ironic cases in
which factory managers decided to bring in new and expen-
sive equipment to improve production for a certain product,
only to find that the product's market life ended before the
equipment was even up and running.

Factories should be regarded as living entities sadly lack-
ing in first-aid care. We need to practice “JIT improvement”
by making just the improvements needed, just as soon as
they are needed, and in just the amount needed.
5. Correct Mistakes the Moment They Are Found

Whenever we sense anything wrong at the factory, that is the time to do something about it. Once we make an improvement to correct the mistake, we may well find another problem has surfaced. Again, we get right to it, solving problem after problem just as soon as they are noticed.

Improvements do not always happen smoothly. Sometimes people who are full of enthusiasm for making JIT improvement lose heart as soon as problems appear with the change, and instead of trying to solve the problems, they go back to square one.

For example, suppose we are switching a workshop over from shish-kabob production to one-piece flow production. We suddenly decide it was all a big mistake and, without even trying to solve the problems, we go back to the old shish-kabob routine. That kind of attitude will get us nowhere. We need to be persistent, even stubborn, in maintaining the momentum of improvement without giving up and backtracking.

6. Don’t Spend Money on Improvements

I will be the first to admit that improvements made at great expense are much easier than those that do not cost much. We have more freedom to do things when we feel free to spend $10,000 here and $20,000 there. Making improvements without spending much money is, by contrast, a tough challenge.

“Don’t spend money on improvements” is saying that taking the easy and expensive way out does not encourage us to use our wits. These days, a lot of companies are opting for the apparent expediency of throwing money at problems. But where is the resourcefulness in that? The success of an improvement depends not on how much money we put into it, but how much wisdom and ingenuity we invest.
Improvements that arise from brainstorming and that do not cost much money can be implemented right away. To put it another way, there is no time for spending money. We have to make the improvement as soon as possible, before the office-bound people get hold of the problem and start writing up big improvement plans that will end up costing a small fortune. Harsh as it sounds, our attitude should be: “Don’t spend money on improvements. Use your wits. If you haven’t got any wits, then use your sweat. If you haven’t got either, then just be quiet and go away.”

7. Problems Give You a Chance to Use Your Brain

Ingenuity and “know-how” do not kick in when all is well and good. Only when we are suffering under the burden of difficult, confusing problems are we required to become resourceful and use our brain.

The same goes for JIT improvement. Improvement ideas are not going to sprout and grow in a workshop environment of satisfied, unquestioning workers. What the JIT leader has to do is stir up some trouble. By this, I mean such things as trying out one-piece manufacturing flow under the current conditions and stopping the line whenever a problem occurs.

If we avoid rocking the boat and simply throw money at problems, we will never find out just how ingenious the factory staff can be. That would be a true disgrace. We need to encounter difficulties and put our minds to work in solving them, not our money.

As the old saying goes, “A tree that grows money will never be wise, and a tree that cultivates wisdom will never need to grow money.” Which tree is better at facing adversity?

8. Ask “Why?” at Least Five Times until You Find the Ultimate Cause

Improvement begins with the simple question “Why?” We need to look at the factory with the unclouded and curious eyes of children and, like children, we need to ask “Why?”
about everything we see. “Why?” is the fuel that pushes improvements off the launch pad.

- “Why are we using conveyors here?”
- “Why are the equipment operators sitting?”
- “Why are they driving screws into that workpiece?”
- “Why are they carrying those things around?”

Just like a child, when we get an answer for our first “Why?,” we ask “Why?” about the answer. But sooner or later, the person the child is asking runs out of answers. That dead-end point is where the “wall of fixed ideas” lies. Consider an example.

“Why?” #1: “Why do you carry these workpieces over there when you’re done with them?”
Response: “Huh? Oh, because I’m taking them to the next process.”

Note: The worker is surprised at such a simple question, for which he feels the answer is obvious.

“Why?” #2: “But why are you carrying them to the next process?”
Response: “I said why. Because they need to get processed there.”
Question: “I know that. But why must you carry them?”
Response: “Well. I guess it’s because this process is over here and the next process is way over there. Does that answer your question?”

Note: Notice that the worker is getting a little unsure of what to say.

“Why?” #3: “Why are the two processes so far apart?”
Response: “Hmmm... I guess it’s because that process is in another department.”
**Note:** Now the worker is starting to get curious, too.

"Why?" #4: “Why does the factory keep processes belonging to different departments so far apart?”

*Response:* “I wonder why, too. It’s been this way since I started working here, and I’ve never thought about it until now.”

**Note:** The questioning has reached its mark—the “wall of fixed ideas.”

When we reach that “wall of fixed ideas” (whether it takes four “Whys,” five “Whys,” or more) it is time to start brainstorming improvement ideas. For example, we could link the two processes together or even change the whole factory organization.

We have just seen an example of how the five “Whys” (5W’s) lead up to the question of how (1H) to make an improvement. This fact-finding method is known as the “5W1H” approach.

Have you ever asked anyone “Why?” until you find their “wall of fixed ideas”?

**9. Ten People’s Ideas Are Better Than One Person’s**

Expertise in JIT improvement is not what we cultivate just by reading books, attending lectures, and pondering solutions. Such expertise is earned by hands-on work in the factories, looking at problems point-blank. It is a knowledge we gain with our whole being, mental and physical. If we attempt to carry out improvements based on book knowledge alone, we are doomed to failure. If we get our knowledge the hands-on way in the factory, we are destined to succeed. Experiential wisdom makes all the difference. When searching for an answer to a physical problem, what possible value could one man’s book knowledge have in comparison to the
experience-based wisdom of the people who have poured their wits, toil, and sweat into the matter?

10. Improvement Knows No Limits

Improvement is boundless. This means two things, essentially. It means that our fast-changing world will always demand ongoing improvement. That is the horizontal meaning. Vertically, it means that improvements can always be taken to a deeper level. Improvements point the way toward further improvements.

If the thread of ten people's experiential wisdom can be woven along these horizontal and vertical axes, it will create a tough fabric of improvement that is always tailored to meet the world's everchanging needs.

Removing Wasteful Movement of Things

Arrow diagrams are good tools for finding major forms of waste within the movement of things. They are easy to create and bring major waste to the surface so that anyone can recognize it.

The sequence of major waste related to the movement of things goes from retention (Step 1) to conveyance (Step 2), nothing at processing and inspection (Steps 3 and 4), then material handling (Step 5).

Making arrow diagrams is a good way to bring the retention and conveyance steps into focus. But the question is how to remove this waste once we have it in focus. Fortunately, there is a way that does not require any specialized training. In fact, it is quite simple.

We just try to remove all of those retention and conveyance points. There is no magic involved in eliminating waste. The only way to effectively remove this kind of waste is to eliminate the retention and conveyance itself.

Figure 3.38 shows a flow diagram of the same printed circuit board factory we had discussed earlier (see Figure 3.25).
Before Improvements

![Arrow Diagram Before Improvements]

### Process Symbols
- **C** = Carts
- **M** = Manual operation

**Conveyance distance:** 150 meters

**Staff:** 49

After Primary Improvements

![Arrow Diagram After Primary Improvements]

### Process Symbols
- **C** = Carts
- **M** = Manual operation

**Conveyance distance:** 150 meters

**Staff:** 49

---

**Figure 3.38** Arrow Diagrams of Printed Circuit Board Factory Before and after Primary Improvements.
This is how the factory looked prior to improvement. This factory takes up two floors and includes six major processing lines, among which are 24 retention points and 16 conveyance points.

As the first improvement, we got rid of several retention and conveyance points and brought all of the inspection processes together at one station. These two actions made the overall flow of goods a little more streamlined.

As a whole, the post-improvement layout had a smoother flow of goods than the pre-improvement one. After this first improvement, there were still 14 retention points, eight conveyance points, and one inspection point. This meant a reduction of 10 retention points, eight conveyance points, and two inspection points. It also enabled the factory to reduce its workforce by seven persons, from 49 workers to 42 workers.

This first set of improvements turned what was a very wasteful factory layout into a typically wasteful one, such that if we go there and look at things, we can get a grasp of how the goods are flowing. Now it is time to get into some full-fledged improvements by abolishing lots and switching to one-piece flow, and then to multi-process handling. To do this, we must do something about the larger pieces of equipment that are taking up too much space, and we need to further reduce the labor force by about 50 percent.

To recapitulate, we began our improvements by removing the obvious major forms of waste from the retention and conveyance processes. Interestingly enough, in most cases conveyance waste occurs because of goods being retained. Therefore, we can say that retention is the mother of conveyance.

Our next improvement step was to eliminate the retention of goods that so often gives rise to conveyance waste.

1. **Eliminating Retention Waste**

Retention is when a workpiece remains in one place for any length of time, waiting for the next production step to occur.
“Waiting” is the key word here, since it is a visible phenomenon that always goes hand in hand with retention.

We should look for two kinds of waiting: “process waiting,” which means the workpiece is at a process waiting its turn to be processed; and “lot waiting,” which means the workpiece is waiting to join the rest of the lot.

Removing “process waiting” waste. Process waiting can happen in three different ways. In all cases, the entire lot is being kept waiting due to some problem that has caused a pause in processing. The three kinds of process waiting are called “machine/people (capacity) waiting,” “materials waiting” and “operation method waiting.” (See Figure 3.39.)

Machine/people (capacity) waiting refers to situations in which the workpieces are ready for processing, but they must wait because the machine and/or its operator are busy. The causes and waste removal methods for this type of waiting are:


When there is a gap between the previous and next process, we can identify this as a capacity imbalance. To solve this, we need to match the previous process’s capacity to the next process’s capacity so that they are synchronized. This usually calls for some kind of system
or device (such as the full work system) that will keep the capacity of upstream processes from exceeding that of downstream processes. The result is “pull” (rather than “push”) production.


Imbalances can occur when workpieces are accumulated at one process and then are dispersed among several others. This usually calls for a study of the process sequence and balance, but usually the best response turns out to be bringing all processing together into one line. To do this, we must use only small, in-line equipment.

*Materials waiting* occurs when we have everything we need to start processing—except for one essential part that for some reason or other is not on hand. In other words, the cause is a “missing part.” If the part is being supplied by an outside vendor, then the solution must be something along the lines of JIT’s “vendor guidance,” “delivery method re-evaluation,” or a “restructuring” based on an evaluation of vendor performance. If the missing part is manufactured in-house, we need to investigate and correct the cause directly. Likely causes include process imbalance, defects, or machine breakdowns. In any case, we must first make improvements to correct the cause.

*Operation method waiting* tends to happen when the factory is understaffed and workers are processing lots at more than one process station. We call these kinds of work operations “caravan operations.” The first thing to do in this case is to bring all the processes into one line, then implement multi-process handling, and finally switch to one-piece flow.

**Removing “lot waiting” waste.** Lot waiting means that the workpiece’s lot is being processed and that one part of the lot has been processed and waits on the downstream side of the process machine while the other part waits on the upstream side. Lot waiting happens for only one reason:
lot processing. When we ask “Why?” again—“Why are they doing lot processing?”—we may discover one of the following reasons:

1. **The processes are separated.**
   The previous and next processes are separated in such a way that precludes one-by-one conveyance, and so the workpieces are processed in lots. To remove this form of waste, we must redesign the equipment layout into an in-line formation, get rid of conveyance altogether, and establish one-piece flow.

2. **Mass production equipment.**
   If the machines and other equipment in the factory are mainly designed for high output, they tend to be used for lot production. This is especially common where lots are subdivided into batches for batch processing, such as for cleaning, polishing, pressing, or inspecting. The appropriate improvement is to carry out one-piece flow using compact machines that can be kept in pace with the cycle time. The key point in manufacturing such machines is that they should emphasize the essential processing or assembly function and do away with nonessential functions. This makes them much less expensive to build.

3. **Product changeover takes too much time.**
   Switching products takes a long time, so the factory uses large lots to minimize the number of changeovers. At assembly stations, changeovers in part sets and operation methods tend to cause bottlenecks, so they try to do all their jig and die changeovers at the processing stations. To solve such problems, we can try “changeover within cycle time” at all assembly stations, go all the way to “zero changeover,” or aim for “totally mixed production.” These improvements are designed to reduce the multiple changeovers at processing stations to single changeovers or even zero changeovers.
4. *Operations are hard to balance.*

This type of thing happens all the time at labor-intensive assembly processes. Obvious differences in operator skill level and operations that are inherently difficult to balance lead such assembly lines toward lot processing in which each worker works at a separate little island. Improvement tactics for this problem include the “SOS system” for immediate line balancing, the “baton touch zone” method, or training workers in multiple skills to enable multi-process handling.

Figures 3.40A and 3.40B list the causes and improvement suggestions for removing retention waste in the form of “process waiting” waste and “lot waiting” waste, and notes the kinds of resistance we can expect to encounter when trying to actually remove the waste.

**Removing Wasteful Movement by People**

Generally, we can use the term “operations improvement” to refer to the activity of removing the wasteful motions that workers make. This includes torso motions, foot motions, hand motions, and every other motion that workers make, all of which contain waste.

Naturally, each motion is actually a combination of various motions, and we need to see what goes into these combinations before we begin removing wasteful ones. To do this, the most important question is “Why?” Why does waste occur in such-and-such movement? We need to keep asking “Why?” until we are able to know what the essential motions are for building the product.

For example, let us just consider manual conveyance (carrying and cart-handling) operations. Here, we need to look for ways to keep the hips from turning, better ways to use the carts, and so on. Again, to do this, we need to
## Cause

<table>
<thead>
<tr>
<th>Waiting for machines and/or people</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unbalanced processes</td>
</tr>
<tr>
<td>Unbalanced due to gap between previous and next process.</td>
</tr>
</tbody>
</table>

### Improvement (Waste Elimination) Point

- **Synchronization**
  - Upstream process needs to be synchronized with downstream process.
- **Pull Production**
  - Need a device or system (such as full work system) to keep the previous process from producing in excess of the next process's capacity.

### Expected Resistance

- “This workshop is different. It’s impossible here!”
- “The gap is due to different skill levels, so there’s nothing we can do about it.”
- “So let’s tell the previous process to ease up a little.”

## PROCESS WAITING

### Accumulation/dispersion of processes

This occurs when workpieces for the same product are gathered at certain processes and spread out at others.

### In-line layout (flow production)

- Processes where workpieces accumulate are like large islands, apart from the rest of the line. They need to be brought back into a closely linked line.
- Use smaller equipment
  - Smaller machines that fit more easily into a closely linked line can be built inexpensively.

### Expected Resistance

- “This machine is stuck here, so we can’t have an in-line layout!”
- “I’ve never seen a small machine that can do this process.”
- “If we do that, we’ll lose efficiency.”
- “They don’t make machines like that.”
- “We’ll have to spend a fortune buying new equipment!”

### Materials waiting

3. Operations delayed by missing materials or parts

### Parts from outside vendors

- **Vendor guidance**
  - Need to provide guidance and training in JIT and re-evaluate the vendor’s delivery system.
- **Reorganization**
  - Need to reorganize based on number of orders and vendor evaluation.

### Expected Resistance

- “No, the vendor is a bigger company than we are.”
- “Sure, we can try to help them, but it won’t do any good.”
- “It’ll cost us more if we ask them to deliver more often.”
- “There’s no way to avoid having those few defectives.”
- “Machines break down because they’re machines—it’s inevitable.”

### Operation method waiting

4. Caravan operations

The factory is understaffed and workers are processing lots at more than one process station.

### In-line formation

- Redesign the scattered processes into an in-line formation.
- **Multi-process handling**
  - Develop operations into multi-process handling.
  - **One-piece**
    - Switch from shish-kabob production to one-piece flow.

### Expected Resistance

- “We have no choice—we’re short of workers right now.”
- “One-piece flow sounds like one big hassle. It wouldn’t work.”

