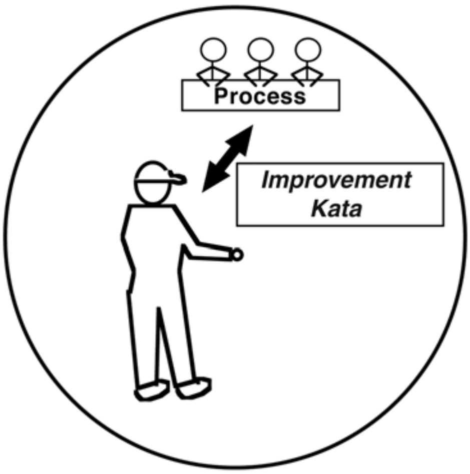
Part III

The Improvement Kata: How Toyota Continuously Improves



Introduction to Part III

In Chapter 2 we saw that the question "What can we do?" often results in scattershot improvement attempts. The more difficult and focused question is, "What do we need to do?"

How does Toyota determine the answer to that question?

Briefly put, the continuously repeating routine of Toyota's improvement kata goes like this: (1) in consideration of a vision, direction, or target, and (2) with a firsthand grasp of the current condition, (3) a next target condition on the way to the vision is defined. When we then (4) strive to move step by step toward that target condition, we encounter obstacles that define what we *need* to work on, and from which we learn (Figure P3-1).

Chapters 5 and 6 together comprise a description of the improvement kata. Chapter 5 explains target conditions, and Chapter 6 explains how to go about moving toward a target condition.

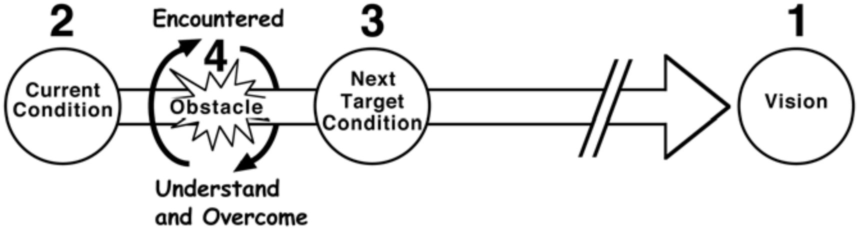


Figure P3-1. The improvement kata in brief

Although the improvement kata describes a routine for continuous improvement, keep in mind that this kata is also part of Toyota's way of managing people every day. The psychology of the improvement kata is universal, and at Toyota everyone is taught to operate along the lines of this systematic approach. You will find it applied to many different situations, not just in manufacturing. The content varies, but the approach is the same.

You will also find the improvement kata is practiced at all levels at Toyota, like fractals. The same kata is utilized on both the operative and strategic levels. The scope of the issues addressed with the improvement kata gets broader the higher in the organization you go, but the approach at all levels is basically the same.

The examples in Part III of this book are at the process level in production operations, where I first learned about the improvement kata. The process level is a good place to first focus our attention and learn, since this, along with product development, is where value is added in a manufacturing company. To distinguish between target conditions at the process level and those at higher levels I will sometimes use the phrase "process target condition."

In production, processes are the individual chain links of a value stream (Figure P3-2), and the word *process* refers to several different kinds of activity, not just material-conversion activities such as stamping, welding, painting, or assembly. Material handling and scheduling, for example, though not value adding (NVA) in themselves, are nonetheless processes in a production value stream. Such necessary NVA processes should be continuously improved too, in a way that moves the value stream toward the 1x1 flow ideal state.

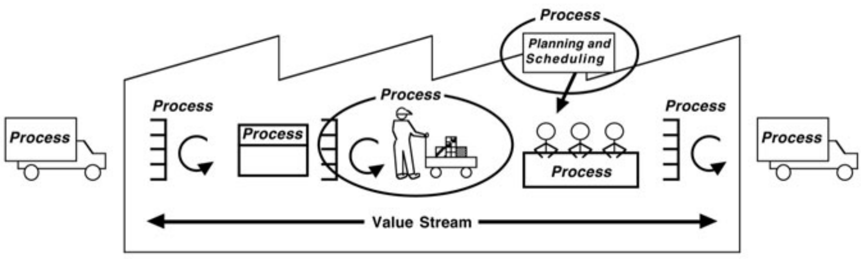


Figure P3-2. Some examples of processes in a manufacturing value stream

Chapter 5

Planning: Establishing a Target Condition

Once you have experienced the role a target condition plays in Toyota's improvement kata, you will find it difficult to work without one. You will also discover how difficult it is to explain what a target condition is and its importance to any manager, engineer, or executive who has not experienced it for themselves. That is a Catch–22 we will deal with in Chapter 9. Over the course of this chapter the target condition idea should become clearer to you, but in the end there is no substitute for learning by doing.

Having a target condition is so important for effective process improvement and management that Toyota will usually not start trying to improve or move forward before a target condition has been defined. This ensures that people's efforts will be focused on actual needs rather than on various ideas and opinions about what we *can* do.

A target condition describes a desired future state. It answers questions like:

- How should this process operate?
- What is the intended normal pattern?
- What situation do we want to have in place at a specific point in time in the future?
- Where do we want to be next?

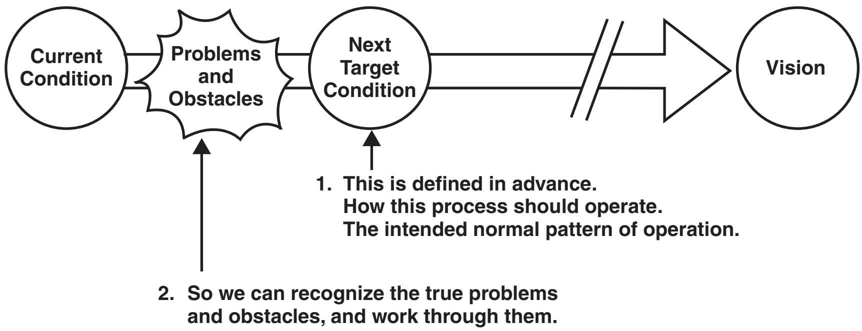


Figure 5-1. The role of a target condition

A target condition works like a pair of eyeglasses that helps you focus and see what you need to do. You will discover problems and obstacles any time you establish a target condition and then try to move toward it (Figure 5-1). This is completely normal, and you have two choices:

1. Avoid the obstacle(s) and move off in a direction other than the vision.
2. Work through the obstacle(s) by understanding and eliminating its causes.

For example, the employees at the sensor cable company in Chapter 3, who pointed out the problems associated with reducing the lot size from one week to one day, were correct, but what they were pointing out were obstacles, not reasons to change direction.

Seeing Lean Techniques in a New Light

A good way to begin our discussion of target conditions, or *target-condition thinking*, is to look at some lean techniques we may think we already understand. For each of the four techniques below I will briefly review the technique and then discuss its less apparent but more important intention from the perspective of target conditions.

- Takt time
- 1x1 production (continuous flow)

- *Heijunka* (leveling production)
- Kanban (pull systems)

After using these techniques as examples to get us started in understanding the idea of a target condition, I will broaden the discussion to describe important characteristics of target conditions overall.

Takt Time

Takt time is the rate of customer demand for the group, or family, of products produced by one process. Takt time is used most often at assembly-type processes that serve external customers.

Takt time is calculated by dividing the effective operating time of a process (for example, per shift or day) by the quantity of items customers require from the process in that time period (Figures 5-2 and 5-3). "Effective operating time" is the available time minus planned downtimes such as lunches, breaks, team meetings, cleanup, and planned maintenance. Note that unplanned downtimes and changeover times are not subtracted at this point, because they are variables you want to reduce.

Say an assembly process has 26,100 seconds effective operating time per shift, and over some period of time the customer requires an average of 450 pieces per shift:

The quotient of 58 seconds means that, based on our available time, on average the customer is currently buying one unit every 58 seconds.[1]

$$\text{takt time} = \frac{\text{your effective operating time per shift}}{\text{quantity customer requires per shift}}$$

Figure 5-2. The takt time calculation

$$\frac{\text{26,100 seconds available time}}{\text{450 pleces required}} = \text{58 seconds takt time}$$

Figure 5-3. Calculating takt time

How is this number used?

It does not automatically mean you should produce at a rate of one piece every 58 seconds. The actual intended cycle time of an assembly process, called *planned cycle time*, is usually less (faster) than the takt time. For example, if there is a changeover time between different part types, we have to cycle the process faster than takt in order to compensate for time lost during changeovers. So in a sense takt time represents an ideal repetitive cycle for an assembly process, a cycle at which we would be producing in sync with the customer demand rate—sell one, make one.

The Intention Behind Takt Time

Takt time becomes interesting in our discussion of target conditions when we use it as something to strive for. Two ways to do this are trying to produce consistently to planned cycle time, and trying to move the planned cycle time closer to the takt time.