---

**Figure 3.40A** Ways to Remove Waste from Retention Points (Process Waiting).
<table>
<thead>
<tr>
<th>Cause</th>
<th>Improvement (Waste Elimination) Point</th>
<th>Expected Resistance</th>
</tr>
</thead>
</table>
| 1. Process is separated | • In-line  
Line up the equipment according to the process sequence.  
• One-piece flow  
Switch to one-piece flow. | • “That machine can’t be moved over here.”  
• “That is a very high-precision machine. It shouldn’t be moved.”  
• “One piece at a time? What are you talking about?” |
| 2. Mass-production equipment | • Cycle time  
One-piece production must be in accordance with cycle time.  
• One-piece production  
Don’t gather workpieces into batches for processing, always process just one at a time.  
• Use smaller equipment  
Smaller machines that fit more easily into a closely linked line can be built inexpensively. | • “Making things one at a time had got to result in lower efficiency.”  
• “I’ve never even heard of a machine built for one-piece processing.”  
• “It’ll get expensive if we start changing the equipment.” |
| 3. Product changeover takes too much time | Assembly  
• Changeover within cycle time  
Changeover of parts, jigs, and so on should be able to be finished within the cycle time.  
• Sequence feed or marshalling  
Parts should be fed to the line according to the assembly sequence.  
Processing  
• Changeover  
Improve changeover to enable single changeovers or even zero changeovers. | • “There are just too many parts. It can’t be done.”  
• “If we do that, we’ll need too much labor on the line.”  
• “Changeover time can’t be made any shorter than this.” |
| 4. Operations are hard to balance | • SOS system  
Balance the line immediately and without further planning.  
• Baton touch zone method  
Perform each operation at a prescribed pitch, then move directly on to the next one.  
• Multi-process handling  
Train workers to handle all processes on the line, from start to finish. | • “Stop the line? You must be crazy!”  
• “If we ever forget to touch the baton, there’ll be lots of defectives.”  
• “Frankly, I don’t think I could learn to handle so many processes.” |

Figure 3.40B  Ways to Remove Waste from Retention Points (Lot Waiting).
repeatedly ask “Why?” We also need to switch from small islands to one closely linked line. This gets rid of the major waste involved in conveyance by getting rid of the conveyance points themselves.

Thus, there are two ways to approach operations improvement. The first is “improving the actions” by removing waste from within the motions that comprise the operation and the second is “improving the point of the operation” by re-evaluating the entire operation to possibly find a more sweeping improvement that serves the same purpose. In JIT, we always put primary emphasis on the latter, more radical approach. (See Figure 3.41.)

The “principles of economy of motion” can be a good tool for improving the motions of workers to remove waste from human actions. These 17 principles are grouped into three sets of principles relating to (1) use of the body, (2) layout of the workplace, and (3) jigs, tools, and machines.

Principles Relating to the Use of the Body

Apply these principles when attempting to eliminate or minimize body motions.

- **Principle 1: Start and stop manual operations using both hands at once.** When a manual operation requires the use of both hands, both hands should move in unison to start and stop the operation.
- **Principle 2: Keep arm motions simultaneous and symmetrical.** Arm motions should follow the principle...
of the breast stroke in swimming: Move with the same timing but in opposite directions, symmetrically.

- **Principle 3: Minimize leg and torso motions.** At the assembly line, if the parts are kept behind the assembly workers, the workers must move their legs to get them. If kept at their sides, they need to move their hips to twist aside for them. If kept in front of them but up on a shelf, they need to move their shoulders to reach up for them. If kept at chest level in front and just to the right and left of the shoulders, they only need to move their arms, wrists, and fingers. We need to minimize movement beginning with the largest motions (feet) and then gradually work down to smaller motions, going from hips, to arms, wrists, and finally fingers. We begin by standing alongside each worker and carefully observing his or her motions to understand what kind of motions the worker is making in performing the operation.

- **Principle 4: Use gravity instead of muscle power.** The more we use our muscles, the more tired we get. Whenever possible, put the force of gravity to work in moving things.

- **Principle 5: Avoid motions that zigzag or turn sharply.** Try to keep motions smooth along continuous curves. Avoid “hairpin turns” and complicated zigzag patterns.

- **Principle 6: Make motions rhythmic.** Motions without an easy, natural rhythm often lead to defects or injuries. Find a rhythm that fits the cycle time and that is easy to steadily maintain.

- **Principle 7: Ensure easy posture and easy motions.** Having to bend over a work table that is too low or strain the arms and shoulders to work at one that is too high will only make work uncomfortable, which can only lead to waste.

- **Principle 8: Use the feet, too.** The feet can also be put to work without strain, such as in pressing foot switches.
Principles Relating to Workplace Layout

Principle 9: Keep all materials and tools in front and close (maximum proximity of use points). The points at which the worker must reach to pickup and/or replace materials and tools should be kept in front and as close to the worker as possible to minimize the worker’s motions. (See Figure 3.42.)

Principle 10: Lay out materials and tools in their order of use. Place all materials and tools within easy reach and arrange them to follow the sequence of the manual operation. This will not be possible unless we make the parts layout as compact as possible by feeding only a few parts at a time to the work table and by thoroughly implementing the 5S's to keep things neat and orderly.

Principle 11. Use inexpensive types of power. Use inexpensive types of mechanical power to extract and feed materials to processes.

Principle 12: Keep the work tables and equipment matched to the worker’s height. Make sure that the
work tables and other equipment are not too high or too low, as this will cause undue stress and fatigue.

- **Principle 13:** Make the work environment as comfortable as possible. Operations will go more easily and smoothly if such environmental factors as lighting, ventilation, and temperature are controlled for maximum possible comfort.

**Principles Relating to Jigs, Tools, and Machinery**

- **Principle 14:** Let the feet work, too. Many switching operations can be comfortably handled by the feet, thus freeing the hands for other work.

- **Principle 15:** Integrate tool functions to minimize tool variety. Sometimes, a single tool can cleverly combine the functions of two or more other tools. This saves space and simplifies tool organization and handling.

- **Principle 16:** All materials and parts should be easy to pickup. Keep all materials and parts in front of the worker and lower than chest level, so that they can be picked up easily. All containers should also be within easy reach.

- **Principle 17:** All handles and knobs should be in convenient places and in an easy-to-use shape. If possible, the operator should be able to reach all handles and switches without having to shift or bend his or her torso. The position and shape of these things should be designed for maximum operability and efficiency.

**Removing Waste in the Way People, Goods, and Machines Are Combined**

The basic work of eliminating waste from operations is to remove waste from each of the “3M” factors involved: man, materials, and machines.

However, some of the waste that these three factors include may not be so easy to identify. Therefore, it is wise to look
also at the way the three factors are combined as another possible source of waste. Our objective is to combine these factors in the way that is most efficient and “flows” most easily, much like the harmonic parts that make up a pleasant piece of music. In a sense, we are removing everything that does not harmonize with the operations flow, and the result should be a pure combination of harmonic resonances.

Combination charts for standard operations are the best tools to use for grasping the “surface waste” in this combination. The more waste we can find and remove from this combination, the more standardized the operations will become. First use these combination charts to find the “surface waste” in just the combination of people and machines. Make a complete and careful observation of how manual operations (indicated by solid bars in the chart) relate to auto feed operations (indicated by broken lines).

The two ways in which people and machines can work together are serially and in parallel.

**Serial Operations**

In serial operations, the worker and the machines take turns adding value to the product. Ordinarily, we begin with the worker’s standard operations and when those are done, it is the machine’s turn to begin working. (See Figure 3.43.)

**Parallel Operations**

In parallel operations, the worker and the machine work alongside each other, which is to say that they work together
to add value. Sometimes the worker and machine are able to work completely in parallel, which is called “full parallel operations,” and sometimes the worker is in parallel with the machine only part of the time (usually during standard operations), which is called “partial parallel operations.” (See Figures 3.44 and 3.45.)

We need to pay attention to different things depending upon whether we are trying to remove waste from serial or parallel operations. In serial operations, we should try to mechanize the overall operation to simplify and facilitate the worker’s share of it, while in parallel operations we should try to keep the worker as separate from the machine as possible.

To do the latter, we need to carefully observe the parallel operations and continually ask, “Why can’t that worker be separate from the machine right now?” We should then start brainstorming ways in which the machine can take over more and more of the worker’s tasks, especially simple tasks.
such as pressing switches. This is the kind of thing that JIT refers to as “human automation.”

Next, we must address the need to separate workers from the materials. No matter how completely we separate workers from the machines, it will do no good if the worker is still tied down to handling the workpieces. The way to do this is by having machines handle single workpieces by themselves and automatically send them to the next process.

Figure 3.46, found on page 228, shows how a wood products manufacturer used combination charts to remove waste from production operations.

**Secrets for Not Creating Waste**

Waste is something that tends to gather around us and remain there. In factories, we can never even hope to be permanently rid of waste. But if factory people take that as an excuse for accepting waste as inevitable, they are only sending their factories down the tubes. The successful factories will be those whose workers strive day in and day out to eliminate waste.

In general, there are two “secrets” for not creating waste in the first place. One is to take preventive measures against waste by thoroughly implementing standard operations and developing the discipline to maintain such operations. In other words, we need to consistently deal with waste at its very source.

The other “secret” is to follow up on these source-deep measures by looking out for abnormalities and problems that occur whenever there are gaps or loopholes in our antiwaste measures. Recognizing such abnormalities and problems is just one short step away from recognizing the waste that led to their creation. We can use them as “symptoms” pointing us back to the source of waste in order to enact further
### Before Improvement

**Standard Operations Combination Chart**

<table>
<thead>
<tr>
<th>Process No.: 391-3637</th>
<th>No. required: 303 (600)</th>
<th>Manual operations</th>
<th>Auto feed</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item name:</strong> Door jamb (lintel)</td>
<td><strong>Cycle time:</strong> 89&quot; (54&quot; needed)</td>
<td>Entered by: Kawano</td>
<td>Date: 1/17/89</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pull out workpiece</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Process S101 gain (small) at circular saw bench</td>
<td>15 10</td>
</tr>
<tr>
<td>3</td>
<td>Process S102 gain (large) at circular saw bench</td>
<td>23 18</td>
</tr>
<tr>
<td>4</td>
<td>Finish B101 hinge fastening at multi-spindle drilling</td>
<td>12 7</td>
</tr>
<tr>
<td>5</td>
<td>Insert edge (using cutter) at work table</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>Cut edge (using cutter) at work table</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Set up new workpiece</td>
<td>2</td>
</tr>
</tbody>
</table>

**Operation times (in seconds)**

<table>
<thead>
<tr>
<th>Manual</th>
<th>Auto feed</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### After First Improvement

**Standard Operations Combination Chart**

<table>
<thead>
<tr>
<th>Process No.: 391-3637</th>
<th>No. required: 303 (600)</th>
<th>Manual operations</th>
<th>Auto feed</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item name:</strong> Door jamb (lintel)</td>
<td><strong>Cycle time:</strong> 89&quot; (54&quot; needed)</td>
<td>Entered by: Kawano</td>
<td>Date: 1/31/89</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pull out workpiece</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Process S101 gain (small) at circular saw bench</td>
<td>15 10</td>
</tr>
<tr>
<td>3</td>
<td>Process S102 gain (large) at circular saw bench</td>
<td>23 18</td>
</tr>
<tr>
<td>4</td>
<td>Finish B101 hinge fastening at multi-spindle drilling</td>
<td>12 7</td>
</tr>
<tr>
<td>5</td>
<td>Insert edge (using cutter) at work table</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>Cut edge (using cutter) at work table</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Set up new workpiece</td>
<td>2</td>
</tr>
</tbody>
</table>

**Operation times (in seconds)**

<table>
<thead>
<tr>
<th>Manual</th>
<th>Auto feed</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis No.: 1of 1**

**Time**

**Item name:** Door jamb (lintel)

**Sequence**

**Description**

**Time**

**Operation times (in seconds)**

**Analysis No.: 1of 1**

**Manual**

**Auto feed**

**Walking**

**NOTE:** Implement secondary improvements to further remove waste.

---

Figure 3.46 Wood Products Manufacturer’s Combination Charts for Standard Operations: Before and after First Improvement.
waste-removing measures. To ensure that such checking up occurs, we must make abnormalities and other problems visible and obvious to everyone. This will make us better able to address the true causes of these problems and prevent their recurrence. The chief tools for doing this are visual control, auditory control, and the 5W1H approach to problem-solving.

In this section, we will be covering the following topics as we discuss the “secrets” for removing waste:

- Thorough standardization and standards maintenance
- Visual control and auditory control
- The 5W1H sheet

**Thorough Standardization**

Standardization is a very important thing for factories. Why? Mainly because factories are operated by large numbers of people, and if each worker is left to his or her own methods (or even his or her interpretation of the standards), product quality and production efficiency are bound to suffer. To avoid this, we must have standards that are precisely followed to ensure consistency in product quality and manufacturing methodology. This is what we mean by “standardization.” The key word to remember when standardizing operations is “anyone.” Anyone should be able to understand and use the standard operations.

Factories require a wide variety of standardization. The major types include:

- Machine standardization: Enabling *anyone* to operate the machines in the same way.
- Operation standardization: Enabling *anyone* to perform operations in the same way.
- Control standardization: Enabling *anyone* to tell the difference between normal and abnormal conditions.
Clerical standardization: Enabling anyone to carry out clerical procedures in the same way.
Procurement standardization: Enabling anyone to perform procurement tasks in the same way.

Thus, standardization basically means establishing procedures so that anyone assigned to carry them out can easily understand and do them in a consistent manner. These series of procedures must then be recognized as the particular factory’s standards, which means what is to be expected as the normal way of doing things. This makes it much, much easier for anyone to identify the abnormalities and problems that are the first symptoms of waste. As such, we can think of such problems as the “buds” from which waste unfolds.

While recognizing the importance of the “anybody can do it” concept in standardization, we should also be well aware of the major advantage such standardization brings: the ability to identify abnormal conditions and other problems. Naturally, standardization is not a one-time goal; standards must be meticulously maintained for waste to be minimized. This is where training and discipline come in. Each and every worker must have both if waste is to be continually nipped in the bud.

At all factories, training and discipline contain the seeds of toil and trouble. No matter how thoroughly we implement the 5S’s, there is going to be some backsliding. No matter how clear and simple the rules of standard operations are, they will soon be broken. People will also tend to “bend” the rules of standardization toward their own idiosyncratic way of doing things. The more they do this, the harder it will be for them to identify abnormalities and other problems. If this trend goes unchecked, more and more waste will accumulate until it adversely affects the quality and character of the entire factory.

There are various tools for establishing and maintaining training and discipline, including classes and periodic
check-ups. However, the foundation for strong training and discipline will always be to “catch them in the act.”

Once anyone finds the 5S’s being ignored or standard operations being bent toward personal inclinations, he or she must alert the supervisor and have the transgression dealt with immediately. There is no other way. This means, of course, that supervisors need to be immediately accessible and not hidden away in some office. No supervisor—not even one who can draw the entire factory layout from memory—can deal with factory problems from anywhere but the factory. Supervisors need to be in the factory regularly in order to keep a regular watch on current conditions. Each supervisor should make a complete inspection tour of the factory (or his part of the factory) twice a day, at the very least. Any supervisor who does not maintain at least this minimum inspection routine does not deserve to be a supervisor. All factory work happens at the factory, using real materials and real, observation-based facts.

**Visual Control and Auditory Control**

Visual and auditory control will be taken up in detail in Chapter 9. For now, let us note that no matter how thoroughly we implement standardization, the standards will sooner or later become obsolete. Any number of factors can cause such obsolescence, such as switching to a new product, or adjusting output to match changing sales and price trends. If we get right down to it, we must admit that producing even a single defective product will send a minor tremor through the foundation of the current standards.

It cannot be repeated often enough that the factory should be regarded as a living thing. Even when everything is being operated according to the latest standards, abnormalities and problems will inevitably crop up occasionally. In view of this fact, we must bring such problems to the surface and immediately devise improvements to correct them before they
first develop into habits, and then into an established part of “how we do things here.” The best methods for doing this are visual and auditory control.

Instead of finding problems through statistical analysis and other management data, we use our own eyes and ears as measurement instruments that alert us to problems immediately so we can make an immediate response.

Very often, visual and auditory control use the tools known as *kanban* and *andon*. However, we must recognize that these are just the tools that alert us to problems, and that we need other tools—our own energy and ingenuity—to actually solve the problems.

Many people tend to forget this basic fact about visual and auditory control and instead rush headlong toward setting up *kanban* and *andon* systems as if they were the whole answer. Needless to say, such systems are absolutely worthless until they are followed up by problem-solving measures.

With that in mind, we are ready to view a summary of tools and procedures that can be used as part of a system for visual and auditory control of the factory.

**Red Tagging**

Red tag teams take a cold, hard look at the factory and stick red tags on everything they judge to be currently unnecessary. This enables *anyone* to recognize unnecessary items.

**Signboards**

We use signboards to clearly indicate what things are, where they belong, and how many of them there should be.

**Outlining**

Putting outlines around the standardized places for keeping things—from tools to work-in-process, machines, carts, and so on—shows *anyone* exactly where they belong. Outlining is especially useful for indicating the place and amount of unprocessed and processed workpieces at each production station.
Andon

*Andon* are alarm lights (usually accompanied by buzzers or bells) that immediately inform us when an abnormality or other problem occurs on the production line.

Kanban

*Kanban* are small signs that we use to maintain Just-In-Time production. When these signs are still attached to work-in-process, they are referred to as *kanban*. As soon as they have been removed from the work-in-process, they serve as order forms, work instructions, or some other kind of voucher.

**Pitch and Inspection Buzzers**

Pitch buzzers or pitch horns can help maintain the pitch of assembly operations, and so forth. During inspection, inspection buzzers or horns sound whenever an inspector finds a defect, and this auditory recognition helps reinforce visual recognition of defects.

**The 5W1H Sheet**

The 5W1H sheet is a very good tool to use for following up on problems we have discovered through visual and auditory control. Our follow-up is to continually ask “Why?” until we find the problem’s root cause. Then we can ask “How?” to correct the problem. The 5W1H (five “Whys” and one “How”) sheet provides a format and procedure for performing these follow-up tasks.

If we neglect to make good use of 5W1H sheets, chances are that whatever improvement we make will only scratch the surface of the problem and will not be a lasting improvement. Installing devices that will automatically stop the line whenever a defective is produced will do nothing but create a place where known defectives can accumulate—unless we take the 5W1H approach.
In the previous example, we need to ask, “Why are defectives being made?” over and over again until we find the root cause whose elimination will prevent the defective’s recurrence.

Figure 3.47 shows an example of the 5W1H sheet being used to follow up on line stops.

As it turned out, the root cause in this case was inadequate drill bit storage. The improvement was to solve the root cause of the line stops by modifying the drill bit drawer with vertical felt ridges, as shown in Figure 3.48.

As you can see, the 5W1H sheet is a very important tool for preventing the recurrence of waste. When trying to use this sheet themselves, managers must be sure to keep the following five key concepts about 5W1H in mind.

**Key Concept #1: Look with the Eyes of a Child**

Never cease to look at machines, people at work, material on the move, and everything else in the factory with the pure and unclouded eye of a child. The first “Why?” should always be lurking in the back of your mind. Never let it out of mind; all improvements begin with that initial “wondering why.”

**Key Concept #2: Remember the Three Essentials for 5W1H**

Each workshop reflects the character of the entire factory. When investigating any kind of factory-related abnormality or problem, the problem can best, most quickly, and most reliably be understood only at the particular workshop(s) where it originated. So, managers must know that the first thing to do is get up and go to the workshop, see the abnormalities and problems first-hand, then confirm the facts based on their own observations. The best-run workshops take their strength from observing these three essentials.

**Key Concept #3: Be a Walker**

As we all know, many managers typically spend all day at their desks. Sometimes they sit with a calculator in hand
### 5W1H SHEET

**Improvement target:**
List stops

**Why No. 1:** (analysis)
Why did the line stop occur?

**Current status:**

**Why No. 2 or improvement proposal (HOW):**

**Current status:**
Line stopped when dimensional defect was found in processed item.

**Why No. 2:**
Why did the dimensional defect occur?

**Current status:**

**Why No. 3:**

**Current status:**
Two workpieces got processed at once.

**Why No. 3:**
Why did two workpieces get processed at once?

**Current status:**

**Why No. 4:**

**Current status:**
Two workpieces got stuck together.

**Why No. 4:**
Why did two workpieces get stuck together?

**Current status:**

**Improvement proposal:**
Due to inadequate drill bit storage (drill bits are kept in a casual pile), the drill was able to drill two workpieces together.

**Improvement proposal:**
Device storage improvement and reinforce the 5S’s.

---

Figure 3.47  5W1H Follow-Up after Line Stops.
busily developing data. They believe (or assume) that all these figures and analytical data will afford them an understanding of what is happening in some workshop. But no matter how much data they develop, its total sum of meaning can be correctly calculated as zero. First, managers must get up on their atrophying feet. Next, they need to write WALKING in capital letters in their job descriptions, then they must head to the factory for a walk around. Once in the morning and once again in the afternoon—at the very minimum. Taking their time. Weight-conscious managers say it is also good for their health.

Key Concept #4: Break Down the Walls of Fixed Thinking

Everyone carries these types of walls in their mind to channel and confine perception and thinking. When we ask “Why?” over and over about the same phenomenon, we reach a point where we run out of “known” answers. That dead end is where we meet a wall that protects and defines our fixed ideas and taught assumptions about things.

Earlier in this chapter, I described a question-and-answer dialogue about conveyance. As you may recall, the gist of the conversation was:

“Why?” #1: “Why do you carry these workpieces over there when you’re done with them?”
Response: “Huh? Oh, because I’m taking them to the next process,”
“Why?” #2: “But why are you carrying them to the next process?”
Response: “Well. I guess it’s because this process is over here and the next process is way over there. Does that answer your question?”
“Why?” #3: “Why are the two processes so far apart?”
Response: “I wonder why, too. It’s been this way since I started working here…”

That is where the worker being questioned ran into his own wall of fixed ideas. When the “way of doing this here” becomes firmly established, people stop wondering about other ways to do it. None of us will reach the root cause and the optimum improvement unless we face that wall head-on, and keep pounding on it until it tumbles down.

Key Concept #5: Do It Now

In working toward the root cause or the appropriate improvement, once you know, “I’ve got it,” head straight for the workshop and put your idea into practice. First realize the form and once that is in place, the content will naturally follow.
The “5S” Approach

What Are the 5S’s?

There is a curious JIT axiom that says, “Good workshops develop beginning with the 5S’s. Bad workshops fall apart beginning with the 5S’s.” The first part of the axiom refers to the thorough implementation of the 5S’s that we need in order to lay the groundwork for subsequent improvements. The 5S’s are our foundation blocks, upon which we can lay flow production, visual control, standard operations, and various other JIT building blocks. All of this long, hard block-laying will in a few years turn the factory into a close approximation of the JIT production system.

On the other hand, it only takes a moment for a workshop to begin falling apart. This process also begins with the 5S foundation block, even though all those other blocks have been placed on top. Like a skyscraper whose bottom floor is suddenly demolished, the proud edifice of JIT production can also be destroyed from the bottom up.

The strength of the 5S foundation is a reliable sign of how strong the entire JIT edifice is. There is no such thing as a factory that manufactures things well without a strong 5S foundation. On the contrary, any virtually waste-free factory is bound to be in top condition as far as the 5S’s are concerned. In fact, thoroughness of 5S implementation is directly proportional to production strength.
This chapter is devoted to this essential foundation for improvements and corporate survival. It also includes the following sections:

- Benefits of the 5S's
- Meaning of the 5S's
- The Visible 5S's
- Keys to Success with the 5S's

**Benefits of the 5S's**

Once, when entering a certain factory for the first time, I encountered a big sign posted a little above eye level emblazoned with two words “seiri, seiton” (Proper Arrangement and Orderliness), written in very large characters. When I took a quick look around the factory, though, I could see that the sign was a big lie.

That magic pair of words—seiri and seiton—can be found on factory walls all over Japan. I guess they are in fashion now.

Just the same, it is amazing how few of these factories are actually properly arranged and orderly. For almost all of them, these magic words are just powerless incantations. At best, they are statements of hope: “Wouldn’t it be great if we could have proper arrangement and orderliness here?”

Some factories are more insistent on these two concepts. Their signs read “Proper Arrangement and Orderliness Now!” They line up everything in a neat grid of parallel vertical and horizontal rows with 90-degree intersections, and then declare, “We’ve done it!”

As popular as the magic duo “Proper Arrangement and Orderliness” is, there are precious few factories where people actually understand what seiri and seiton mean and put them into practice. Most people interpret them as arranging things into orderly rows.

This is where the 5S’s come in. The 5S’s are five Japanese words whose romanized renderings all begin with the letter
“S”: seiri, seiton, seiso, seiketsu, and shitsuke. Their respective English counterparts are Proper Arrangement, Orderliness, Cleanliness, Cleaned Up, and Discipline.

Some people add yet another Japanese “S” word—shukan (Habit)—to get 6S’s instead of 5S’s. However, the 5S’s are enough to communicate the basic concepts, and the most basic of these 5S’s is the popular pair of seiri and seiton (Proper Arrangement and Orderliness). These lie at the root of other JIT basics, such as zero defects, cost reduction, safety assurance, and zero breakdowns.

For example, most factory workers have simply grown accustomed to “searching” as part of their jobs. They search for parts, carts, tools and jigs. The more searching they do, the lower their productivity sinks, and the more obsolete their factory becomes in today’s era of product diversification.

People take little notice of the five minutes they spend searching for jigs, tools, dies, and carts during an hour-long changeover procedure. But when the factory switches to single changeovers, those five minutes of searching time suddenly become an obvious waste.

The facts are simple:

- A neat and clean factory will have higher productivity.
- A neat and clean factory will turn out fewer defective products.
- A neat and clean factory will make more on-time deliveries.

I have gathered the essential benefits the 5S’s afford into a chart that shows their various interrelations. Figure 4.1 shows this chart.

Benefit #1: Zero Waste Bringing Lower Costs and Higher Capacity
- Eliminate “stand-by waste” in in-process inventory and warehouse inventory.
- Eliminate unneeded storage places (such as warehouses, shelves, cabinets).
- Eliminate “stand-by waste” in waiting for conveyance equipment (such as pallets, carts, forklifts).
- Eliminate waste arising from unneeded allocation of space and equipment.
- Eliminate wasteful motion in searching, sidestepping, and so forth.
- Eliminate actions that do not add value (such as picking up, putting down, counting, carrying).
Benefit #2: Zero Injuries—Bringing Improved Safety
  - When the equipment is kept in spotless condition, you are able to discover mechanical failures and hazards immediately.
  - Maintain well-defined places to put things and make sure there are plenty of uncluttered aisles and rest areas.
  - Things should be placed in a safe manner to prevent breakage and so on.
  - Fire-extinguishing equipment and emergency exits should be clearly marked in case of fires, earthquakes, or other emergencies.

Benefit #3: Zero Breakdowns—Bringing Better Maintenance
  - Trash, dirt, and dust can all lead to major equipment breakdowns and much shorter equipment life.
  - Get rid of shavings, filings, oil leakage, and keep the workshop sparkling clean to make it easier to see how the equipment is running.
  - Maintain and check the equipment daily to nip breakdowns in the bud.

Benefit #4: Zero Defects—Bringing Higher Quality
  - Defects are harder to discover when the workplace is a mess.
  - Pickup things from their proper places and put them back properly. This will help eliminate part- and tool-selection errors.
  - A clean and well-organized workplace makes workers more conscious of the way they are making things.
  - Proper maintenance and storage of quality-assuring inspection tools and measuring instruments is a prerequisite for zero defects.
Benefit #5: Zero Changeovers—Bringing Product Diversification
- Proper arrangement of dies, jigs, and tools eliminates a major form of waste: “searching waste.”
- Sparkling clean equipment and a neat and clean workplace help raise operational efficiency.
- Thorough implementation of the 5S’s makes workshops simple and transparent enough for observers to understand with ease.
- Just say “NO” to using nonspecified jigs for the sake of convenience.

Benefit #6: Zero Delays—Bringing Reliable Deliveries
- When defects are gone, deliveries go out on time!
- We need good work environments and smooth operations.
- Absenteeism is lower at 5S workshops.
- Operational efficiency is higher in waste-free workshops.

Benefit #7: Zero Complaints—Bringing Greater Confidence and Trust
- Products that come from a neat and clean workshop have no defects.
- Products that come from a neat and clean workshop cost less to make.
- Products that come from a neat and clean workshop are not delivered late.
- Products that come from a neat and clean workshop are not dangerous.

Benefit #8: Zero Red Ink—Bringing Corporate Growth
- People who work in 5S workplaces earn more respect and trust in their community.
- Customers are happy to buy from manufacturers that have rid themselves of waste, injuries, breakdowns, and defects.
Factories that have mastered the 6S’s (proper arrangement, orderliness, cleanliness, cleaned up, discipline, and habit) are growing factories.

**Meaning of the 5S’s**

A factory superintendent once proudly informed me, “When it comes to proper arrangement and orderliness, we don’t fool around.” But when I looked around, I saw chaos in the parts warehouse, things piled directly onto the factory floor, and various parts piled here and there.

As I said earlier, *seiri* and *seiton* are a very popular pair of words in Japanese factories. You can find them on signboards and banners everywhere. In fact, I cannot think of a slogan that is more popular than this one in Japanese factories today.

Ironically, it is these same two words that are probably the least understood. “*Seiri* and *seiton,*” or “Proper Arrangement and Orderliness,” does not mean “Let’s start arranging things properly and being orderly.”

The true meaning of these words cannot be written down anywhere, not on signboards, papers, or banners. As written words, these concepts are sometimes counterproductive: People write them on signs, post the signs, and then rest on their laurels, feeling proud and confident that the factory is moving in the right direction. Therefore, we should not even teach workers to look at such signs. These two most basic concepts are not about looking at signs and thinking—they are about *doing*.

With that in mind, let us once again confirm the meaning of the 5S’s.

**Seiri (Proper Arrangement)**

How often this simple term is misunderstood! People say, “Let’s get things arranged right!” and then they busily line everything up in neat rows and declare, “We’re finished. Great job!”
Proper arrangement has very little to do with lining things up in rows or piling them into neat stacks. All that is just line-forming.

When proper arrangement is done correctly, it is broad-ranging enough to include proper arrangement of job assignments, proper arrangement of outside orders, and so on. When the factory experiences a lull in orders, managers should be able to easily determine which workers are still needed and which are not and make the necessary personnel changes. Only when it comes to factory hardware does proper arrangement basically mean arranging things in neat rows and stacks.

Please take a moment to be sure you know the full meaning of this word. And remember:

Proper arrangement means clearly distinguishing between what is needed and kept and what is unneeded and thrown out.

It is surprising that such a simple concept can be so easily misunderstood. At first, it is hard to distinguish between what is needed and what is not. At this point, my suggestion is: *If in doubt, throw it out.*

People tend to be pack-rats. They hang onto parts thinking, “We can use this for the next order.” They look at an inappropriate machine and say, “Well, let’s use it anyway.” Meanwhile, inventory and machinery continue to pile up and start getting in the way of everyday production activities.

Naturally, this leads to a mass buildup of waste that spreads far and wide through the factory.

The following are a few types of waste that contribute to errors and defects.