Trying to produce consistently to planned cycle time means striving to develop a stable process. Many of us track pieces produced per hour or per shift and therefore are unable to answer the question: "At how many seconds per piece should this process be cycling?" We have an aggregate outcome target, but not a target condition, and we get trapped by such outcome metrics because they prevent us from seeing the actual condition of the process. The result is that an astonishing number of processes come close to making their numbers on average, but their output cycles actually fluctuate excessively from cycle to cycle (Figure 5-4). This condition is not only expensive

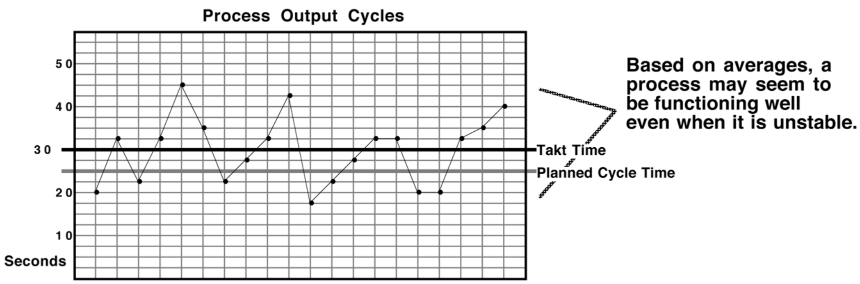


Figure 5-4. An unstable process

(requiring extra resources) and adversely affects quality, but many process improvement efforts will simply not stick when the process fluctuates too much.

When you have identified the degree of fluctuation from cycle to cycle in a process, the next question becomes: "What should the range of fluctuation be?" With that desired condition in mind, you can then observe the process with an eye to identifying, understanding, and eliminating obstacles to that condition.

Once a process cycles relatively consistently within the desired range, you have a basis to possibly go further by striving to reduce the gap between takt time and planned cycle time. For example, we might establish a process target condition that includes a planned cycle only 15 percent less (faster) than takt time. As you try to achieve this condition you will again discover obstacles (changeovers, machine downtime, scrap, absenteeism, etc.) you need to work on (Figure 5-5).

Takt time and planned cycle time are only one part of a target condition for a production process, and I am not suggesting that utilizing takt time in this way is the priority improvement for every situation. The point is, we have missed the target-condition intention behind it. Most factories I have visited know about takt time and even calculate

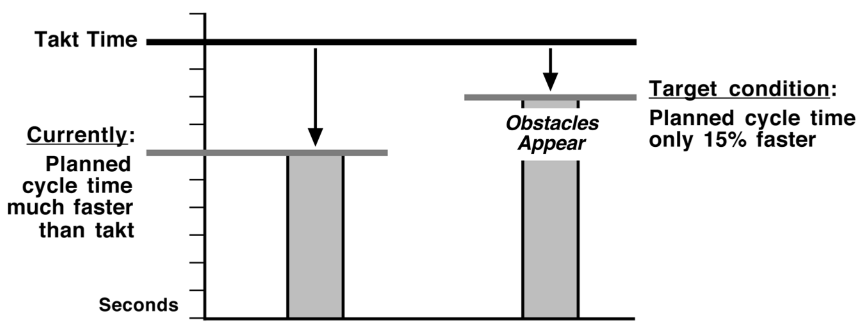


Figure 5-5. Reducing the gap between takt time and planned cycle time

Note: Toyota subtracts changeover time in calculating the planned cycle time of a process, but not unplanned downtime, which is made up with overtime, as necessary, at the end of each shift, rather than by further speeding up the planned cycle time to compensate for it in advance. This is done to keep problems visible. Of course, to take this approach you need a time gap between shifts that can accommodate such overtime.

it, but so far I've found few factories outside of the Toyota group that use takt time as something to strive for in the manner described here. Only then does it become useful.

> I once mentioned to one of Toyota's supplier support specialists that I'd figured out how to see what one needs to work on at a process. My idea was to ask the supervisor what would happen if we were to slow his process cycle down so it was only 15 percent faster than the customer takt time. The obstacles and objections that the supervisor mentioned would be what we needed to work on!
>
> "Well," the specialist replied, "the supervisor will be telling you her opinion. To understand the true obstacles, maybe you should build up a little safety stock and temporarily run the process at the slower cycle time. The obstacles that then actually arise are the true ones you need to work on next."

1x1 Flow

Let us begin by looking at two processes: one without 1x1 flow and one with 1x1 flow. The assembly process depicted below has four workstations, and one operator at each one. There are small quantities of in-process "buffer" inventory between the workstations, as indicated by the inventory triangles (Figure 5-6). The work content each operator has per cycle is shown by the black bars of the operator balance chart.[2]

Is there a 1x1 flow in this process?

No. Work pieces do not move from one processing step directly to the next. They pass through small buffer inventories.

Is the number of operators correct here?

No. The four operators are not fully loaded up to the planned cycle time. There are extra operators in this process.

What happens if one operator experiences a problem?

Not much. The other operators can keep working because of the buffers between the processing steps.

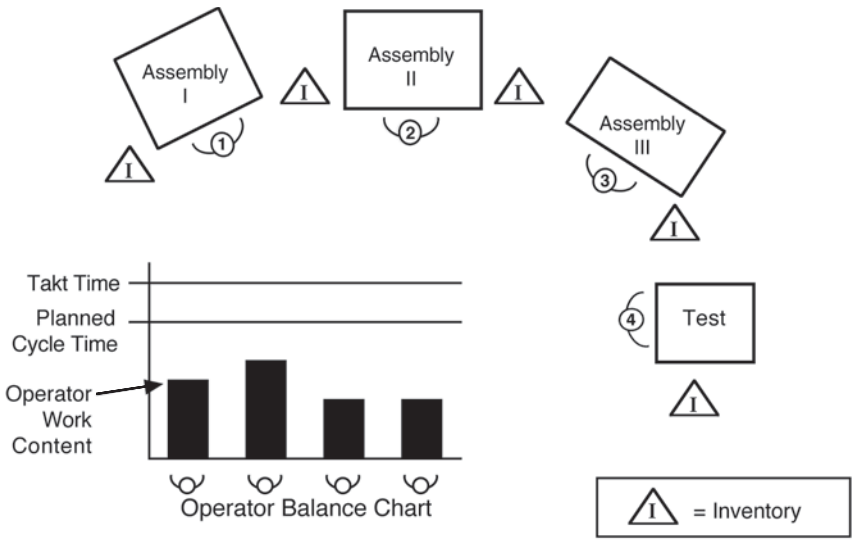


Figure 5-6. Assembly process with four workstations

Is this process flexible?

Many of us would say yes, this process is flexible, because despite small process problems and stoppages, it can still produce the required quantity every day. With extra operators in the line, the process has the "flexibility" to work around problems and still make the target output.

Now here is the same process, but with the workstations moved a little closer together and the work content distributed in a different manner. There are now two operators who move across the workstations, as shown in Figure 5-7, and no buffers between the processing steps. Takt time and planned cycle time are the same as in the previous diagram.

Is there a 1x1 flow in this process?

Yes. Work pieces move directly from one processing step to the next, rather than passing through buffer inventories between the processing steps.

Is the number of operators correct here?

Yes. The two operators are fully loaded up to the planned cycle time. This process is operating with the correct number of operators for the current planned cycle time.

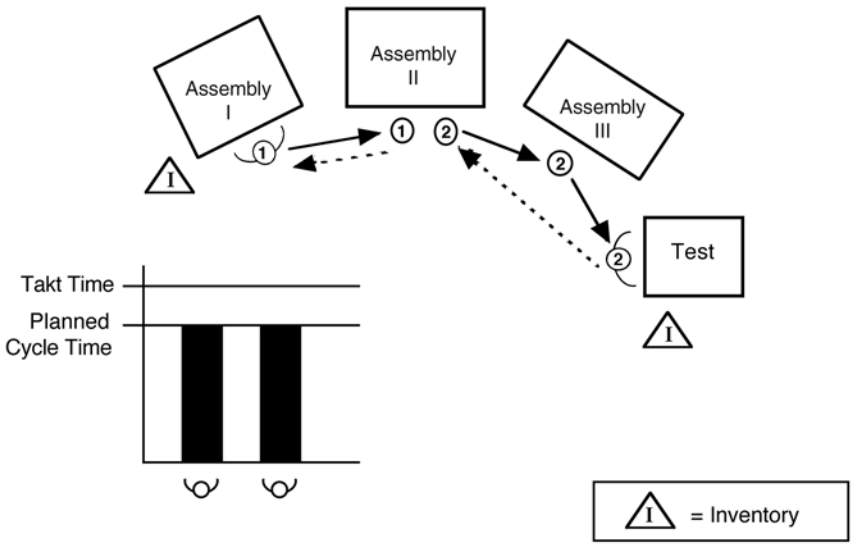


Figure 5-7. Assembly process operated in a different manner

What happens if one operator experiences a problem?

The entire process will come to a stop. The other operator cannot continue working because there are no buffers between the processing steps.

The Intention Behind a 1x1 Flow

Here is a key point: of these two process configurations, the one that looks better depends upon your philosophy. If the prevailing philosophy is to "make production," then the first process with four operators seems preferable. This process can work around problems and still make the target output, which is why you find this kind of arrangement on so many shop floors. On the other hand, at Toyota this sort of flexibility is considered negative, since problems go unresolved and the process gets into a nonimproving, firefighting cycle.

With Toyota's philosophy of surviving by continuously improving, striving for the second configuration, a 1x1 flow, is preferable because both that striving and the 1x1 flow itself reveal obstacles and show us what to focus our attention on. A 1x1 flow is not just part of the ideal state condition, it is also a means for helping to get there.

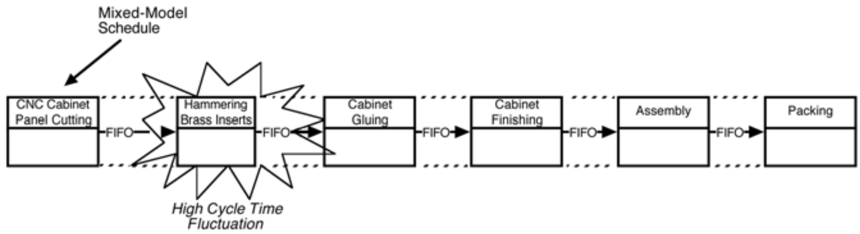


Figure 5-8. The speaker value stream

Figure 5-8 depicts an example from a factory that makes a variety of stereo loudspeakers. The factory has three nearly identical neighboring production value streams, whose individual processes are operated in a connected FIFO fashion (FIFO = first in, first out), as shown in the simplified value stream map. Speakers are built to order, so different size speakers go through the value stream one after another. A small speaker may be followed by a large speaker, and so on.

The leadoff process involves cutting the wood panels for a speaker cabinet, one speaker at a time, on an automatic CNC machine. This process has a consistent cycle time regardless of speaker cabinet size. In the next process (Figure 5-9) an operator manually hammers threaded brass inserts into predrilled holes in the cabinet face panel. The cycle time for this process varies greatly. A large cabinet with 18 brass inserts requires much more operator hammering time than a small cabinet that gets just eight inserts. As a result of this fluctuation, the rest of the downstream processes and operators often receive work at an uneven rate.

To compensate for this fluctuation, the downstream operators naturally walk from one value stream to assist in another, rather than idly waiting. When a set of large loudspeaker cabinet panels takes a long time to get through the brass insert process, operators step over to a neighboring value stream to assist there. Of course, this workaround is not a process improvement, and although it is done with good intention, it introduces even more fluctuation into the value streams.

What is happening here is that there is no process target condition other than “make production” or “keep the operators working,” and as a result, problems push factory operations in different directions on an

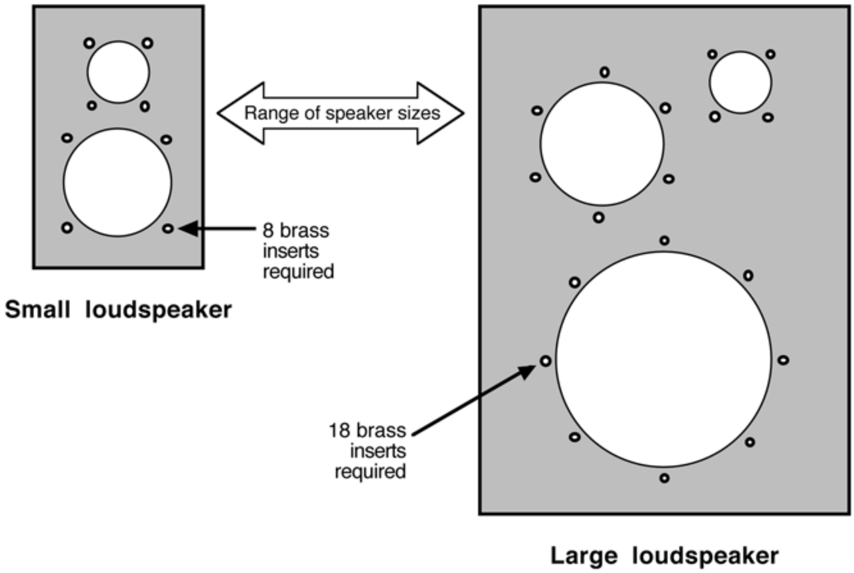


Figure 5-9. The number of brass inserts varies with loudspeaker size

ad hoc basis. What would happen instead if the process target condition included a 1x1 flow with the right number of operators at a consistent cycle time from speaker to speaker? Now there is only one choice: be creative and develop a way to install the brass inserts with the same cycle time no matter what size cabinet is being processed. If this is done resourcefully, at low cost and complexity, it would be a true process improvement, and progress for the company.

As this example illustrates, a target condition is a challenge. We do not know up front how we will achieve a consistent cycle in the brass-insert process, and that is how it should be. If we knew the answer up front, we would only be in the implementation mode, as discussed in Chapter 1.

A similar and common example is assembly cells that have been designed with the intention that the cell operators will help one another when a problem occurs, rather than having a firm target condition. Say Operator A normally performs assembly steps one, two, and three, and Operator B normally performs steps four, five, and six. If Operator A gets stuck at step two, then Operator B will also pick up step three on that cycle. This self-adjusting mechanism is often considered positive, but it is actually a work-around that reveals a "make production" rather than an improvement mind-set.

At Toyota, such self-compensating flexibility in processes would strike fear in the hearts of managers because of all the problems that go unnoticed and unaddressed. Such a mode of operation would not be allowed, and would be viewed as a failure to manage the process. This does not mean, however, that Toyota would just enforce work standards and prohibit the cell operators from assisting one another. The problems the operators are experiencing are real, and we must deal with them in some way. If we're going to strive for a consistent 1x1 flow target condition and expose problems, then we need to have a way of responding to and dealing with those problems. More on this in Chapter 7.

For a long time I misunderstood Toyota's desire to staff processes with the correct number of operators as simply a productivity goal. Higher productivity, higher quality, and lower cost may indeed be the overall objectives. But today I see that Toyota sets target conditions that include a 1x1 flow with the correct number of operators as a means to find out what needs to be worked on step by step to achieve those objectives.

In a processing area at a Nippondenso factory in Japan (part of the Toyota group of companies), aluminum parts go directly from hot die casting to machining in a 1x1 flow—that is, with no buffer in between. This is a great achievement and a true improvement. But the important point for us to learn is not the solution, but how it was developed. Imagine the factory establishing this particular 1x1 flow as a challenging target condition and then working through the obstacles one by one for months, and perhaps even years, until they achieved it.

Heijunka (Leveling Production)

It is a misconception, perhaps stemming from the pull system idea, that Toyota assembles vehicles in the same order in which customers buy them. Someday Toyota would like to have achieved that kind of 1x1 flexibility in its production operations (and also to have smoothened customer demand in the market). Today, however, Toyota is at the point that it strives to run an intentionally levelized schedule in many of its assembly processes. The diagram in Figure 5-10 illustrates, in a simplified fashion, the basic mechanics of *heijunka*, or leveling an assembly process.

The schedule for the assembly process—in this case kanban cards that circulate when customers pull corresponding items from the finished goods inventory—is not sent directly to the assembly process. Instead, the cards are routed through a kind of sorter, depicted in the diagram as a box.

This sorter typically levels two things, the mix and the quantity:

1. *Leveling the mix.* The sorter rearranges customer orders (the kanban cards) into a predefined sequence by item type. The sequence could be selected, for example, to minimize total changeover time or to break up large batches of demand and spread them across the day. In the example, the predefined sequence is A→B→Z→E→D→F→G→H. Two additional slots in the example sequence box are left open for various low-volume items, which are ordered only occasionally.[3]

   The assembly process will try to produce items in this predefined sequence. The intended time to get through the entire sequence depends on the lot size. If, for example, the process can change over often enough in one day to make every type, called "every part every day," then the lot size for any item is one day's worth. In this case the process would try to get through the entire sequence each day, and begin again at the front of the sequence the next day.
2. *Leveling the quantity.* The sorter also defines for each item the maximum quantity of that item that should be produced on one pass through the sequence. This is based on the production lot size and the current customer demand rate for each item. If the lot size is one day, then on any one pass through the sequence the maximum quantity that the process should produce of any item is the average one day demand for that item. In the example, the average one-day quantity of item A = eight boxes, item B = seven boxes, item Z = nine boxes, and so on.

In the diagram, you can see that a customer has purchased eight boxes of Item B, pulling them out of inventory, which puts eight kanban cards for B in circulation. However, according to the leveling pattern (the sorter), the current average demand for item B is seven boxes and the assembly process should only produce a maximum of seven boxes of B before changing to item C. The eighth kanban card for item B should be filled on the next pass through the sequence.

This is where Toyota's leveling efforts get counterintuitive from the process perspective. Imagine the assembly supervisor having eight kanban cards for item B in hand, the assembly process is currently making item B, all is running well, and now we are telling the supervisor that he should only produce seven boxes of item B and go on to item C.