- Unneeded inventory incurs extra inventory-related expenses.
- Suddenly, the factory needs more warehouse space and shelving, and space becomes scarce.
- When unneeded conveyance occurs, it requires extra pallets and carts.
More shelving means more purchasing costs and other management and labor expenses.

It becomes more difficult to tell what is needed and what is not.

Stocked items become obsolete due to design changes, limited shelf life, and so forth.

Unneeded in-process inventory leads to quality defects and machine breakdowns that can nip improvements in the bud.

Unneeded equipment is a daily hindrance for production activities.

Having extra stuff around makes equipment layout design that much more difficult.

Visible methods of proper arrangement (such as red tagging) make identifying waste easier.

Seiton (Orderliness)

Once again, we have a term that is used all the time but is rarely understood. Orderliness means much more than an orderly appearance.

Moreover, orderliness always goes hand in hand with proper arrangement. When we have arranged everything properly, the only things that remain around us are the necessary things. The next step is to clarify where these things belong so that anyone can immediately understand where to get them from and where to put them back. In this sense, orderliness means standardizing the places where we keep things.

Orderliness means organizing the way we keep necessary things, making it easier for anyone to find and use them.

I would like to emphasize the idea that anyone at all should be able to easily understand the order of things in the factory. This is very important. Having to “learn the ropes” or “become a veteran” before understanding where things go is nothing but bad news for everyone.
The signboard strategy is a visible orderliness method that helps anyone understand where things go and thus helps make operations run more smoothly.

**Seiso (Cleanliness)**

This is the kind of cleanliness most people like to maintain in their own houses. Unfortunately, for some people, cleanliness stops at home and they tend to be litterers in public. Even at the workplace—where many of us spend more time than we do at home—people ironically tend to ignore cleanliness.

Cleanliness means sweeping floors clean and keeping things tidy.

Cleanliness in a factory is closely related to the ability to turn out quality products.

The basics of cleanliness are simply sweeping floors and wiping off machinery. As a labor-saving device, we also need to find ways to prevent dirt, dust, and debris from piling up in the workshop. The two main targets for improvement are debris from cutting and drilling machines and oil leakage.

Cleanliness should be integrated into everyday maintenance tasks. The equipment operator should be the person who best understands how the machine or other equipment is running. Often, it is only when we are wiping dirt from a machine that we notice, “Hey, this thing is leaking oil!” or “It smells like something’s burning in this control panel!” We need to demolish the distinction between the operator’s work and the maintenance technician’s work and instead get everyone involved in developing better maintenance activities.

**Seiketsu (Cleaned Up)**

“Cleaned up” differs just enough from proper arrangement, orderliness, and cleanliness to warrant a separate description among the 5S’s. Unlike cleanup, these other three can be seen as activities, as something we “do.”

However, cleaned up does not refer to an activity, but to a state. Therefore, we define it as follows.
Cleaned up means that the first three S’s (seiri, seiton, and seiso) are being maintained.

Although “cleaned up” relates to all three of the first three S’s, obviously it is most strongly linked with seiso or cleanliness. Cleanliness means keeping the machinery and its environs free of debris, oil, and dirt; cleaned up is what we get when we perform cleanliness consistently over a period of time. We can take the state of being “cleaned up” one step farther by devising ways to prevent dirt and the like from occurring in the first place. Workshops that have accomplished this are well on their way to being top-notch 5S workshops.

For example, Figure 4.2 shows how some ingenious person found a way to keep fingernail clippings out of the workshop. Figure 4.3 shows another example involving a drill press. In this example, workers placed a cover to prevent drill shavings from being scattered onto the floor. The debris was stopped near its source. The closer we can get to the source of the debris, the easier it will be to maintain a “cleaned up” workshop.

**Shitsuke (Discipline)**

The first four S’s can be implemented thoroughly without major difficulty if the workshop is already one where the employees maintain certain habits—such as friendly hellos and goodbyes among co-workers at the start and end of their shifts, work uniforms, name tags, and helmets—that help maintain good safety, a clean shop, and a positive work
attitude. Such workshops are probably already characterized by high productivity and high quality.

The Chinese character that Japanese uses for the word *shitsuke* (discipline) is a combination of two characters. One of these component characters means “body” and the other means “beauty” or “beautiful.” The sound of the character also associates it with careful and precise craftsmanship, such as in sewing.

As such, discipline is seen as the most important of the 5S’s, and is indeed a pivotal factor for the production system as a whole.

Discipline means making a steady habit of properly maintaining correct procedures.

The time and effort involved in establishing proper arrangement and orderliness will all be in vain if we do not have the discipline to maintain them. Factory supervisors work their tails off establishing the first four S’s, only to discover that the workers lack the discipline to maintain the new procedures.
The managers can organize as many “5S Campaigns” and “5S Contests” as they want, but the 5S’s will not last for long without discipline in the workshop.

The key to discipline lies outside of any specific tool, such as the 5S checklist. The seeds of workshop discipline need to be planted by factory bosses and managers who are themselves deeply committed to establishing and maintaining the 5S’s. The foreman should be called to the workshop if even just one screw is left lying on the floor. The foreman needs to use strong language to emphasize the importance of the 5S’s and to condemn, not the particular worker at fault, but the attitude that it is OK to leave debris on the floor. The person who is ultimately responsible for any 5S backsliding is not any particular worker, but rather the relevant top manager, such as the factory superintendent.

Managers who are not willing to accept responsibility for maintaining the 5S’s do not have the right to complain if their workers feel the same way. For managers, discipline means maintaining the heartfelt conviction that workers’ transgressions against established procedures are a rebuke to their authority as the person most responsible for workshop discipline.

This concludes our introduction to the 5S’s: proper arrangement (seiri), orderliness (seiton), cleanliness (seiso), cleaned up (seiketsu), and discipline (shitsuke). Figure 4.4 summarizes their meaning and primary results.

The Visible 5S’s

Every factory is more or less concerned with the company’s survival and is undertaking various rationalization and cost-cutting measures to improve the company.

Many factories are full of enthusiasm for such improvements, but still make no real progress. Usually, the managers at these companies wonder, “Is the JIT production approach really being taught throughout the company?” or “Are people really learning what they need to know to make improvements?”
This questioning often prompts them to decide on such “positive measures” as more training and outside seminars for key people.

But still no progress. This leads to further wondering, “Is there something wrong with the way we're promoting JIT?” or “Do the project members really know what they are doing?” Then more positive responses, but still no progress.

The real problem at such companies is that the managers do not know how to look for the real problems. The real problem seldom concerns improvement methods or a weak promotional organization. It usually concerns a failure to ask what forms of waste or other problems remain in the workshops.

Once people have learned to spot waste and other problems as they are in the workshop, they are already well on their way to success. All they need to do next is put their experience and knowledge to work in devising and implementing improvements. The easiest way to do this is to make...
the whole array of waste, abnormal operations, and other problems as explicit and visible as possible so that anyone observing the workshop can quickly spot them.

*There is no such thing as a problem-free factory!*

The world is full of companies and factories. There are some excellent factories and some abominable ones. But all factories have one thing in common: problems, problems, and more problems. What makes the excellent factories different is that when they find a problem, they move *immediately* to solve it. Once they solve the problem, they follow up by dealing *immediately* with any problem that occurs subsequently.

The worst factories do not even recognize the problems as such. They just do what they can to get around them. Since avoiding problems does nothing to solve them, the problems soon take firm root as part of the factory’s “way of doing things.” This is happening all the time—new problems crop up, get ignored, and take root.

All factories are full of problems. The difference between the good factories and the bad ones lies in whether or not they recognize the problems as such and do something to solve them. To put it differently, the good factories have discovered a “trick” that enables them to recognize various problems as they occur.

In JIT production, there is a “trick” that enables *anyone* to recognize various types of waste, problems, and abnormalities, whether they are in the warehouse, factory equipment, or production operations.

The trick is called “visual control.” *While the 5S’s stand as the foundation for improvement, the “visible 5S’s” are what the 5S’s must become in order to be preserved.* (See Figure 4.5.)

**Visible Proper Arrangement**

Almost all factories contain more stuff than they need for current production purposes. There are many materials, parts, and even numerous machines, jigs, and other equipment that are not currently needed. There is so much superfluous stuff,
in fact, that it tends to obstruct production activities, lower efficiency, and create waste.

Once everyone decides to get rid of all this useless stuff, they are still not able to do anything until they learn how to tell what is actually needed from what is not. This is where the red tag strategy comes in. Red tag teams know how to make this distinction. They inspect the factory and attach red tags to all items they deem unnecessary. This enables anyone to see what must be disposed.

The red tag strategy is an effective means of turning the first “S” (seiri, or proper arrangement) into the first visible “S.” (The red tag strategy is described more fully later in this chapter.)

**Visible Orderliness**

If proper arrangement has been implemented thoroughly, there should be nothing left in the factory that is not needed for current production. Now is the time to start asking all the
“Where?” “What?” and “How many?” questions that will lead us toward an orderly arrangement of these necessary items. To make all this organization planning more visible, we should use the signboard strategy. (The signboard strategy is described more fully later in this chapter.)

All the various types of signboards, such as “standing signboards” and “display signboards,” serve the same important purpose: to make the establishment and maintenance of orderliness more visible.

Other handy tools for making orderliness more visible include color coding of items to make different types of items easier to spot at a glance, and outlining jigs and tools in their correct positions so that they can be easily returned to exactly the right place. (Color coding and outlining will also be described more fully.)

**Visible Cleanliness**

Cleanliness refers mainly to the daily cleaning tasks that should go hand in hand with basic daily maintenance tasks. Figure 4.6 shows an example of how “cleanliness inspection checklists” can be used to verify how well the daily cleaning tasks are being carried out.

**Visibly Cleaned Up**

As mentioned earlier, “cleaned up” is a condition that can only be established by maintaining the first three S’s (proper arrangement, orderliness, and cleanliness) on a daily basis. Figure 4.7A shows an example of the “five-point cleaned up checklist” that we can use to rate how cleaned up the workshop really is.

As can be seen in Figure 4.7B, the checklist includes separate sections for rating the state of the cleaned up condition in terms of the first three S’s (proper arrangement, orderliness, and cleanliness). Each of these sections has five levels for scoring, as shown in the figure.
Visible Discipline

One cannot tell simply by looking at the workers whether or not discipline is in force. This is because discipline has its source deep in the hearts and minds of the workers, and thus is not so obvious to the casual observer. However, there are certain types of behavior that we can expect if discipline is truly there. Therefore, we should look at the workers’ actions and the results those actions bring to determine whether or not discipline is being maintained.

In other words, how well the workshop has done with the first four S’s is itself a good gauge for determining how well discipline has been established. This means we can put the five-point check for cleanliness and other forms to work for us as tools for evaluating discipline.

Since discipline is a mental and spiritual phenomenon, we cannot be too critical of workers who have not yet managed to develop it. As in the oriental martial arts, we first have to practice the forms and, while doing that, we gradually develop the psychological and technical aspects of the art.
The “5S” Approach

Likewise, with the 5S’s, we begin by establishing and practicing the first four S’s, and by doing this we develop the fifth S: *shitsuke*, or discipline.

The following are some of the things we can do to make this process of developing discipline more visible.

- **5S badges**
  
  Figure 4.8 shows an example of a 5S badge that graphically portrays the 5S’s centered on discipline as a means of encouraging the development of discipline.

- **5S mini motto boards**
  
  We can use small signboards for posting 5S-related mottoes invented by the company’s own workers to help heighten awareness and participation. Figure 4.9 shows a 5S mini motto board that was posted in the men’s restroom. This company changed its motto boards every week. The mottoes and illustrations should always be simple enough to be read and understood in about a minute.
### (1) 5-point check for proper arrangement

<table>
<thead>
<tr>
<th>Description</th>
<th>Points</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Needed and unneeded items are mixed together in the workshop.</td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Needed and unneeded items are basically separated.</td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· It is easy to see what is not needed.</td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· All unneeded items are kept somewhere away from the workshop.</td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· All completely unnecessary items have been disposed of.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
</tr>
</tbody>
</table>

### (2) 5-point check for orderliness (warehouse and in-process inventory)

<table>
<thead>
<tr>
<th>Description</th>
<th>Points</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Can't tell what things belong where and in what amount.</td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Can basically tell what things belong where and in what amount.</td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Workshop is using only place indicators and item indicators.</td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Workshop is using place and item indicators and outlining to make item organization visible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>· Input and output from workshop are clearly indicated and amount indicators are also being used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
</tr>
</tbody>
</table>

### (3) 5-point check for orderliness (for jigs and tools)

<table>
<thead>
<tr>
<th>Description</th>
<th>Points</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Can't tell what things belong where and in what amount.</td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Can basically tell what things belong where and in what amount.</td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Workshop is using only place indicators and jig/tool indicators.</td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Measures have been taken to make item placement more visible (color coding, outlining, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>· Jigs and tools have been streamlined by combining functions, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
</tr>
</tbody>
</table>

### (4) 5-point check for cleanliness

<table>
<thead>
<tr>
<th>Description</th>
<th>Points</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Workshop is left dirty for a long time.</td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Workers clean up the workshop occasionally.</td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Workers clean up the workshop daily.</td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Daily cleaning tasks and maintenance have been integrated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>· Workers have devised ways to prevent messes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>♦</td>
</tr>
</tbody>
</table>

Figure 4.7B  Detail of Cleaned Up Checklist.
The “5S” Approach

- 5S stickers
  No matter how frantically busy a factory is, there is still one place where people are not busy working. In fact, workers tend to spend a good five minutes there, just sitting. The place is the restroom. At one household electronics manufacturing plant, I saw 5S stickers (shown in Figure 4.10) pasted on the walls of the toilet stalls. When people are too busy to read anything else, these stickers still get read.

- Five-point check for “cleaned up” status
  We can use this checklist to help maintain cleanliness by posting the various scores for proper arrangement,
orderliness, and cleanliness on workshop walls as a means of stirring up concern in problem-plagued workshops. These checklists are powerful tools for making the “cleaned up” status more visible.

5S checklists and 5S contests

Figure 4.11 shows a completed 5S checklist. This particular list was compiled during this company’s “5S Month,” which emphasized the 5S theme. The company conducted checks once a week during this month. They also carefully conducted an “overall workshop check” at each workshop, and posted the total points at the end of the month to find out which workshop would win the Excellent Workshop Award in a “5S Contest.”

5S patrol score sheet

Once a month, a “5S Patrol Team” should wander through the factory, filling out the 5S Checklist shown
The “5S” Approach

in Figure 4.11. After scoring each workshop according to the checklist, it should enter the workshop scores onto a “5S Patrol Score Sheet,” as such as shown in Figure 4.13. The 5S Patrol Team must be sure to enter improvement deadlines when filling out this score sheet.
Figure 4.12  5S Photo Exhibit (seiri and seiton).

**JIT 5S Patrol Score Sheet**

<table>
<thead>
<tr>
<th>Area</th>
<th>Score</th>
<th>Area</th>
<th>Score</th>
<th>Area</th>
<th>Score</th>
<th>Area</th>
<th>Score</th>
<th>Area</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall 1</td>
<td>50</td>
<td>Materials 1</td>
<td>46</td>
<td>Manufacturing 1</td>
<td>49</td>
<td>Parts 1</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall 2</td>
<td>44</td>
<td>Materials 2</td>
<td>42</td>
<td>Manufacturing 2</td>
<td>45</td>
<td>Parts 2</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials 3</td>
<td>44</td>
<td>Manufacturing 3</td>
<td>56</td>
<td>Parts 3</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials 4</td>
<td>45</td>
<td>Manufacturing 4</td>
<td>61</td>
<td>Parts 4</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials 5</td>
<td>37</td>
<td>Manufacturing 5</td>
<td>46</td>
<td>Parts 5</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials 6</td>
<td>54</td>
<td>Manufacturing 6</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HIC</td>
<td></td>
<td>Manufacturing 7</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Overall 2</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>47</td>
<td>44.7</td>
<td>51.8</td>
<td>47.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.13  5S Patrol Score Sheet.
The “5S” Approach

**5S photo exhibit**

In addition to the monthly inspection by the 5S Patrol Team, a 5S Photographers Team should also be sent out once a month to inspect the factory and take pictures of both good and bad examples of 5S workshops. The photos should have comments added below and ought to be posted in a common space, such as the company cafeteria. (See Figure 4.12.)