Why do this?

Two already well-known reasons for leveling production in an assembly process are to be able to serve a variety of customers in a short lead time, and to limit the bullwhip effect, aka the "Forrester effect." The latter states that any unevenness in assembly is increasingly amplified as the demand is transmitted to upstream processes. Since upstream processes must hold enough inventory to meet demand spikes, the amount of inventory—that is, lead time—in a value stream will be lower when the downstream assembly process operates in a level

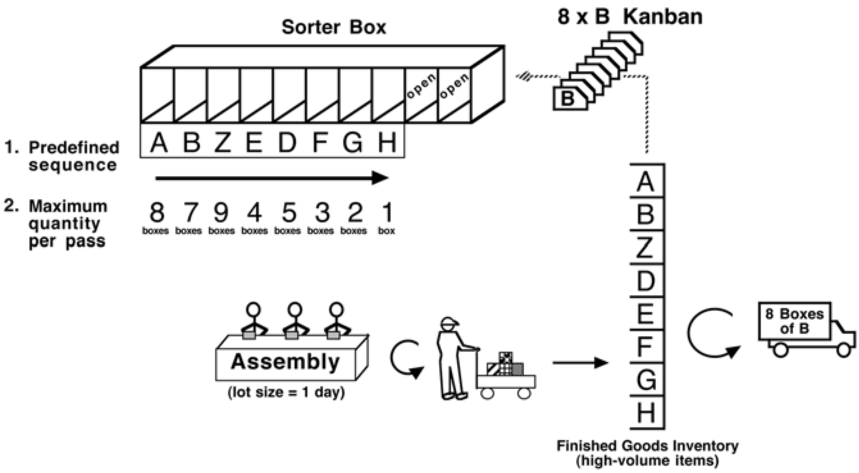


Figure 5-10. Example of a leveling scheme

fashion. For this reason, leveling in assembly is often a prerequisite for introducing kanban to upstream processes, since without it the upstream kanban-system stores ("supermarkets") may have to hold an unacceptably large amount of inventory.

In the example, a customer has ordered eight boxes of item B, which is one box more than his current average daily demand rate. The assumptions are that over a period of time the customer will be buying the average quantity, and if the customer buys one extra box today, he will buy one less box in the near future.[4] If the assembly process were to produce that extra box right away, it would send a demand spike upstream, which will be amplified and generate waste and extra cost the farther upstream it goes.

Smoothing production activities is the prevailing rationale behind leveling, or heijunka, but despite many attempts, I was never able to make heijunka work for very long. And neither can a lot of factories that I visit. I understood how to lay out the leveling sequence and lot sizes just like Toyota, but within a very short time we would have to deviate from the intended sequence because of problems, and we would quickly be back to frequent schedule changes, expediting, and firefighting. It seemed that Toyota must be experiencing fewer problems and practicing more stick-to-the-leveled-schedule discipline. But how?

The answer came to me because of two events.

When I paid my second visit to a factory in southern Germany, the production control manager met me with an angry face and the exclamation, "Please go away with that leveling concept!" On my first visit we had established a leveling sequence for one assembly process, but it did not last long, as usual. "We constantly experience part shortages," the manager told me, "so if we try to stick to a predefined assembly sequence, we would lose valuable production capacity." I had to agree.

The manager went on to show me the scheduling software program they had developed and were using instead. Every day, customer orders, inventory quantities, and parts availability are entered into the program, and from that information the next day's assembly schedule is generated. "See," the manager explained, "this is an assembly schedule that we know we can run." Of course, the assembly schedule was different every day.

The second event came later that same week. I was having dinner with a Toyota person, and at one point in our conversation he said, "Well, so many of the things we do at Toyota we do so there is a pattern." The penny finally dropped for me at that moment.

The Intention Behind Heijunka

What the heijunka leveling sequence provides is a pattern, or in other words, a target condition. It is something to strive for; something that helps us see what we need to work on, and to focus our improvement efforts where they are needed. Here is how it works:

1. Load the leveling device, the sorter, with kanban according to the intended sequence and maximum lot size specification.
2. Ask, "Can we run this way today?"
3. If yes, do so. If no, ask, "What is preventing us?" Pursue one problem, and meanwhile temporarily go off the intended sequence. Strive to get back on the intended sequence as quickly as possible.

At the beginning, the answer to the question, "Can we run this way?" will be no more than yes. But if you do this over and over and tackle the obstacles one by one, the yeses will increase. What you are doing is improving the associated processes step by step in a systematic way—by leading people in a direction.

Now we can see that while the scheduling software at the German factory does ensure a feasible schedule every day, in doing so it works around problems and leaves the factory standing still rather than improving its processes.

"Ah, I see," the German production control manager said when I explained what I had learned. "Toyota is trying to get to the point where the answer to the question, 'Can we run this way?' is always yes."

In fact, that is not the case. At that point we will not yet have reached the ideal state, and there must still be waste in the system. If the answer to the question, "Can we run this leveling pattern?" is almost always yes, then Toyota might, for example, reduce the lot size further in order to get back to a situation where the answer is no occasionally. Otherwise we are likely to stop improving.

One way to assess your efforts in leveling an assembly process is to measure sequence attainment per day. At one factory in the United States we set up a leveling sequence, and after one month the team proudly reported a sequence attainment of 73 percent. But I have never seen sequence attainment get so high so fast. We took a closer look and realized that the team was not measuring sequence attainment, but rather the old outcome metric—schedule attainment. That is, no matter how you did it, if today's shipments went out on time, you have schedule attainment for that day. Sequence attainment is a tighter process metric, which means if the assembly process has to deviate from the intended leveling sequence, then even if shipments are still made on time, you do not have sequence attainment for that day.

The team recalculated and was crestfallen to find that their sequence attainment after one month was actually only 13 percent. But this is not a reason to be sad. It is simply the current situation, nothing more and nothing less. The only thing to think about is, "Okay, what is the first obstacle that we need to tackle?" By thinking this way, the team began to go after the obstacles to achieving a level pattern one at a time, with considerable enthusiasm and on their own initiative. It became a challenge. After one year the sequence attainment for this assembly process was in the 60 percent range and the team continued to work. Each step forward represented a true improvement for the factory, and people were adopting a new way of thinking. Not bad.

After almost 20 years of benchmarking Toyota, we have set up a lot of leveling boxes and schemes at various production processes in factories all over the world. It is revealing, however, to observe what happens when a senior manager visits the factory. The leveling boxes are cleaned up beforehand and put in perfect order. All the right kanban cards are in the proper slots, and someone explains to the guest how the leveling system works. The visitor asks a few probing questions about the mechanics of the leveling scheme, eventually nods in approval, and then everyone moves on to the next stop on the facility tour.

What is happening here is a bit of a charade. Many leveling schemes are not working (which is, in fact, what one would expect, at least at the start) and are not actually in use, because we have misunderstood what they are for. The reality in many cases is that the assembly process still decides what to produce based on a schedule prepared anew every day. What the senior manager or executive who is being shown a leveling scheme should be asking is, "Okay, and what is currently your biggest obstacle to being able to run in this fashion?" There are a lot of heijunka boxes in our factories, but for the most part we are not yet using them as target conditions.

Contrary to what we might have thought, the heijunka pattern itself is not why production processes at Toyota factories run more level and more on time than in our factories. Establishing the heijunka pattern changes little in most cases. The point is how Toyota utilizes the heijunka pattern as a target condition to drive process improvement (Figure 5-11). It is the process improvement—the striving toward the target condition—that makes the difference.

Heijunka is one of the most far-reaching techniques in the Toyota toolkit, and a particularly useful target condition because pursuing it sheds light on so many elements of an assembly process and its associated value stream. Once we understand that heijunka, or leveling, is not a straitjacket, but a target condition, we can better reap the benefits of pursuing it.

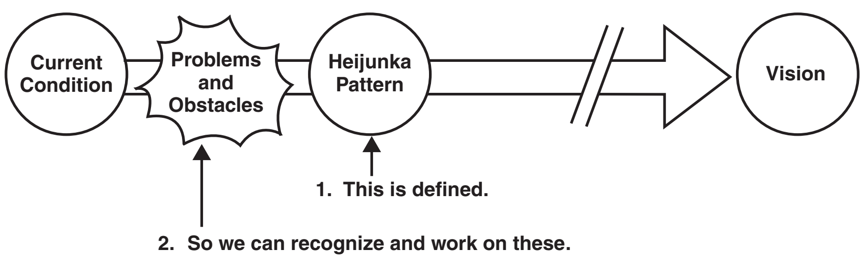


Figure 5-11. The heijunka pattern as a target condition

Pull Systems (Kanban)

The traditional approach for regulating production, which is still in wide use, is that each process in a value stream gets a schedule. These schedules are based on predictions of what the downstream processes will need in the future. Since humans, even with the help of computer software, cannot accurately predict the future, this approach is called a "push system." That is, each process produces what we believe the next process will need and pushes that material on toward the next process.

The alternative approach for regulating production—Toyota's "pull," or kanban, system—is by now also well known, and its basic mechanics are summarized in Figure 5-12.

1. The customer process, here assembly, receives some form of production instruction. Perhaps this is a leveled production instruction as described on the previous pages under *heijunka.*
2. The material handler serving this assembly process regularly goes to the upstream store and withdraws the parts that the assembly process needs in order to fulfill the production instruction.
3. The supplying process then produces to replenish what was withdrawn from its store.

The difference with the pull approach is that production at the supplying process is regulated by the customer process's withdrawals from the supplying process's store, rather than by a schedule. In this manner the supplying process only produces what the customer process has

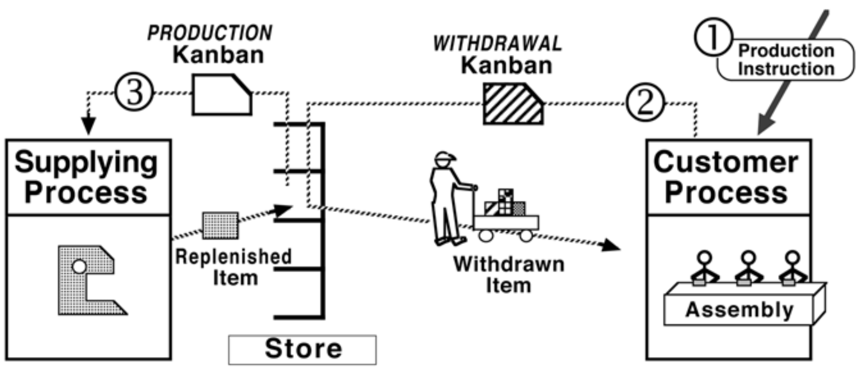


Figure 5-12. Basic kanban, or pull-system, mechanics

actually used, and the two processes become linked in a customer/supplier relationship.

These *mechanics* of the kanban system are what we benchmarked at Toyota, and those mechanics are what we have been trying to implement in our factories for many years. However, as with leveling, our success with pull systems has not been so good. In many cases what begins as an effort to introduce a pull system devolves into just better-organized inventory, and the supplying process continues to produce to some kind of a schedule.

Let us use the depiction in Figure 5-13 of a material flow between two production departments to take a deeper look at Toyota's kanban

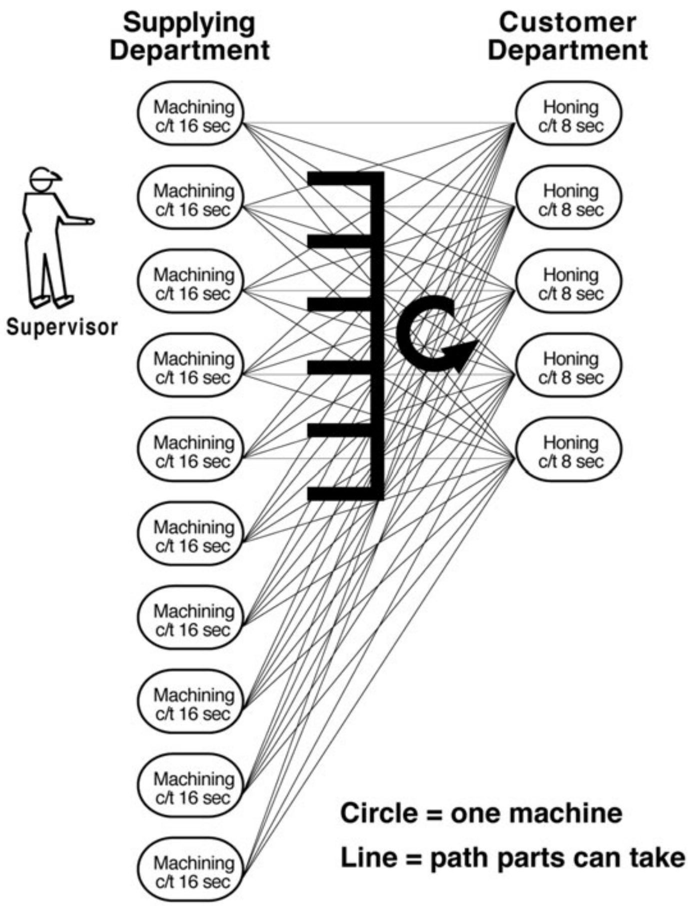


Figure 5-13. Material flow between two production departments

system. Each circle in the diagram represents one machine, and there are multiples of the same machine in each department. Each line in the diagram represents a path that parts may take, and any part number can be run on any machine. As is suggested by all the lines, currently the supplying department runs parts on whatever machine is available at the time. Also shown is the supervisor of the supplying department.

Now assume that we would like to insert a supermarket (kanban system) between these two departments, as shown. Perhaps we are doing this because the departments are located far apart, or maybe the machines in the supplying department have vastly different change-over times than those in the customer department.

To set up this pull system, we will need some information, which includes, among other things, part numbers, quantity, and the following two locations, or "addresses":

1. Where, in the supermarket, the parts associated with a kanban card will be kept
2. On what machine the parts associated with a kanban card should be produced

The act of specifying the second address—of defining what parts should be run on what machine—helps us to see what kanban is really about at Toyota. How do you think the supervisor will respond if we ask him to define what parts run on what machine?

The supervisor is likely to object to someone taking away his flexibility to run the parts on whatever machine is available. Perhaps he will say something like, "If we are going to define what parts will run on what machine, and thereby reduce my ability to run items on any machine, then we better start improving the reliability of these machines." And so kanban has already started working for us. It has shown us an obstacle, and now we need to roll up our sleeves and look into that problem.

I have heard many managers and engineers say, "We tried the kanban system, but it doesn't work here." To this, a Toyota person might well say, "Ah, kanban is actually already working. It has revealed an obstacle to your progress, which you now need to work on and then try again." We gave up at the place where Toyota rolls up its sleeves and gets going.

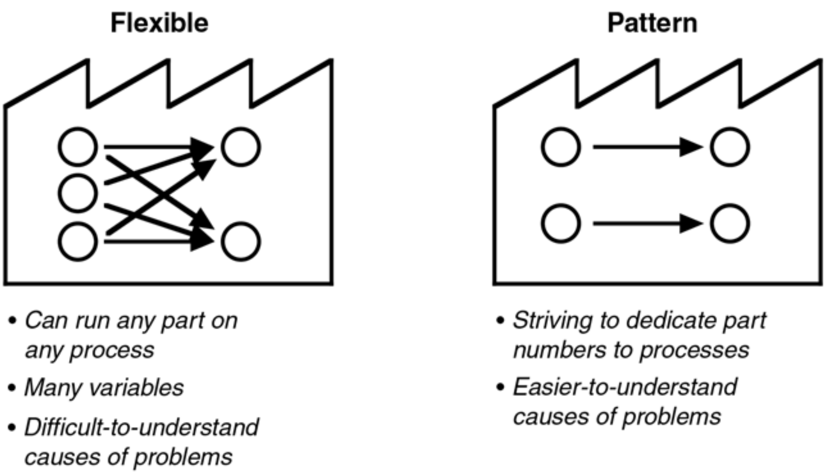


Figure 5-14. Two different approaches

It is the same point again. Whether all those crossing lines—the flexibility to run parts on any available machine—look good or bad to you depends on your purpose (Figure 5-14):

- If your purpose is "make production," then the flexible system looks good because despite the existence of problems you can work around them and still make the numbers.
- If your purpose is "survive by continuously improving," then the flexible system looks bad. In fact, operating this way is not permitted at Toyota.[5] Working around problems by making the same part here and there increases the number of variables and makes understanding the cause of problems considerably more difficult. Flexible systems that autonomously bypass problems are by their nature nonimproving. You may make production today, but will you still beat the competition tomorrow?

The Intention Behind Kanban

The overt, visible purpose of kanban is to provide a way of regulating production between processes that results in producing only what is needed when it is needed. The invisible purpose of kanban is to support process improvement; to provide a target condition by defining a desired systematic relationship between processes, which exposes needs for improvement. In a push system, processes are disconnected from one another and routings are too flexible. There is no target condition to strive for.

> ***. . . according to Ohno, the kanban controlled inventories . . . served as a mechanism to make any problems in the production system highly conspicuous . . .***
>
> —Michael Cusumano, *The Japanese Automobile Industry*

The difference between the visible and invisible purposes of kanban is very much the difference between the *implementation* and *problem solving* orientations I described in Chapter 1. We have been trying to implement the visible purpose of kanban without the invisible problem-solving effort, but one does not work without the other. No matter how carefully you calculate and plan the details of a pull system, when you start up that system it will not work as intended. This is completely normal, and we are setting ourselves an impossible target if we think we can achieve otherwise. What we are actually doing with all our careful preparation for a pull system—as with so many Toyota techniques—is defining a target condition to strive for.