**5S Maps**

Maps showing each workshop’s layout should be posted, as shown in Figure 4.14. Whenever someone tours the factory or even just passes through, he or she should be able to glance at these maps. If they notice areas where enforcement of the 5S’s can be improved, they can make
a note of it on memo pads that are provided with the map. They should check up on the improvement every morning or evening and write further improvement memos if necessary.

**Keys to Success with the 5S’s**

After the big push to establish 5S workshops, we may succeed in getting rid of unneeded items, setting up clearly defined places for keeping things, and cleaning floors and machines until they shine.

But all this means nothing unless we also establish a system for maintaining all of these 5S improvements. This is why we should be sure to organize a “5S Promotion Team” that will be responsible for the maintenance and further improvement of 5S conditions in the factory.

The following are eight main points that can serve as keys to success in establishing and maintaining 5S workshops. We call them the “Eight Keys to 5S Success.”

**Key #1: Get everyone involved**
- The 5S’s cannot be the responsibility of a concerned few. Everyone must get into the act.
- All levels of factory management should take part in the decision-making.
- Carry out 5S activities as part of the factory’s small group activities.

**Key #2: Get company authorization**
- 5S activities should not be performed in secret or disguised as overtime work. Get management approval for all 5S activities.
- Make signs and posters to explain the 5S’s to everyone. (See Figure 4.15.)
- Have a general monthly meeting where company and factory managers can address 5S issues and themes.
Key #3: Final responsibility rests with the president

- The 5S's will not be taken seriously until the factory superintendent and even the company president take personal responsibility and interest regarding their implementation.
- Nothing could be worse for 5S success than to have managers who “pass the 5S implementation buck” to their subordinates.
- Company managers must take a strong leadership role in 5S promotional meetings and other 5S events.

Key #4: Make yourselves understood

- Don’t leave people wondering, “Why are we sticking red tags on things?” or “Is all this 5S stuff really necessary before we can make improvements?”
- Hold 5S promotional meetings to clearly explain the 5S’s and to answer all questions from all participants.
- When explaining the 5S’s, present actual examples of successful 5S implementation, or take the participants on tour of successful 5S workshops.
Key #5: Do it all the way

- When establishing proper arrangement, be sure to carry out red tag campaigns and be sure to use the correct red-tagging formats and procedures.
- When establishing orderliness, use signboards. Make sure the signboards have the proper format, descriptions, and locations.
- Make up your factory’s own 5S (or 6S) manual, complete with all the necessary details.

Key #6: The president should inspect the factory personally

- The president should personally inspect factories and point out their various positive and negative conditions.
- The president should help out by pointing out specific improvement items and proposing improvement themes at 5S promotional meetings.
- Workshops should work individually and in groups to study and report on improvement methods taken in response to improvements suggested by the president.

Key #7: Don’t stop halfway in establishing the 5S’s

- Don’t do things halfway. Once the 5S promotional organization and methods have been established, get started and stick with it.
- When developing red tagging and signboards throughout the factory, make sure everyone gets involved.
- Once you have laid the foundation by establishing proper arrangement and orderliness, start developing “discipline” habits to keep the foundation strong.

Key #8: The 5S’s are a bridge toward other improvements

- Don’t stop with the 5S’s: Follow through with zero defects, cost reduction, and other improvement activities.
- Once the factory has been cleaned up, start putting casters on machines to make them easily movable.
- Eliminate defects as close to their source as possible and implement flow production.
Red Tags and Signboards:  
Proper Arrangement and Orderliness Made Visible

In JIT production, everything in the factory should be made as clearly visible as possible. This means that the flow of goods, the appearance of abnormalities, and everything else that exists or occurs in the factory should be readily apparent at a glance. As the very foundation for improvements, the 5S’s must be made visible. This is all the more true for the most basic of the 5S’s, proper arrangement (seiri) and orderliness (seiton).

It is therefore only natural that we should want to further enhance and emphasize these two most basic factors as “visible proper arrangement” and “visible orderliness.” The two tools we should use to make them more visible are red tags (afūkuda) and signboards. We use “red tag strategy” to make proper arrangement more visible and “signboard strategy” to make orderliness more visible.

Invariably, the situation in the factory prior to 5S implementation can be characterized by two shortcomings: We cannot easily tell what is necessary from what is not, and, walking around the factory, we cannot tell what things are, where they belong, and in what quantities. Red tagging and signboards are two strategic tools that identify and clarify factory waste and other problems.

No matter how attractive the design and execution of the factory’s “Proper Arrangement and Orderliness” signs are, things are not going to become better arranged or more orderly on their own.

The first thing to do is clearly distinguish between what is needed and what is not. The best way to do this is to have a company-wide red tag campaign aimed at visible proper arrangement. Red tagging clearly marks the unneeded items, which we can then move over to a temporary pile of “red-tagged” items for subsequent disposal.
This leaves only the needed items in the factory. Now we are ready to look at these necessary items and start asking “Where?” “What?” and “How many?” A factory in which both red tagging and signboards have been implemented this way is a factory where anyone can readily see what is necessary, where each type of thing belongs, and in what amount.

Figure 4.16 shows the overall procedure for implementing red tagging and signboards. Each step in this procedure is described below.

**Step 1: Separate Needed Items from Unneeded Items**

Factories are full of all kinds of things: machines, parts, dies, jigs, and so on. However, not all of those things are needed for whatever type of production is currently being done. There are usually some items sitting around to be available for future orders or items that were scheduled to be used but got canceled by a design revision.

These unnecessary items are mixed in with the necessary ones. So the first thing to do is separate them. The most visible and simplest way to do this is by attaching red tags to all items that are deemed unnecessary. Use brightly colored red tags that are easy for anyone to see.

**Step 2: Move Out the Unneeded Items**

Once the unneeded items have been marked with red tags, we can remove them from the factory and temporarily store them somewhere else. Suddenly, the factory is much less cluttered; only the really necessary things remain.

**Step 3: Throw Out Whatever Is Really Not Needed**

Now we need to go through the piles of unneeded items, figure out which are truly superfluous, and dispose of them.

**Step 4: Intensive Improvement**

Carrying out a red tag campaign will remove the unnecessary items from the factory, leaving only what we need for current
production purposes. This generally means that red tag campaigns lower in-process inventory to one-half or one-third the previous amount. However, since inventory, especially in-process inventory, is part of the factory’s basic way of doing things, it reflects the ability of the factory to produce things. Figure 4.17 shows how simply removing unneeded items is soon betrayed if we maintain the same way of doing things.
The conventional way of doing things will cause inventory to creep back up to its former level.

Therefore, just as soon as we finish a red tag campaign, we need to carry out intensive improvements—working all night if need be—to change the production set-up over to flow production. This will keep inventory from climbing back to its previous level. Such intensive improvement attests to greater production ability, while the reduction in inventory affords a proportionate reduction in waste.

**Step 5: Indicate Where, What Type, and How Many**

Naturally, we will need to change the equipment layout as part of our intensive improvements. Once we have changed the equipment layout, we need to change the production set-up by placing things in the most efficient way. Furthermore, we need to clearly indicate what goes where and in what amount. This labeling of items is the signboard strategy.

**The Red Tag Strategy for Visual Control**

The red tag strategy has become very popular among Japanese factories in recent years. The 5S’s have also gained
wide recognition as the foundation for improvement. Both have been praised as tactics that cost little yet produce good results in terms of reducing inventory, raising productivity, and so on. Another reason for the red tag strategy’s wide acceptance in Japan is that attaching red tags to unneeded items is a simple procedure that anyone can perform.

In fact, the red tag strategy has become popular not only in Japan, but also in faraway France and neighboring Korea. The red tag strategy is a new wave in visual control and “visible proper arrangement” that is gradually becoming a global trend.

This section describes the following red tag strategy topics:

- What is the red tag strategy?
- Steps in the red tag strategy
- Red tag computers
- A red tag episode: laughing and learning
- Case study: red tag strategy at Company S
- Case study: spreading the news about red tag implementation

What is the Red Tag Strategy?

The following is something that happened just the other day. I was invited to a ribbon-cutting ceremony to mark the completion of a factory that would be staffed by about 100 people. Everything in the brand-new factory was sparkling clean—walls, floors, pillars, and so on. Not a speck of dust anywhere. It was refreshing just to look at such a bright and shining place.

Give that factory a year or two, and it will become just as dirty as any other typical factory. The dirtier it gets, the more hospitable it becomes for the archenemy “Waste.”

Some people will argue that anywhere you have people you’ll have dirt. People perspire and pickup dirt and germs where ever they go, which is how disease is spread. How could it be any different in a factory? But I would argue that
people do know how to wash off the dirt that they carry. Just take a shower or bath.

I have never seen a factory take a shower or bath, though. The question is, can we find some kind of shower/bath substitute for the factory?

The best “factory bath” I have ever run across is the 5S’s: proper arrangement, orderliness, cleanliness, cleaned up, and discipline.

People are used to treating all the unnecessary things in the factory—vouchers, operations, equipment, and all the inventory those things require—as if they were their proud, personal possessions. That is why it is so important that we look all around us and determine what is really needed and what is not.

This is where the red tag strategy comes in. Every strategy is aimed at conquering a certain “enemy.” Obviously, the enemy we use red tagging against is waste and the other “evils” we create.

Even for workshop workers, it is not always easy to identify the “evils” of the factory. They seldom have any notion of how to separate items needed for current production from other unnecessary items. Conservative-minded factory managers can look at factory evils right in the face and still not recognize them as such.

We need a simple method for bringing such evils to the surface and for enabling even the most tunnelvisioned factory manager or company president to tell the difference between what is needed and what is not. The red tag strategy just happens to fit the bill. (See Figure 4.18.)

**Steps in the Red Tag Strategy**

Once red tagging gets underway, we suddenly find red tags all over the place! But there is no such thing as too many red tags. Neither is a factory full of red-tagged items anything to be ashamed of. When red tagging is carried out well at a typical factory, the whole factory starts looking red.
Why do we use the color red? The reasons are many. First of all, red is a bright and conspicuous color. Second, red is the color of stop signs and stop lights. Third, in Japan, the word for red (aka) is a homonym with another aka that means “dirt.” The criteria for attaching red tags on items differs from factory to factory. If the factory is typical, red tags are attached to all items that will not be needed for the next month’s production schedule. At the stricter factories, the “need period” for items is the next week’s schedule.

Sometimes, no one in the factory can tell for sure whether or not a particular item will be needed during the next week or month. In such cases, some factories use yellow tags for these items. Personally, I am not fond of using any yellow tags, since that opens the door to vagueness and indecisiveness, resulting in a factory that may soon be full of nothing but yellow tags. I prefer to use only red tags and keep things cut-and-dried. Figure 4.19 shows the steps for carrying out a red tag strategy.

**Step 1: Launching the Red Tag Project**

Optimally, red tagging is something that happens every day. But even factories that devote a few minutes each day to red tagging still need to carry out factory-wide red tag campaigns at least once or twice a year.
What is the red tag strategy?
The red tag strategy is a means of implementing proper arrangement by labeling all unneeded items with conspicuous red tags.

STEP 1 Launching the red tag project
- Members: Employees in manufacturing, materials, management, and accounting divisions
- Period: One to two months
- Key point for JIT consultant: Help the factory employees understand how to identify what items are not needed.

STEP 2 Identifying red tag targets
- Inventory: Raw materials, parts, in-process inventory, and products
- Equipment: Machines, miscellaneous equipment, jigs, tools, carts, desks, chairs, dies, vehicles, fixtures, etc.
- Space: Floor and shelving

STEP 3 Setting red tag criteria
- Set the criteria for determining what is needed and what is not. Example: All items that will be needed for the next month's production schedule are not to be tagged, and all other items are to be tagged.

STEP 4: Make the red tags
- The red tags should be about as large as a standard (8 1/2” × 11”) piece of typing paper to ensure eye-catching prominence.
- For inventory items, the red tag teams should write down the item's name, quantity, retention period, reason for retention, and other related information.

STEP 5: Attach the red tags
- People from indirectly related divisions should come to the workshop, listen to a description of the current conditions, and use their objectivity to attach red tags on all unneeded items.
- Look with a cool, critical eye.
- Do not let the workshop's own workers decide where to stick the red tags!
- The workshop workers tend to think that everything is necessary.
- Show no mercy when attaching red tags!
- If in doubt, red tag it!
- Red tagging should be done intensively over a short period of time.

STEP 6: Evaluate the red tag targets
- Divide red tags into two types: one for "dead stock" and the other for "retained stock."
- Set the "need period" for service parts according to the product life of corresponding products. Keep service parts in the warehouse for the appropriate need period.
- Create and execute a schedule for disposing of dead stock. The schedule should indicate the quantity, value, and disposal period.
- Write up a list of all unneeded inventory to facilitate understanding of the unneeded inventory and for use in accounting.
- (Equipment:)
  - Basic principle: Whatever gets in the way during improvement activities should either be disposed of or moved.
  - Follow the company's disposal application procedure to dispose of unneeded equipment.
  - If the equipment that is in the way during improvement activities is an off-the-book asset, simply get rid of it, since there are no applications to fill.

Figure 4.19 Steps in Red Tagging Strategy.
Implement each campaign as a distinct red tag project. The person who takes final responsibility for the project should be a top manager, such as the company president, the manufacturing division chief, or factory superintendent.

Project members should come from almost every division in the company. It is especially important that accounting division members get actively involved in the disposal of unnecessary warehouse stock and equipment.

**Step 2: Identifying Red Tag Targets**

In the manufacturing division, the main targets for red tags include inventory, equipment, and space.

Inventory can be divided into warehouse inventory and in-process inventory. Warehouse inventory has its own subdivisions: material warehouse, parts warehouse, product warehouse, and so on. We need to be especially careful to target all inventory that does not have a specified location, such as inventory that gets piled up alongside aisles or on shelves in the factory. In the management division, we need to target all the unnecessary paperwork, along with superfluous desks, lockers, and the like.

The point is to make immediately obvious what is needed and what is not. That is what the red tag strategy is all about. When red tagging is carried out thoroughly, it gets to the point where we even can begin red tagging superfluous staff. This is a rather inhumane way to treat people, however, and it would be better to address surplus labor in other ways. (See Chapter 7 regarding manpower reduction.)

**Step 3: Setting Red Tag Criteria**

The most difficult thing about red tagging is knowing how to tell what is needed from what is not.

If a red tag team member asks someone who works in the workshop whether a particular item is needed, the answer is almost always, “Yes, we need that!” Even items such as parts and machines that get used no more often than once every
two or three years will be judged “necessary” by the workshop staff. They will look at parts that have been rendered obsolete by equipment changes and say, “Let’s hang onto those. We’ll find some way to use them sooner or later.”

All too often, we will run into people who exclaim, “Throw it away? What a waste!” This sentimental attachment to things waxes especially strong when the things were built or customized by the workshop staff themselves.

We must face it: People are naturally reluctant to throw familiar things away. So how do we get around this? Generally, we need to establish clear-cut criteria for deciding what is needed and what is not. The most common criteria is the next month’s production schedule. Whatever is needed for that schedule is needed. Whatever is not required for the schedule is superfluous and can be hauled away.

Some factories may be able to take on a stricter criterion by using next week’s production schedule instead of next month’s. But at the average factory, this one-week criterion would result in almost everything being red-tagged. Usually, it is best to stick to the one-month production schedule criterion.

Step 4: Make the Red Tags

It does not matter what you make the red tags out of. Use red paper, thick red tape, or whatever else that works. The key is to make sure the red tags call attention to themselves. (See Figure 4.20.)

We need to laminate whatever material we use with plastic or something that will protect the red tags during repeated use. Red paper is usually the easiest thing to use for red tags. In any case, the whole purpose is to make eye-catching memos. The types of things we should write down on the red tags are:

- Category: This provides a general idea of the type of thing the tag has been attached to, such as a warehouse item, machine, or whatever. The major categories include
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Raw materials, in-process inventory, products, equipment, jigs, tools, dies, and fixtures.

- **Item name**: Write the name or number of the item to which the red tag has been attached.
- **Quantity**: Indicate the number of items included under this red tag.
- **Reasons**: Describe why you attached a red tag. If the item is an inventory item, give only the main reason (“unneeded,” “defective,” or “not needed soon”).
- **Division**: Write the name of the division responsible for managing the red-tagged item.
- **Date**: Enter the red-tagging date.

### Figure 4.20  Example of a Red Tag.

<table>
<thead>
<tr>
<th>Category</th>
<th>Measure H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Raw material</td>
<td>7. Quasi products</td>
</tr>
<tr>
<td>2. In-process stock</td>
<td>8. Finished products</td>
</tr>
<tr>
<td>3. Idle equipment</td>
<td>9. Quasi materials</td>
</tr>
<tr>
<td>4. Unneeded tools and fixtures</td>
<td>10. Office products</td>
</tr>
<tr>
<td>5. Other</td>
<td>11. Paper, pens, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item name</th>
<th>Manufacturing No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Units</th>
<th>Value</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reason</th>
<th>Disposal by: Department/Division/Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not needed</td>
<td></td>
</tr>
<tr>
<td>2. Defective</td>
<td></td>
</tr>
<tr>
<td>3. Late (missing items, old technology)</td>
<td></td>
</tr>
<tr>
<td>4. Surplus (Surplus or marginal surplus)</td>
<td></td>
</tr>
<tr>
<td>5. Destination unknown</td>
<td></td>
</tr>
<tr>
<td>6. Inappropriate destination</td>
<td></td>
</tr>
<tr>
<td>7. Inappropriate destination</td>
<td></td>
</tr>
<tr>
<td>8. Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disposal method:</th>
<th>Disposal completed (signature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Discard</td>
<td></td>
</tr>
<tr>
<td>2. Return</td>
<td></td>
</tr>
<tr>
<td>3. Move to red tag storage site</td>
<td></td>
</tr>
<tr>
<td>4. Move to separate storage site</td>
<td></td>
</tr>
<tr>
<td>5. Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Today's date:</th>
<th>Posting date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal date:</td>
<td>Disposal completed (signature)</td>
</tr>
</tbody>
</table>

| Red tag file number                            |                                           |
Step 5: Attach the Red Tags

Make sure the entire red-tagging team thoroughly understands the criteria for telling the unneeded items from needed ones, then send the team to the workshops.

It is better if the people attaching the red tags are not from the workshop being tagged. The people who work there are likely to hate seeing red tags being attached to their stuff and will protest, “Hey, we need that in case we get a big order!” or “But we’ll probably use that next month!”

Instead, let managers or other people from outside the workshop do the red tagging. They will be better able to red tag items unhindered by sentimental resistance or regret. In fact, these outsiders should be encouraged to take devilish delight in their work as red taggers. Such a game-spirited attitude has led to a popular nickname for red taggers: “red devils.”

The best way to carry out red tagging is to do the whole factory in as short a time as possible. Stringing the red tag project period out any longer than necessary tends to put a damper on morale. It is important to regard red tagging as a swift and powerful event.

Step 6: Evaluate the Red Tag Targets

The final step in red tagging—evaluation of red tag targets—is a very important step.

First, we need to examine the targets in the inventory categories. We need to clarify the types of unneeded warehouse items and how they were being warehoused. That will help us decide what to do with the items. Figure 4.21 shows the major types of unneeded warehouse items and the corresponding disposal methods.

After we have analyzed the unneeded items and have better understood them, we are ready to apply the “unneeded inventory items list,” which is the basic tool for reducing unneeded items. Figure 4.22 shows an example of this list.
As a target for red tagging, equipment is just as important as warehouse inventory. We should move all red-tagged equipment away from the areas where daily production activities take place. However, large equipment and equipment that is firmly attached to the floor may be quite expensive to move. To avoid undue expenses, it is sometimes better not to move such equipment unless it really gets in the way of daily production activities or prevents workshop improvements. Until
such a time, the unneeded and unwieldy equipment should be marked with a “freeze” red tag.

Figure 4.23 shows an example of the “unneeded equipment list” that we need to draw up and use for deciding how to dispose of red-tagged equipment.

**Red Tag Computers**

Wide-variety, small-lot production with short delivery deadlines. We have all heard, spoken, and dreamt of this kind of production for years now. And all this time, this new wave of wide-variety small-lot production has grown stronger, as have the demands for shorter delivery schedules and lower costs.

The day of large volume production is long gone, and a new day of production centered on small lots of many product models has dawned. This new day has dawned over all
manufacturing industries, and these industries must find a new production system that will provide the key for changing from volume-oriented production to model-oriented production.

This radical change is what is known as the “factory revolution.”

“Making things” remains the foundation of production. But everything above that foundation—wide-product variety, short delivery schedules, information-intensiveness, and overall speed—has changed dramatically.

During the era of volume-oriented production, factories had only a handful of products to manage, and they could afford to take their time in deliveries. Many shipped products only once a month, on the regular “shipping day.”

In today’s era of wide variety and small lots, factories must handle a much wider assortment of product models, all of which have increasingly short life cycles. This trend has caused a rapid surge in the amount of information that factories need to have about each of their products.

Unlike the corner grocery store, when the variety of products increases in a factory, the factory must deal with hundreds or even thousands of additional parts. Wider product variety also means an exponential increase in the variety and volume of order-related data and parts management data.

In this light, how can factories still manage to shorten their delivery times?

Even when factories ship only once a month, they must manage the shipments in two ways: as dealer-based deliveries and as time-based deliveries. This alone requires a vast volume of information. In other words, the switch to wide-variety, small lots, and shorter delivery schedules has engendered both a factory revolution and an information management revolution.

With further expansion of information expected in the future, people are rightfully concerned about how they are
going to handle it all. This trend is making computers an
indispensable part of every factory.

This brings us to our current subject: red tag computers.

When managers see all kinds of items being red-tagged
and disposed of, they want to know all the details: “We need
specific accounts of how parts and products are affected by
all this reduction of inventory!” or “We need to know how
these things are being disposed of in each factory division!”

How can we come up with all of these analytical reference
data? Red tags are themselves a very important type of data since
they indicate the factory’s superfluous items. But how can we
put these data to good use? I would propose the following.

One way is to remove the red tags from items just before
they are disposed of, then enter the data written on the red
tag into a computer. To facilitate computerized data process-
ing, data such as the item category, item name, reasons for
red tagging and company division should be converted to
codes before being entered.

Figures 4.24 and 4.25 show examples of red tag-related
data lists output by a computer, a general red tag list, and a
more detailed reason-specific red tag list.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of red-tagged items</th>
<th>Total units covered by red tags</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Equipment</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2. Jigs and tools</td>
<td>11</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>3. Measuring instruments</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4. Materials</td>
<td>10</td>
<td>8,431</td>
<td></td>
</tr>
<tr>
<td>5. Parts</td>
<td>1,022</td>
<td>6,692,659</td>
<td></td>
</tr>
<tr>
<td>6. In-process items</td>
<td>6</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>7. Quasi products</td>
<td>97</td>
<td>201,238</td>
<td></td>
</tr>
<tr>
<td>8. Finished products</td>
<td>19</td>
<td>7,655</td>
<td></td>
</tr>
<tr>
<td>9. By-product materials</td>
<td>60</td>
<td>645</td>
<td></td>
</tr>
<tr>
<td>10. Office materials</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11. Documentation materials</td>
<td>4</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>(Total)</td>
<td>1,251</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** RED TAG STRATEGY: Red Tag List ***

Figure 4.24  Example of a Computer-Operated Red Tag List.
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When people operate a factory year after year, dirt and grime gradually accumulate without anyone noticing anything. The red tag strategy is a direct battle against such dirt. Many humorous “war stories” have been born of these battles against dirt. The following eight red tag episodes offer lessons that you may find applicable to your own situation.

**Episode 1: Twenty Years of Inventory**

One plant supervisor recalls how bad the inventory situation had been at his factory: “It was nothing to be proud of. I was shocked by what we found. For instance, we found a part that had been sitting in the warehouse for 20 years!”

In hindsight, it seems that somehow the wrong part name was assigned for the part when it was ordered. For 20 years, until the factory carried out a red tag campaign, the part sat unnoticed in the warehouse. Apparently, even the person who originally ordered the part failed to notice the mistake.

The factory superintendent reflected, “We were not especially concerned with superfluous parts in the warehouse. As
long as there were no missing parts, we felt that all was well. The red tag strategy showed us where we were wrong.”

**Lesson 1**—Just as we keep an eye out for missing parts, so must we watch for excess inventory!

**Episode 2: Twice Red Tagged**

Another factory established March as “Red Tag Month.” Unexpectedly, though, their red tag project lingered on into April. I asked someone at the factory what happened. He told me, “March is also the audit month at our company. People thought the factory would look horrible to the auditors if red tags were stuck all over the place, so we took the tags off.”

The audit was completed at the end of March. In April, the factory workers put the red tags back on again. Obviously, people at that company do not really understand what red tagging is all about.

**Lesson 2**—Check twice to make sure that everyone completely understands the red tag strategy!

*Episode 3: Red Tagging People, Too?*

One factory had already carried out red tagging of targets such as unneeded inventory, equipment, and space.

The red tag project leaders exhorted everyone, “Don’t hold back. Tag everything that deserves to be tagged.”

Later, it was discovered that someone stuck a red tag on the desk belonging to the chief of the manufacturing department! It was not clear whether or not this was meant as a joke. The department chief in question took it as a bad joke. I would venture to suggest that red tagging desks may indeed be called for in certain situations, but never, even in jest, should we stick a red tag on someone’s back, where it would seem like the proverbial “kick me” sign.

**Lesson 3**—Don’t red tag people unless you want to be red-tagged yourself!
**Episode 4: Now We Have Too Many Pallets!**

This factory was suffering a pallet shortage, and so it sent out an order for another 300 pallets to fill the gap. However, a red tag project was carried out before the new pallets arrived. The project achieved inventory cutbacks that resulted in a 300-pallet surplus!

The factory superintendent asked everyone, “Now what are we going to do when we get those 300 pallets we ordered?” With a wry smile, he answered his own question: “I know. We’ll turn this place into a pallet factory!”

**Lesson 4**—An appetite for more pallets is a sure symptom of a gluttonous production system.

**Episode 5: A Yellow Tag Flop**

Factories are mysterious entities. It is not always easy to tell what will be needed for next month’s production and what will not. One factory sought to appease peoples’ reluctance to red tag certain items by allowing yellow tags to be used for items having doubtful necessity. When the red tag campaign was completed, the factory was full of yellow tags and nary a single red tag could be seen. As a result, the whole campaign was one big flop.

**Lesson 5**—If you go halfway with yellow tags, you won’t have any red tags!

**Episode 6: Red Tag Stickers**

When red tag project members at a major household electronics manufacturer discussed how to make the red tags, they decided it would be convenient to have red tag forms on adhesive-backed paper and eliminate the need for rolls of cellophane tape. However, these large red tag stickers were not cheap: Each one cost over a dollar. When the factory superintendent saw these fancy stickers, he called a worker over, saying, “Hey, bring me some of those red tag stickers!”
A curious group of people gathered around and watched in amazement as the superintendent placed one red tag sticker onto a bunch of other ones. He then announced, “I’m putting a red tag on these needlessly expensive red tag stickers!”

**Lesson 6**—Improvement—including red tagging—should not be expensive. The more money we spend, the less we use our own ingenuity to find solutions.

**Episode 7: Each Person Should Attach at Least Four Red Tags**

I once visited a factory that was disappointed with the results of its red tag project. I figured that since the factory employs about 300 people, each person should have found at least four things to tag, which adds up to about 1,200 red-tagged items.

When I got to the factory, I asked the superintendent how many items were red-tagged.

“Oh, I guess about 40 or 50,” was his reply.

No wonder they were disappointed!

**Lesson 7**—A red tag project is not a red tag project unless each member attaches at least four red tags.

**Episode 8: Showing No Mercy**

This factory had set-up its red tag project, had made the red tags, and was all ready to start attaching them to unneeded items. The red tag team distributed red tags to workshops throughout the factory and instructed the workers there to stick red tags on everything not needed.

A week later, the red tag team received almost all of the red tags back from the workshops. Every workshop had the same excuse for returning them: “There aren’t any unneeded items in our workshop.”

**Lesson 8**—Everyone must understand and use the same criteria for deciding what is needed and what is not needed.

The people who work in the target workshop will all say, “We need that!” about everything. Instead, let managers or other people from outside the workshop do the red tagging.
And it’s better to avoid the production engineering staff. It knows the workshops too well and tends to have sentimental attachments to them.

**Lesson 9**—When red tagging a workshop, we must be as cold-hearted as the Devil!

As these episodes illustrate, red tagging reaches right down into the hearts of factories and can be expected to bring major results. It is indeed a very important strategy.

About the only thing that produces greater results and boosts improvement higher than red tagging is “visual orderliness”—in other words, the signboard strategy.

**Case Study: Red Tag Strategy at Company S**

The following is a case study of red tag strategy implementation at a company we shall call Company S.

**Finding Oneself Amid the Waste**

Company S’s production division sponsored a meeting of the production management subcommittee on February 24. Its main concern at this meeting was to concentrate on the 5S’s to lay the foundation for improvements. It realized it needed the top manufacturing managers’ complete understanding and backing, but so far no progress had been made to secure that support.

The production division chief addressed the meeting in a loud, authoritative voice: “Right! Let’s get the 5S’s done so we’ll be ready to start really improving the factory. I say we should make March our 5S Month.”

Naturally, the production division chief’s suggestion was taken as a command. Company S inaugurated “5S Month” by kicking off its red tag strategy. On March 1, the production division chief had a notice sent to all manufacturing departments in the company. (See Figure 4.26.)

The production management division should be active only in the overall promotion and organization of the red tag project.
All of the details should be handled by the factory people themselves, using their hands-on know-how and ingenuity. At one of the company’s factories, they figured they would use about 500 red tags. However, once they started tagging things, they soon found themselves running out of red tags. They ended up using about 1,500—three times their original estimate.

Through red tagging, the factory staff finally came to realize just how much dirt and waste they were working amid.

**Anticipatory Large Lot Production**

Company S was founded in 1954, and is currently one of Japan’s top manufacturers of stainless steel sinks and other kitchen fixtures and furnishings.

The key to survival in today’s highly competitive manufacturing world is to produce a wide variety of products in small lots and with short delivery times. And that is not all—the products must also be built with high quality, but at low cost.
To help motivate employees toward this challenge, Company S's president came up with the “SS” strategy. SS stands for Company S's “survival.”

As part of this SS strategy, Company S set-up a comprehensive computer-based sales/production system that helps it promptly identify current market needs and distribute this information to the proper manufacturing divisions.

The company was trying to beef up its information-related strengths by putting more information into its “brains” and making that information more accessible.

However, it is not enough to have a lot of “brains” in the company. Any brain needs a healthy body to survive. In other words, a powerful brain and a frail body makes it difficult for the whole body to function well. Companies need to have quick and agile bodies that can provide prompt “hardware” responses to the “software” (information) they receive from the computer system.