My colleague Joachim Klesius and I once visited a large, 6,000-person factory that had decided to get into lean manufacturing. When we asked the plant's management what their first step would be, the answer was, "We will be introducing the pull system across the entire factory." This not only reveals our flawed thinking about pull systems, it also simply cannot work:

- Anytime you start up a pull system, it will crash and burn within a short time. There will be glowing and charred pieces, so to speak. But it is precisely these charred and glowing pieces that tell you what you need to work on, step by step, in order to make the pull system function as intended. Your second attempt to make that pull system work may then last a bit longer than the first, but it too will soon fail. And again you will learn what you need to work on. This cycle will actually repeat, albeit with longer intervals between the problems, until someday you have a 1x1 flow and no longer need the pull system. Keep in mind, by the way, that the kanban system does not cause problems, it only reveals them.

- Pull systems are rarely the first step in adopting lean manufacturing. Many production processes are currently unstable, and the amount of inventory you would need in order to have a functioning pull system between unstable processes would be unacceptably high. That much inventory would be detrimental anyway, since you would be covering up instability rather than first setting other process target conditions that help you understand and eliminate that instability.

If kanban is a tool for process improvement, then it makes sense to introduce pull systems on a small scale first and expand step by step as we learn more about and improve the relevant processes. If we try to introduce kanban quickly across an entire factory, an unmanageable number of problems will surface. Toyota's organization could not handle that either.

All this means that just introducing a kanban system by itself will improve very little; the system only mirrors and sheds light on the current situation. It does not, for example, by itself reduce inventory. It just organizes and utilizes inventory.

This in turn means it is impossible to implement a pull system. We should think of and use the pull system as a tool to establish target conditions in our effort to keep improving toward the ideal state condition. Each state we achieve is simply the prelude to another.

This last point was made clear by remarks from two Toyota people. The first was: "The purpose of kanban is to eliminate the kanban." While I was still pondering that one, I heard another Toyota person say: "We don't know how you make progress without kanban."

Ah-ha! Kanban is a tool to help us shrink the supermarket (inventory) over time and move progressively closer to 1x1 flow. That is why when a kanban loop at Toyota has been running trouble-free for some time, a manager might remove a kanban card from the loop. In this manner inventory is reduced, in a controlled fashion, and problems can begin surfacing again. Kanban is used to define successive target conditions, on the way to a 1x1 flow (Figure 5-15).

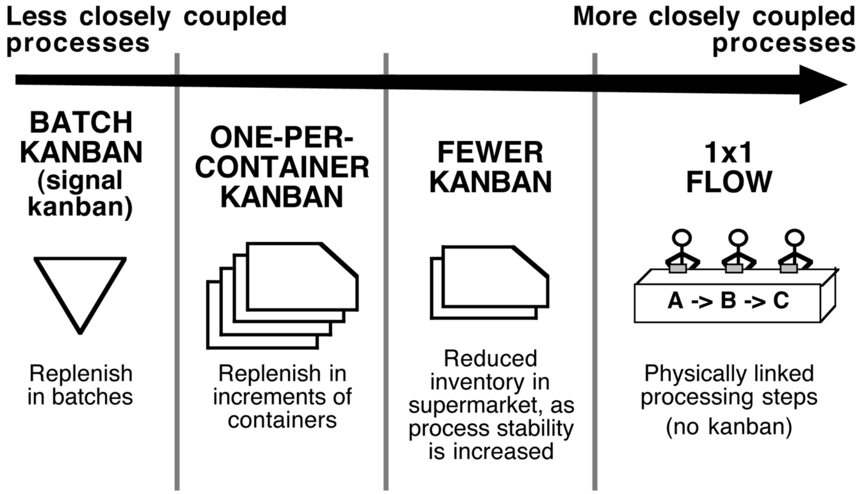


Figure 5-15. Kanban allows us to define challenging target conditions on the way to a 1x1 flow

Now Toyota's Tools Make More Sense

Toyota's tools and techniques become more understandable, and effective, when we view them in the context of striving to achieve a target condition by working step by step through obstacles. These tools and techniques are subordinate to the routine of Toyota's improvement kata, not independent of that routine, and our failure to see this perhaps explains some of the limited success we have had in trying to copy them.

> *Simply introducing kanban cards or andon boards doesn't mean you've implemented the Toyota Production System, for they remain nothing more then mere tools.*
>
> —Teruyuki Minoura, President and CEO 1998–2002,
> Toyota Motor Manufacturing North America

If your primary objective is to "make products," then many of Toyota's techniques—which by their nature limit your ability to work around problems—actually make little sense. To "make products" you want to be able to jump quickly to another machine if one breaks down (kanban makes this more difficult), to change to a different production schedule when there is a parts shortage (heijunka makes this more difficult), and so on.

Toyota uses many of its tools, such as takt time, 1x1 flow, heijunka (leveling), and kanban, as target conditions in order to better see problems and obstacles. There is possibly an even more deep-seated and subtle reason for our missing this intention and for our limited success, so far, in utilizing those tools.

Take the example where we monitor process output per shift or day, and thereby fail to recognize how much a process's individual output cycles fluctuate. Perhaps we tend not to think about individual process cycles because we have learned to manage by outcomes and feel we do not have the time to observe such detail. However, with many processes it only takes 20 minutes or so with a stopwatch to see if the process is fluctuating in or out of control. Despite such ease of analysis, I find very few companies where this is done. Why?

As discussed in Chapter 1, there is a human tendency to desire and even artificially create a sense of certainty. It is conceivable that the point here is not that we do not see the problems in our processes, but rather that we do not *want* to see them because that would undermine the sense of certainty we have about how our factory is working. It would mean that some of our assumptions, some things we have worked for and are attached to, may not be true.

In hindsight it seems somewhat foolish to have thought that simply implementing a kanban system or leveling scheme, for example, would result in significant and continuous improvement. The production processes themselves are still performing with essentially the same attributes as before. (There may be small, onetime improvements due to better organizing or paying closer attention.) We can now see that it is not actually the leveling pattern or kanban routine by itself that generates the improvement, but the step by step pursuit of conditions required to make those techniques work as intended. It is the striving for target conditions via the routine of the improvement kata that characterizes what we have been calling "lean manufacturing."

An interesting side note is that since Toyota is pursuing the one contiguous flow ideal, then any solution, tool, or practice that does not yet equal that ideal can be thought of as a temporary countermeasure. For example, I am sometimes asked for a formula to calculate how many kanban cards one needs in a pull system loop. Viewed in the light of moving toward the ideal state, having exactly the right number of kanban is not important at the start. You just need enough inventory, or kanban, to hold the system together while striving to continually improve processes and reduce the necessary number of kanban over time. To want to know the precisely correct number of kanban at the start suggests that we are thinking in static rather than continuous improvement terms.

Mobilizing Our Improvement Capability

Putting our capability for improvement, resourcefulness, and creativity to use takes managing ourselves in a way that marshals that capability. If people act before having a target condition, they will tend to produce a variety of ideas and opinions about where to go and what to do. At each juncture they often end up shifting direction or simply selecting the path of least resistance.

Success depends on your challenge.

—Shinichi Sasaki, former TME President and CEO

In contrast, a target condition—that is, a target pattern—creates a challenge that depersonalizes a situation (not your idea versus my idea about what we *could* do) and brings people's efforts into alignment. The diagram in Figure 5-16 based on an insightful sketch by my colleague Bernd Mittelhuber, depicts this well.

Of course, it is not enough to simply set a challenging target condition and hope people will find a way to achieve it. Toyota's improvement kata requires more than just that, and in the next chapter we will look at Toyota's routine for how to move toward a target condition.

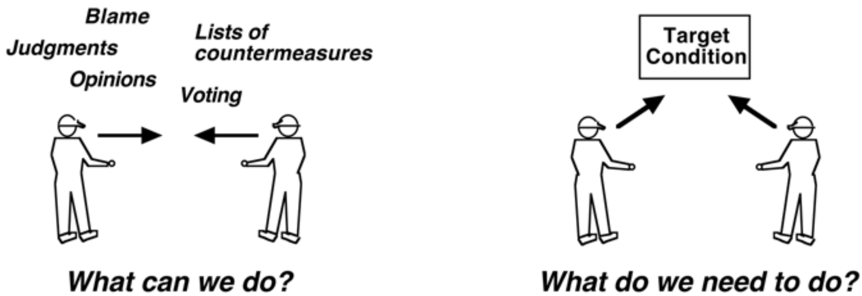


Figure 5-16. What a difference a target condition makes

Target Condition ≠ Target

It is important to recognize the difference between a target and a target condition. A *target* is an outcome, and a *target condition* is a description of a process operating in a way—in a pattern—required to achieve the desired outcome (Figure 5-17). It may take some practice before this distinction becomes instinctively clear to you.