What this all boils down to is a radical change in the character of the old large lot-oriented factories. Obviously, making such a change is a very big project. It requires more than incremental improvements in the factories. A lot of people will not like the idea and will be reluctant to follow along. Such radical improvement will require improvement teams to put in long hours after work, day after day. They must begin by re-educating the workers, then they must overhaul the factory layout and change the production methods.

This Is Nothing Short of a Factory Revolution

Factory improvement is an underlying assumption of the factory revolution. Carrying out the 5S’s is the only way to lay the foundation for factory improvement and to set the stage for the factory revolution.

It is not difficult to find manufacturing people in Japan who are familiar with the 5S’s. In fact, as mentioned earlier,
many Japanese factories post signs and banners showing the first two (and the two most basic) of the 5S’s, seiri (proper arrangement) and seiton (orderliness). But very few factory people have any clear idea of what actually needs to be done to establish those first two S’s!

Company S understood what red tagging meant, and adopted the following basic policy points concerning it: *Properly arrange items by removing currently unneeded items, then make them orderly in every direction—horizontal, vertical, perpendicular, and parallel.*

This humble statement is all a company needs to ignite the sparks of an awareness revolution in its factories.

**We Are Ready for JIT Improvement: Our Inventory Is Now One-Third What It Was Just Six Months Ago**

Company S not only got its larger and smaller factories involved in red tagging, it also enlisted the participation of several subcontractor factories. As a result, some factory managers were reporting that thoroughly implementing the 5S’s was apparently enough to boost productivity about 20 percent. This productivity rise was most likely due to the 5S effect on eliminating the need to search for parts and tools and in removing conveyance-related waste. Another reason was that factories were rendered conducive to visual control.

Company S’s factories now had too many pallets and carts and their inventory levels had dropped dramatically. In the case of the one large factory that received the most attention from the company, red tagging resulted in a one-third inventory reduction over the level recorded just six months before. (See Figure 4.27.) Everyone was amazed at how spacious their factories had become after red tagging. In fact, people felt disoriented without all that familiar clutter all over the place.

If we can get this far, we are halfway there. The stage is all set for factory improvement. Everyone is excited and anxious for the curtain to rise and for the improvements to begin.
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Figure 4.27  Achievement of a 33-Percent Inventory Reduction.

*Total value and inventory value for November were assigned 100 points
Case Study: Spreading the News about Red Tag Implementation

Figures 4.28 through 4.31 show the notice that Company A sent out to employees in all divisions regarding the implementation of their red tag strategy.

MEMORANDUM
TO: All divisions (division chiefs and department chiefs)  
RE: Implementation of Red Tag Strategy

As you all know, the operations division and other divisions have already gained some success in carrying out red tag strategies. However, we still have a lot of space-wasting, unneeded items in various workplaces and, in order to lay the foundation for JIT improvement, we are undertaking the following additional red tag strategy. We hope we can count on your cooperation in this effort.

Signed,

1. Objective  
To remove space-wasting unneeded items from workplaces and to lay the foundation for JIT improvement

2. Implementation period  
February 13-24: Red tag strategy period  
February 28: Report on red tag strategy results

3. Red tag targets  
Equipment, productions, inventory items, etc.

4. Criteria for red tagging  
Attach red tags to all equipment, inventory items, and other items that will not be required under the March production schedule.

5. Organization  
(1) Head office  
Chief executive officer for overall red tag strategy: President  
Vice-chief executive officers for overall red tag strategy: Managing director and factory superintendent

(2) Operations division and other divisions  
Chief executive officers for red tag strategy: Each division chief  
Vice-chief executive officers for overall red tag strategy: Each department chief

Division and department chiefs will set up a red tag strategy promotional organization within each division.

6. Implementation method  
(1) Members of the red tag strategy promotional organization will individually attach red tags to items they judge unneeded, based on reasons other than listed in the red tag criteria used by the division concerned. They will notify the relevant departments of the number of items that have been red-tagged in this way.

(2) While waiting for an investigative team to study the red-tagged items, the people in the division concerned will sort the items out and start arranging for their disposal.

(3) As for shelving or other immovable assets, separate the items for which disposal applications have already been made, then clear as many of them out of the workshop as possible.

Figure 4.28 Company A’s Memo to All Employees.
(4) Main tasks in red tag strategy

<table>
<thead>
<tr>
<th>Development of red tag strategy</th>
<th>Main tasks</th>
<th>Report results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue general instructions for red tag strategy.</td>
<td>Make sure everyone understands the red tag strategy and then establish the strategy’s general direction.</td>
<td>Fill out appended report form.</td>
</tr>
<tr>
<td>Consult with chief and vice-chief executives, then issue more detailed instructions.</td>
<td>Review their own workplaces, related workplaces, and various warehouses. Use appended checklist for reviews.</td>
<td></td>
</tr>
<tr>
<td>Act as person responsible within operation division based on executive instructions.</td>
<td>Act as the team which carries out specific red tag activities (one person will be given responsibility as team leader).</td>
<td></td>
</tr>
<tr>
<td>Investigate disposal of red-tagged items.</td>
<td>Dispose of red-tagged items from their own division. For items from other divisions, consult with division staff first, then attach white tags to items that cannot be disposed of or that must be moved to temporary storage. Determine disposal method for all other items.</td>
<td></td>
</tr>
</tbody>
</table>

7. Long-term storage
Contact the secretary-general’s office to receive instructions regarding storage sites for parts that cannot be discarded. Store items to be disposed of during this business term separately from items to be disposed of after this term.

8. Disposal of administrative materials
Consult with the general affairs department before disposing of administrative materials.

9. Other
The red tag strategy promotion team should work with the head office in dealing with any problems that arise after the red tagging has been completed.
## Red Tag Strategy Checklist

<table>
<thead>
<tr>
<th>TARGET</th>
<th>CHECK POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLERICAL</strong></td>
<td></td>
</tr>
<tr>
<td>File cabinets, books, documents</td>
<td>Dispose of all books and documents for which the specified storage period has expired. Bundle up all documents that require incineration. Leave necessary files alone or put them into storage.</td>
</tr>
<tr>
<td>Signs and other posted items</td>
<td>Remove and dispose of all outdated or otherwise old items.</td>
</tr>
<tr>
<td>Desks, tables, etc.</td>
<td>Organize what is on top of, inside or underneath, and next to all desks. Leave only items that are necessary to the current operation on top of the desk. Minimize the number of documents, tools, and other small articles kept on the desk.</td>
</tr>
<tr>
<td>Fixtures and machines</td>
<td>Dispose of all unneeded items.</td>
</tr>
<tr>
<td><strong>WORKPLACE</strong></td>
<td></td>
</tr>
<tr>
<td>Inventory items</td>
<td>All quasi products, finished products, in-process inventory, testing materials, and other items that fall outside of the red-tagging criteria.</td>
</tr>
<tr>
<td>Equipment</td>
<td>Items that fall within the red-tagging criteria and that are not expected to be needed, off-the-book items, etc.</td>
</tr>
<tr>
<td>Work tables</td>
<td>Items that fall outside of the red-tagging criteria or that are rendered unnecessary by a layout revision or other reason.</td>
</tr>
<tr>
<td>Jigs and measuring instruments</td>
<td>Unneeded shared or individually used items and defective items</td>
</tr>
<tr>
<td>Tools</td>
<td>Unneeded items stored in boxes or on shelves</td>
</tr>
<tr>
<td>Wires, cables, etc.</td>
<td>Return all materials that cannot be disposed of to the distribution department or store them in a common storage site.</td>
</tr>
<tr>
<td>By-products materials</td>
<td>Store or dispose of unneeded bolts, nuts, clamps, chemicals, etc.</td>
</tr>
<tr>
<td>Shelving and boxes</td>
<td>Dispose of all shelving and boxes that are unnecessary and/or detract from productivity.</td>
</tr>
<tr>
<td>Drawings</td>
<td>Check what is not being used currently and what is being stored in duplicate.</td>
</tr>
<tr>
<td>Other</td>
<td>Be sure to dispose of whatever does not seem to be needed.</td>
</tr>
<tr>
<td><strong>WAREHOUSE</strong></td>
<td></td>
</tr>
<tr>
<td>Retained goods</td>
<td>Items related to management or design that are of questionable need in schedules, off-the-book items, items that are removed from equipment and stored, items that have never been used, etc.</td>
</tr>
<tr>
<td>Books, files, wires, steel plates, metal fittings, etc.</td>
<td>Review all of these and dispose of all unneeded items.</td>
</tr>
<tr>
<td>Equipment</td>
<td>Dispose of all items not expected to be used, old and worn items, and outdated items.</td>
</tr>
</tbody>
</table>

**Figure 4.30** Red Tag Strategy Checklist.
The Signboard Strategy: Visual Orderliness

The signboards we use in the signboard strategy are sometimes confused with the well-known *kanban* system in which signs are used as tools for maintaining Just-In-Time production. Signboards are a different kind of tool, though. We use these signboards to make orderliness more visible. The *kanban* system may use some signboards, such as for indicating item names and quantities, operation instructions,
or delivery instructions. But just the same, we should think
of the signboard strategy as a modest “visible orderliness”
strategy that may serve as part of a comprehensive kanban
system that functions as a full-fledged “autonomic nervous
system” for the factory.

This section addresses the following topics concerning the
creation and use of signboards in the signboard strategy.

- What is the signboard strategy?
- Steps in the signboard strategy
- Orderliness beyond signboards

**What Is the Signboard Strategy?**

A simple, two-step procedure is all it takes to lay the founda-
tion for achieving zero defects and eliminating waste: Clearly
separate what is needed from what is not, and remove all
unneeded items from daily production activities.

After that, all that remains is needed items, and the natu-
ral thing to do is arrange and use these needed items in
the most efficient way. While we are at it, we need to post
signboards that indicate just what kind of machines we are
using and “where,” “what,” and “how many” inventory items
are to be kept. In other words, make everything obvious and
visible. The signboard strategy is a tool that makes the whole
organizing process more visible.

Figure 4.32 gives an overview of visible orderliness using
the signboard strategy.

Of these signboards, the most important ones are the
inventory signboards that should clearly indicate where each
inventory item belongs and in what amount, allowing *any-
one* to understand the inventory layout. Signboards should
only be used for items that are needed for current production
purposes. Therefore, the signboard strategy should always be
preceded by the red tag strategy, or we will end up wasting
time posting signboards over unneeded items.
Before getting into a closer look at how to apply the signboard strategy to inventory items, let us turn to the machine/equipment signboard example shown in Figure 4.33.

We simply write down the name of the machine, the process name, the operator or other person-in-charge, and the
machine’s acquisition date. Then we hang the signboard from the ceiling or post it against a wall or on the machine itself.

**Steps in the Signboard Strategy**

After we have carried out the red tag strategy, the factory should contain only items that are needed for current production. Now, the question is what to do with those remaining items. We should remember that the items needed for current production are not necessarily the most efficient types of items.

After red tagging, factories suddenly have a lot of open floor space and empty shelving. Now is the time to consolidate what is left and change the equipment layout or production flow pattern. Once operations have been thus redesigned, we are ready to move the remaining inventory and in-process items to the most efficient and orderly sites.

Figure 4.34 illustrates the signboard strategy procedure.

**Step 1: Determine Locations**

As soon as the red tag strategy has been completed, we need to make improvements that will consolidate the equipment layout and the production flow. Then we are ready to ask where things should be placed to best suit the new layout.

When determining locations, make sure to place often-used items as close as possible to the operator’s position and place seldom-used items farther away from the line. Keep easily portable items about waist-high on the shelves and keep harder-to-carry items on the upper and lower shelves.

**Step 2. Prepare the Locations**

Once we know where we want to place something, we still need to prepare the site. We can use some of the cabinets, shelving, boxes, pallets, or other containers that were rendered superfluous by the red tag strategy.
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While doing this, if we find that there are not enough cabinets or shelves or whatever, we do not need to rush out and buy more. Instead, we should take this golden opportunity to reconsider the containers we are using and try to think of smaller containers that will do just as well. We should also consider whether lot sizes can be shrunk or whether unneeded items can be customized to serve as the kind of cabinet or shelf that we need.

Figure 4.34  Signboard Strategy Procedure.
We might also want to set-up a system that lets us extract items in first-in first-out order, or use labor-saving roller conveyors or other clever devices.

**Step 3: Indicate Locations**

Once we have decided where to put things, we need to make location indicators—in other words, signboards that show the place and address of the item concerned.

Location indicators can be modeled after the postal system’s address system. No matter where in the world we send a letter, if that letter indicates our return address, it can be returned to us. The factory’s address system should be at least as comprehensive as the postal address system. Like the postal address system, the factory address system should include both a “town address” and a “street address.” This means there should be an indication of where in the factory the item belongs, and also what specific address within that area. Address numbers are often duplicated within different areas, so we must be sure to specify the area and not just the number.

An address system and a map are all *anyone* should need to find *anything* in the factory.

Section and address indicators can be separate signboards, as shown in Figure 4.35. In this example, the section signboards indicate which set of shelves (A, B, C, and so on) the items are on and the address signboards show the part of the shelf (1, 2, 3, and so on).

In the example shown in Figure 4.35, the address consists of a vertical address number and a horizontal address number. Once we set-up a system like this one, we can give an item to a brand-new employee in the factory and simply say, “Here, this goes to address A32 on the shelves,” and trust that the item will get put in the right place. This is what we mean by making things *visible* so that *anyone* can understand them.
Step 4: Indicate Item Names

After we have finished setting up the shelf addresses, we still need to indicate what kinds of items go there. For this we use item indicators.

Examples of such indicators abound among high-rise apartment complexes and parking lots. Figure 4.36 shows a comparison between a well-managed parking lot and a poorly managed one.

Let us assume that a new parking lot attendant has arrived for his first day of work at the lot. He finds that all of the parking spaces have people’s last names on them. He sees that a car with license plate number 90R 3G56 is in the space marked as Mr. Smith’s, but he cannot tell whether or not that car is parked in the right space. The “old hand” who managed the parking lot before knew which car belonged to whom and could tell. But the new guy is at a loss.

If the lot were organized and managed as shown in the bottom half of the figure, the new guy could tell right away if any cars were parked in the wrong spaces. In this lot, all parking spaces include item placement indicators that show what specific item belongs in each space. In this case, the items (automobiles) are identified by their license plate numbers. The license plate number on the car parked in
Mr. Smith’s space matches the number shown on the item placement indicator in that space, so the new guy knows immediately that the car is parked in the right space. All over the lot, one glance is enough to see whether the cars’ license plate numbers match the license plate numbers shown in the parking spaces.

The same goes for factories. Figure 4.37 shows how item placement indicators and item indicators can be used similarly for shelf slots in factories.

The item placement indicators show exactly what item belongs in what place, while the item indicators identify each item. If we take this item indicator and include various other data (such as data used to maintain the “pull production” system, operation instructions, and/or delivery instructions), this simple signboard becomes a full-fledged kanban.
Step 5: Indicate Amounts

Unless we keep tabs on the amount of inventory items, they tend to pile up. The best reason to have amount indicators is that they limit the number of shelves and other storage space to be used for inventory items. When exact amounts cannot be indicated, we should at least indicate the minimum and maximum amounts. Color coding is a good way to distinguish between minimum and maximum amount indications. (See Figure 4.38.)

This system enables anyone to spot misplaced items right away. Again, this brings us back to a basic tenet of JIT:
Abnormalities, waste, and all other problems in the factory must be made so visible that they can be recognized at a glance.

**Step 6: Make Orderliness a Habit**

Orderliness means standardizing the new way we place things as a result of *seiri* (proper arrangement). Orderliness should clarify what goes where and in what amount. It should also make all abnormalities and problems immediately obvious to everyone. The key to maintaining orderliness is to respond to problems as soon as they arise by identifying the causes and making the appropriate improvements.

The three most important things to do to prevent backsliding on orderliness are to make orderliness easy to maintain to begin with, stick to discipline, and make the 5S's a daily habit. The following sums up the concepts behind the three main types of indicators used in the signboard strategy:

- Location indicators: “at the specified location”
- Item indicators: “the specified item”
- Amount indicators: “in the specified amount”

**Orderliness beyond Signboards**

Although signboards are the major tool for bringing orderliness to inventory items, there are a few other methods worth noting.

**First-In/First-Out (FIFO)**

It is not hard to find inventory items piling up here and there in factories. The worst kind of inventory stack is when different types of inventory items get mixed up in the same stack, as shown in Figure 4.39. Such stacks often require that we move some of one type of item out of the way so that we can get to another type. This activity should be considered a major form of waste.

Generally, items are accumulated and retrieved in one of two opposite ways: first-in/first-out (FIFO) or last-in/last-out
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(FIFO). FIFO means that whatever gets put in earliest is the first to be taken out. This method is easy to implement on shelves that are accessible from both front and back, as shown in Figure 4.40. The FIFO method is a good way to prevent age-related deterioration of inventory items.

Inventory Liveliness Index

Conveyance-related waste occurs whenever inventory items, in-process stock, or other items are retained. Obviously, it is best to get rid of all waste arising from retention and conveyance, but when this is not possible, we should at least make sure that conveyors are being used efficiently to move such items.
Figure 4.41 shows how the “liveliness” of a factory’s conveyance system can be indexed and evaluated.

When items are simply piled on the floor (zero index points) and then are loaded into a box or other container to be moved, this creates a lot of waste related to loading and unloading items. Higher index totals and averages indicate a reduction of waste.

**Lined Up Inventory Placement**

When materials, parts, or other items are delivered, they are first “inserted” into an inventory pile. When the factory needs to use them, they are “extracted” from the pile and sent to the
factory. Therefore, inventory always includes the two actions we refer to here as “inserting” and “extracting.”

Inventory items can be managed using a function-specific management method that emphasizes easy insertion or using a product-specific management method that emphasizes easy extraction. This latter method is also known as the “lined up inventory placement method.” Both methods are illustrated in Figure 4.42.

Figure 4.42  Function-Specific Method and Product-Specific Method of Inventory Management.
The function-specific method enables centralized management of orders and deliveries, and is thus an easy method to use. However, it also requires warehouse workers to walk deep into the homogeneous stacks of goods to collect everything needed for a particular product. This method is better suited for unit production systems.

On the other hand, the product-specific management method scatters similar items among mixed piles of items needed for certain products. While this makes orders and deliveries more difficult to manage, it makes collecting parts for products very easy and helps minimize waste when the same groups of items are frequently sent to the factory. We call this warehouse organization of parts into product-specific groups “marshalling.” Marshalling is commonly done at the start of assembly lines, so that parts can be sent in prearranged groups for assembly. (See Figure 4.43.)

The advantages of marshalling are that assembly workers do not have to move sideways or turn around to pickup parts, and there will be fewer defects due to missing parts or errors in selecting parts.

Marshalling also has at least one disadvantage: Either the supplier or an operator must take the trouble to arrange the parts into their respective groups, which creates an extra set of unloading and loading steps.

Figure 4.43  Marshalling.
The “5S” Approach

Orderliness Applied to Jigs and Tools

One of the important ways that jigs, tools, blades, and dies differ from materials and parts is that jigs, tools, and the like have to be put back after being used. Parts and other materials go into products and are shipped out with the products, so we do not need to put them back.

Orderliness tends to collapse into disorder. But if we can find some way to make jigs and tools easy to put back, the chance of backsliding on orderliness can be cut in half. This section discusses the following points concerning orderliness as applied to jigs and tools:

- Easy-to-maintain orderliness for jigs and tools
- Orderliness applied to cutting tools

Easy-to-Maintain Orderliness for Jigs and Tools

Almost all materials and parts go into products and are shipped as part of those products, so they do not have to be put back. Jigs and tools, on the other hand, must be put back after they are used so they can be used again. The key to preventing orderliness from lapsing into disorder lies in this distinction between putting back jigs and tools and not putting back materials and parts.

Obviously, we need to store jigs and tools in a way that makes them easy to retrieve and use, but we should also make them just as easy to put back. We must never forget that making jigs and tools easy to put back is a vital part of orderliness as applied to jigs and tools.

There are several stages involved in making orderliness for jigs and tools easy to maintain. We call this progress of stages the “evolution of orderliness for jigs and tools.” The following describes the stages in this evolution.
Stage 0: No Sense of Orderliness; Complete Disorder

In workshops where the people have not yet developed a sense of orderliness, jigs and tools can be found laying in highly unpredictable places, and this causes workers to waste a lot of time searching for them. After the workers find the jigs and tools they are looking for and use them, they just leave them by the machine or wherever else seems convenient. Sometimes, they try to “hoard” the jigs and tools by keeping them close by them, which makes it hard for other workers to use them.

Stage 1: Jigs and Tools Are Kept in Groups; Easy-to-Understand Orderliness

First, the workers put all jigs, tools, blades, and even garbage and various parts together into one big pile. Then they select groups of items, such as a group consisting only of tools, a jig group, a blade group, and so on. This makes finding and replacing these items a little easier.

Stage 2: Visual Confirmation of Where to Put Back Jigs and Tools; Easy-to-Confirm Orderliness

The following devices and methods can be used to make it easier to confirm where jigs and tools should be put back when we are through using them.

- **Indicators**
  
  Label stickers and other indicators are good devices for showing everyone where to put back which jig or tool. Figure 4.44 shows examples of such indicators.

- **Color-coded orderliness**
  
  Color coding of jigs and tools according to their use is another good way of enabling easy confirmation. We call this method “color-coded orderliness.” For instance, if different jigs and tools are used for different machines, the machines and the jigs and tools they use can each
be marked with a certain color, which makes it easy for anyone to match jigs and tools with the right machine.

**Outlined orderliness**

If the place where we are supposed to return jigs and tools is vaguely defined, it becomes difficult to maintain orderliness. “Outlined orderliness” is a good way to solve this problem. “Outlined orderliness” means using markers or tape to show the outlines of the tools that belong in each place. Matching jigs and tools to their outlines is perhaps the simplest way to confirm that we are putting them back in the correct places. It is especially helpful to combine outlining with indicators, and even with color coding.

Some family restaurants use the same idea by providing children with place mats that have knife, fork, and spoon outlines to show where these utensils properly belong. (See Figure 4.45.)
Stage 3: Knowing It by Heart; Orderliness so Simple That Workers Can Maintain It with Their Eyes Closed

People tend to be lazy. They would rather be able to replace something without having to look to see what they are doing. The following devices are therefore worth developing.

- Bring return points to within arm's length.

When busy with their work, operators generally do not feel like putting something back in the right place if the right place is out of reach. That is why it is best to make those places as close to the operator as possible. This is especially true of jigs and tools used for changeover tasks. The operator should be able to remain in the same spot throughout the changeover procedure. Better yet, he or she should be able to reach over to pickup jigs and tools and put them back without even having to look at the jig/tool storage place.
If there are several tools, they should be arranged in their order of use during the changeover procedure. Figure 4.46 shows an example in which a changeover process has been simplified and made orderly using the 5S’s.

**Enlarging dimensions**

Everyone knows how hard it can be to thread a needle. The thread starts bending or the tip of the thread frays and we have to keep wetting and twisting it to restore the point. Likewise, if maintaining orderliness applied to jigs and tools is as nerve-wracking as threading a needle, you can be sure orderliness will not last long.

Threading a needle is so difficult because of the small needle hole we must work with. The small needle hole requires that we use a very thin thread, and thin threads tend to bend and fray.

Let us suppose, for example, that we need to pour some salad oil from one bottle to another, as shown in Figure 4.47. If we try to pour directly from one narrow-mouth bottle to another, chances are we will end up spilling some of the oil. We can get around that problem by enlarging the dimensions we must deal with. We all know which device to use for this—a funnel.
There is no reason why we cannot apply to the factory the same sort of everyday ingenuity that brought us the funnel for pouring. Figure 4.48 shows four stages in the evolution of orderliness applied to a broom and a mallet. As can be seen in the figure, the larger the dimensions...
get, the more we are able to put the items back without even looking at what we are doing. Orderliness becomes progressively easier to maintain.

**Stage 4: “Just Let Go” Orderliness; We Don’t Even Have To Return It**

When it comes to convenience, if you give people an inch they will take a yard. Even when we have made it so easy to put tools back that the operators do not even have to pay attention to how they do it, some operators will still think it is too much trouble. Perhaps the only thing to do with such people is devise a way in which they can simply let go of the tools when they are done with them.

Believe it or not, ways have been found to do just that. At produce stalls or fish stalls in Japanese marketplaces, it is a common practice to hang the money basket from the ceiling using an elastic cord. The merchant reaches up to grab the basket, makes change for the customer from it, then simply lets go of the basket and the rubber cord lifts the basket back up and out of the way. The merchant does not even have to think about returning the basket. This can serve as a prime example for factories.

Assembly factories have already developed a wide array of such “auto-return” devices. Figure 4.49 shows how most of the tools used in an automotive component assembly factory are hung above the assembly workers. We can see the same kind of device used in home electronics or electrical equipment manufacturers where electric screwdrivers are hung by cords. Generally, it is best to hang the tools at points closest to where they will be used.

**Stage 5: Orderliness That Eliminates Some of the Jigs and Tools; We Don’t Even Have to Use Them**

If you give lazy people a whole yard, what will they take next? Even when they can just let go of the tool when they are through with it, they may still think, “Why must I bother
to use that tool, anyway?” The question is, can we come up with a way to eliminate the need for certain tools?

- **Combining jigs and tools**
  By combining the functions of several jigs and/or tools into just a few, we can reduce the amount of jigs and tools to be managed. Figure 4.50 shows how two pneumatic or electric tools used for assembly can be combined into one. Naturally, some parts redesigning was needed for this combination.

- **Transferring tool functions**
  The best kind of orderliness removes the need for orderliness. If the items to be kept orderly are eliminated, we also eliminate the practice of orderliness for those items. Orderliness that no longer exists can hardly lapse into disorderliness.
The essential method for eliminating the need for orderliness is to find some way of performing a particular operation with fewer tools. To do this, we need to look at each tool and ask ourselves three simple questions:

1. “Why must I use this tool?”
2. “What is this tool’s basic function?”
3. “Is there some other way to perform that function without this tool?”

Sometimes we can find answers for all three questions and eliminate some of the need for orderliness. (See Figure 4.51.) The above questions will help us learn what the basic functions of the tools are. If we have a wrench whose basic function is to turn something, we may be able to think of a way to turn that something without needing a wrench or other hand tool. Figure 4.51 shows two such improvements: screw rods whose tops have been replaced by hand-turnable devices. These devices serve the same basic function as the monkey wrench and the alien wrench, but the operator does not have to pickup a tool to do the job.
As you can see, there are many ways we can make orderliness easier to maintain. Below is a summary list of the points discussed above in the evolution of orderliness for jigs and tools, or ways to keep orderliness from becoming disorderly.

Stage 0: No sense of orderliness; complete disorder.
Stage 1: Jigs and tools are kept in groups; easy-to-understand orderliness.
Stage 2: Visual confirmation of where to put back jigs and tools; easy-to-confirm orderliness.
Stage 3: Knowing it by heart; orderliness so simple that workers can maintain it with their eyes closed.
Stage 4: “Just let go” orderliness; we do not even have to return it.
Stage 5: Orderliness that eliminates some of the jigs and tools; we do not even have to use them.

**Orderliness Applied to Cutting Tools**

So far, we have talked about how to apply orderliness to materials and parts used in the factory, as well as to inventory and in-process stock. There are still some tools, however, that we
have not covered. Factories generally include a wide assortment of drill bits, saw blades, measurement tools such as calipers, and various other tools that are required for production.

This section looks at how orderliness can be applied to these tools, too.

**Orderliness for Cutting Tools**

Figure 4.52 shows a few examples of cutting tools. The following are some of the ways we can apply orderliness to tools like these.

- **Layout of cutting tools**
  Cutting tools can be laid out in either a centralized or a decentralized arrangement. A *centralized arrangement*, in which the cutting tools are all kept in one place, is best suited for tools that are not used very often. A *decentralized arrangement*, in which cutting tools are set out near the machines that require them, is best suited for cutting tools that are only used by certain machines.

- **Placement of cutting tools**
  After deciding where to keep the cutting tools, we need to determine how we will place them there. As with parts placement, the two basic placement methods are the function-specific method and the product-specific method.
Using the *function-specific placement* method, we group together cutting tools that have similar functions and place them in the same group. This method is better suited for unit production systems.

With the *product-specific placement* method, we group cutting tools according to which ones are needed to manufacture which products. These groups of tools can then be set as part of the production line. This method is better suited for repetitive production.

**Storage of cutting tools**

Cutting tools are no good without sharp edges. When we store drill bits and tap bits, we must be sure they do not rattle around against each other, which dulls their edges. Figure 4.53 shows how cutting tools can be stored in a manner that prevents such deterioration. The tools should also be oiled to prevent rusting.

**Orderliness for Measuring Tools**

Figure 4.54 shows several types of measuring tools. We must take extra care in handling and storing these tools, since they are high-precision instruments. We must at least ensure that they remain free of dirt, dust, and rust.

**Orderliness for Oil**

Since factory machines need routine oiling, oil containers make certain regular routes through the factory, just like migratory birds. The best way to manage these oil containers is to color code them according to route.
Obviously, we first need to find out just how many types of oil are used in the factory. Next, we observe which types of oil take which routes through the factory. Then we can color code the containers. We can then apply the same color coding to the areas where each type of oil is supplied. An example is shown in Figure 4.55.
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Hiroyuki Hirano believes Just-In-Time (JIT) is a theory and technique to thoroughly eliminate waste. He also calls the manufacturing process the equivalent of making music. In Japan, South Korea, and Europe, Mr. Hirano has led the on-site rationalization improvement movement using JIT production methods. The companies Mr. Hirano has worked with include:

- Polar Synthetic Chemical Kogyo Corporation
- Matsushita Denko Corporation
- Sunwave Kogyo Corporation
- Olympic Corporation
- Ube Kyosan Corporation
- Fujitsu Corporation
- Yasuda Kogyo Corporation
- Sharp Corporation and associated industries
- Nihon Denki Corporation and associated industries
- Kimura Denki Manufacturing Corporation and associated industries
- Fukuda ME Kogyo Corporation
- Akazashina Manufacturing Corporation
- Runeau Public Corporation (France)
- Kumho (South Korea)
- Samsung Electronics (South Korea)
- Samsung Watch (South Korea)
- Sani Electric (South Korea)

Mr. Hirano was born in Tokyo, Japan, in 1946. After graduating from Senshu University’s School of Economics, Mr. Hirano worked with Japan’s largest computer manufacturer in laying the conceptual groundwork for the country’s first full-fledged production management system. Using his own
interpretation of the JIT philosophy, which emphasizes “ideas and techniques for the complete elimination of waste,” Mr. Hirano went on to help bring the JIT Production Revolution to dozens of companies, including Japanese companies as well as major firms abroad, such as a French automobile manufacturer and a Korean consumer electronics company.

The author’s many publications in Japanese include: *Seeing Is Understanding: Just-In-Time Production* (*Me de mite wakaru jasuto in taimu seisanh hoshiki*), *Encyclopedia of Factory Rationalization* (*Kojo o gorika suru jiten*), *5S Comics* (*Manga 5S*), *Graffiti Guide to the JIT Factory Revolution* (*Gurafiti JIT kojo kakumei*), and a six-part video tape series entitled *JIT Production Revolution, Stages I and II*. All of these titles are available in Japanese from the publisher, Nikkan Kogyo Shimbun, Ltd. (Tokyo).