Unfortunately, when they are speaking English, Toyota people from Japan still often use the word *target* when they mean a target condition. This has led to misinterpretations by westerners who are accustomed to

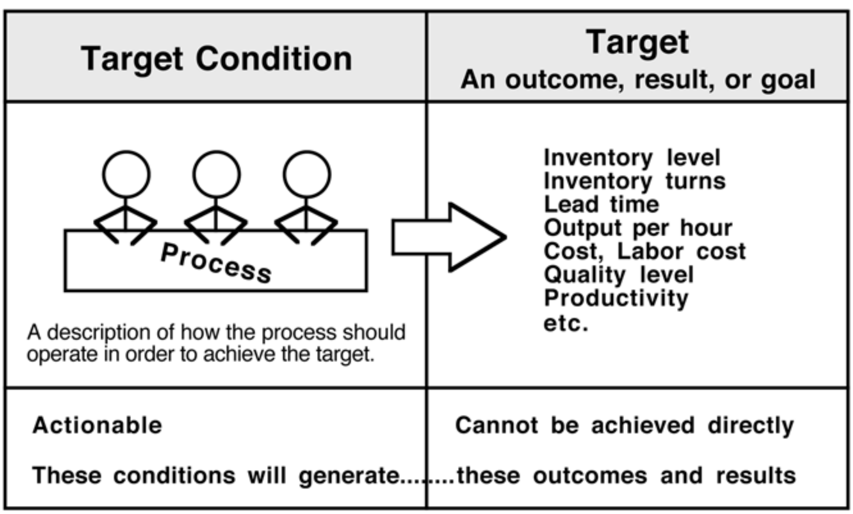


Figure 5-17. Difference between a target condition and a target

managing by setting quantitative outcome targets and focusing less on process details. When a Toyota person asks, "What is the target?" we naturally assume they are referring to a quantitative outcome metric. In actuality, a target condition as defined here is a good description of what Toyota people often mean when they say *target*.

The danger in not being clear about this distinction is that there are many different ways to achieve target outcome numbers, many of which have little to do with actually improving how processes are operating. Having numerical outcome targets is important, but even more important are the means by which we achieve those targets.[6] This is where the improvement kata, including target conditions, comes into play.

For example, a quantitative cost reduction target by itself is not descriptive enough to be actionable by people in the organization. The overall goal may be to improve cost competitiveness, but having that alone will tend to make people simply cut inventory and people.

Inventory-reduction targets are also very common, and when utilized without associated process target conditions, cause a lot of problems. For instance, I have a nice award on my office wall that was given to me for *increasing* inventory. The plant manager at this particular factory had decreed a target of no more than one day of finished goods inventory, and people complied with this by reducing inventory. The result was a tremendous increase in expensive expedited shipping, because one day of inventory was too low for the current lot-size performance of the assembly processes. What I did was point out that the process, not the inventory, should be the focus of our attention.

I once ran into this while touring a Detroit factory with a group that included a mostly Japanese speaking former Toyota executive. At one point on the tour the Toyota person pointed and said, "More inventory here." We chuckled and said, "Oh, your English is a little difficult to understand, but we know Toyota's system and of course you mean less inventory here." To which the former executive exclaimed, "No, no, no! More inventory here! This process is not yet capable of supporting such a low inventory level."

It is easy to say "reduce inventory" and much harder to understand the appropriate and reasonably challenging next target condition for the processes causing that inventory. The inventory around and in a process is an outcome, and there are reasons it is there. We need to dig into the related processes themselves, set the next process target condition, and then tackle the obstacles that arise on the way to achieving that target condition. Then we will learn what it is that requires us to have so much inventory.

The Psychology of Challenge

An interesting question that is still debated is whether Toyota's approach for continuous, incremental improvement would be appropriate for crisis and innovation situations, since in such situations we need to be more aggressive and fast in our efforts to improve. Interestingly, Toyota's improvement kata—including the use of target conditions—resembles how we tend to manage and behave in crisis situations. At such times, it's even more important to focus hard and resourcefully on what you need to do to achieve a challenging condition within the time, budget, and other constraints. You work in rapid cycles, adjust based on what you are learning along the way (see Chapter 6), and concentrate only on what you need to do. To some degree, Toyota is using its improvement kata to make a way of managing and working that we normally reserve for crisis situations an everyday way of working.

For example, the following may be difficult for many of us to accept and adopt, but it is one key to effectively utilizing our improvement capability: only work on what you need to work on. As people make suggestions for what to do, a reasonable question to ask is: "Do we expect this particular action to help us move toward the current target condition at this process?" If the action does not relate to a target condition, then it may be a good idea to stop spending time and resources on that action for now.

You may be thinking that, yes, some have proposed that we should create a crisis, but that's not what I mean. It is easy to create a crisis situation and hope people will then work appropriately. That, by itself, is still too much on the periphery and is not enough. What I mean is teaching people across the organization a behavior routine, a way to proceed, that mirrors good crisis behavior—behavior that aligns people and functions in accordance with the organization's philosophy and vision. Then if you want to create a crisis, okay, because people will have an effective means for reacting to and proceeding through it.

I can illustrate this with an experiment I have conducted many times. At a factory in Germany I took a group of engineers and managers to a shop-floor assembly process, equipped them with pencil, paper, clipboard, and stopwatches, and gave them, in writing, the following assignment:

Please observe this process.

- *Do not conduct interviews, but observe for yourself.*
- *Make a written report on a flip chart answering the following question:*

What do you propose for improvement?

In this case, I had the participants work in pairs and asked each pair to observe a particular segment of the assembly process. One team focused on a particular line segment with one operator and generated the following broad brush list of proposals, which was not very useful. Their list was similar to what most of the other participants produced:

- Reduce setup time
- Clean up and organize the area
- Hunt for waste
- Several suggestions regarding workstation layout
- Apply kanban
- Make a U-shaped line so the operators are not isolated

After this first round of the experiment we went back and carefully analyzed the assembly process and defined a target condition that describes how the process should be operating. (In Appendix 2, I show you a process analysis procedure.) Armed with that process target condition, the teams were given exactly the same assignment and sent to observe the same line segments as before. The results are diagrammed in Figure 5-18.

In this second round of the experiment, the team that focused on the one-operator line segment made completely different and considerably more useful observations. Part of the process target condition was a planned cycle time of 16 seconds, which is to say that the line should be producing a part every 16 seconds. This team watched its line segment and timed for several successive cycles how often a part moved past a specific point. The cycle times they observed fluctuated widely; this line segment was not producing a part every 16 seconds. Then the team asked itself the following question:

"What is preventing us from having a part come by this point every 16 seconds?"

In trying to answer that question, the team observed that the operator had to periodically walk away from the line to get new trays of parts. Of course, this had an impact on the stability of the line cycle time. Can you see the entirely different nature of this team's observations and thoughts before and after a process target condition was defined?

Another example, this one from several years ago. At a factory in Michigan that makes file cabinets, product development was once

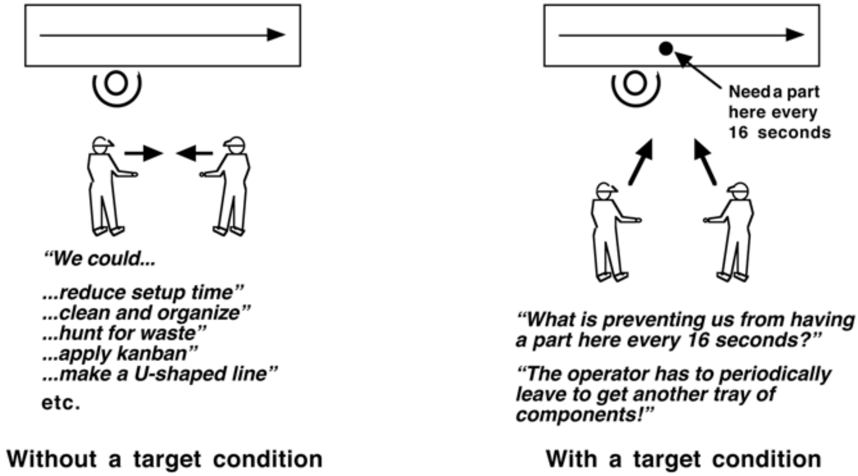


Figure 5-18. What a difference a target condition makes

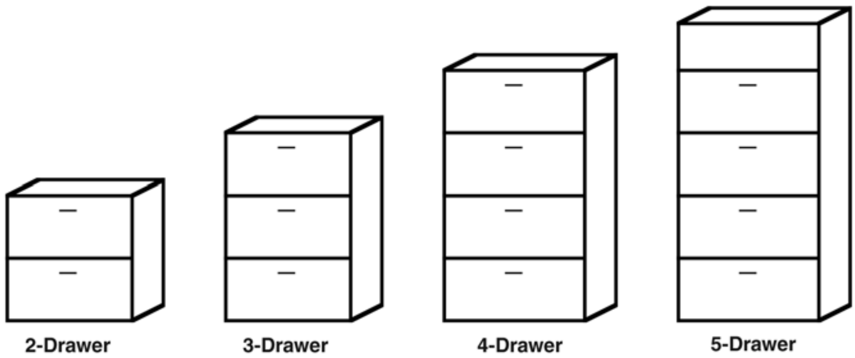


Figure 5-19. The four file cabinet sizes

designing a new line of cabinets that were to be produced in an already existing file cabinet value stream. The production value stream would have to be reconfigured somewhat, and some capacity added, to accommodate the new products.

File cabinets produced in this value stream came in four sizes, as shown in Figure 5-19.

The three main processes for producing all files cabinets were: bending and welding sheet steel→painting→assembly. The current production flow is shown in Figure 5-20.

There was one bending/welding process, consisting of expensive, automated equipment. This process was, in particular, where additional capacity would be needed. Then there were two chain-conveyor paint lines, which already had sufficient capacity to handle the additional new cabinets. These paint lines and their conveyor systems were so monumental that no change was currently feasible here, which is

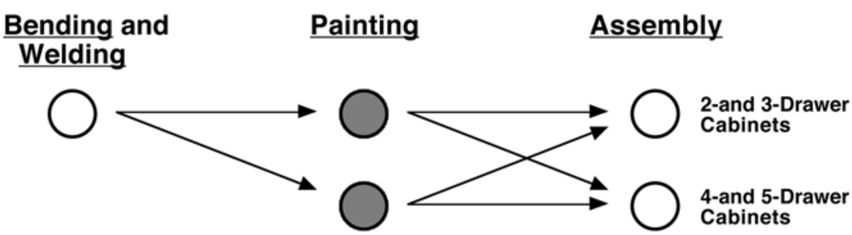


Figure 5-20. Current production flow

why they are shaded in the diagram. Finally, there were two assembly lines: one for the smaller two- and three-drawer file cabinets, and one for the larger four- and five-drawer cabinets. The arrows show the material flow.

The debate among the engineers about how to configure the value stream had gone on for several weeks. There was still no consensus, but it was time to specify and order any necessary equipment. At this point I was asked to spend a week working with the team.

The production design team consisted of about 10 people, and during my first day with them our discussion went in circles. Someone would make a suggestion, such as having two bending/welding lines so there could be more dedicated flows, as in Figure 5-21.

The group would go in this direction for a while, until someone made the counterargument that a second bending/welding line would be too expensive for the budget.

Then we would switch to another suggestion, such as altering the two assembly lines so each one could assemble all four cabinet sizes (Figure 5-22). This would be an advantage because sometimes big

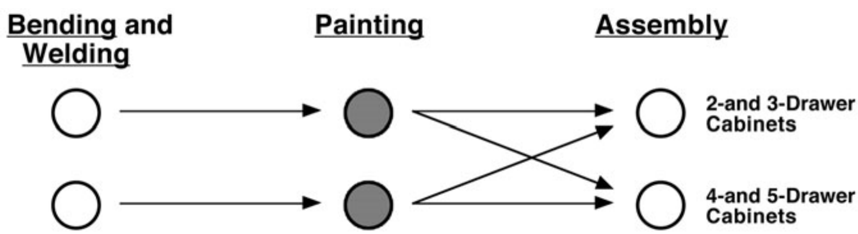


Figure 5-21. First proposal: adding a second bend/weld line

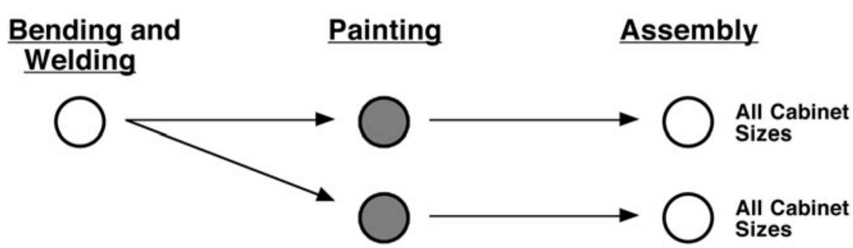


Figure 5-22. Another proposal: universal assembly lines

customers order predominantly the small or large sizes, which overwhelms one assembly line while the other sits idle.

This idea was pursued until someone pointed out that the operator work content and time was much higher for the larger cabinets than for the smaller cabinets, and that the line for small cabinets was elevated for better assembly ergonomics. Small and large cabinets were just too different from one another, and so again we switched to other ideas.

By the end of the first day we were no further along, and I sat in my hotel room thinking about what to do. As mentioned in Chapter 2, many group discussions and efforts go exactly this way. Whoever is most persuasive sets the tone and direction, until someone else has a convincing counterargument. In the worst cases, a voting technique is employed to give an artificial feeling that we know what to do.

Tuesday morning we began with a different approach. I asked the group what would be better, two bending/welding lines or one? Clearly two would be better because of the dedicated flows, but hands quickly went up in objection. "We have already been over that option several times. A second weld/bend line is too expensive." We left the idea on the board, however. Then I asked if it would be better if both assembly lines could process all sizes of cabinets? "Yes, of course, but we've been over that option several times too. The small and large sizes are too different from one another."

Then we drew the value stream shown in Figure 5-23 on the board.

Probably because I was an outsider, the group went along with me as I said, "Okay, no more discussion about where we want to go. This is our direction. Now let's instead put all our effort and discussion into how we can achieve this condition within the allotted budget and time." We had established a basic target condition.

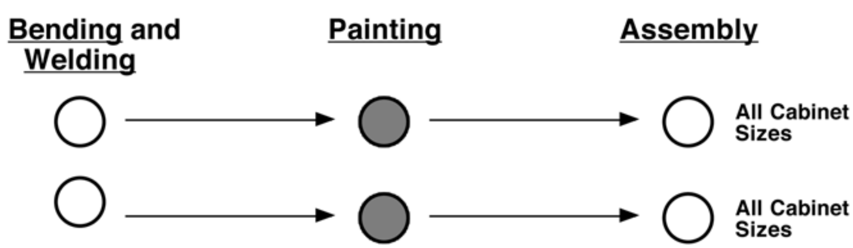


Figure 5-23. A target condition

The change in the group dynamic was striking. We put one team of engineers on the challenge of adding a second bend/weld process within the budget constraints, and it was remarkable how creative and resourceful they were. Here are just a few excerpts from that team's work during the rest of the week:

"We looked at an old unused weld line we have in the back of the plant, and there are several parts of that equipment we can reuse."

"Maybe we can do without the expensive automatic transfer of steel sheets between the steps of the bending process."

"We could utilize simple switches to enable or disable individual spot-weld tips depending on the size of the cabinet being welded, without using a numeric controller."

The team assigned to modifying the two assembly lines so that each could handle all sizes was equally creative:

"How can we make a simple lift system for good ergonomics when a short cabinet comes down the line?"

"If we have a high-assembly-content cabinet coming down the line, let's leave one pitch empty behind it so the operators have twice as long to work on it as on a small cabinet."

Not all ideas could be implemented, and in the end the target condition we set for ourselves was not fully achieved this time, but the progress made was a great example of human capabilities … if we channel them.

Target Condition = Challenge

A target condition normally includes stretch aspects that go beyond current process capability. We want to get there, but we cannot yet see how.

An interesting perspective on this was provided by Toshio Horikiri, the CEO of Toyota Engineering Company Ltd., in a presentation he made at the Production Systems conference in Munich on May 27, 2008. Mr. Horikiri linked the degree of learning, fulfillment, and motivation to the level of challenge posed by a target condition. He proposed that both "easy" target conditions—ones that from the start we can already see how to achieve—and "impossible" target conditions, do not provide us with much sense of motivation and fulfillment (Figure 5-24). It is when a target condition lies between these extremes and is achieved that an adrenalinelike feeling of breakthrough and accomplishment is

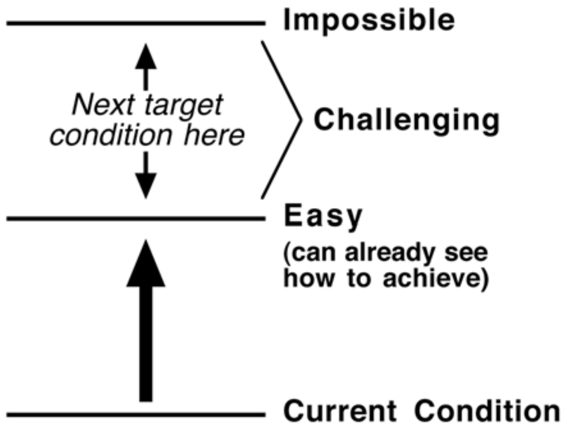


Figure 5-24. Target conditions as a challenging but achievable stretch

generated ("We did it!"), which increases motivation and the desire to take on more challenges.

A simple example: An operator at a metal-forming press fabricates small parts, which will later be painted and then used at an assembly process. The press operator carefully stacks the formed parts into their storage container, which makes it easier for the paint line operators to pick them up one by one. But the stacking takes too much time, and a suggestion is made to reduce time by having the press operator just drop these unsensitive metal parts into the container.

Right from the start we can see how to achieve this suggestion, which means there is probably no real improvement in the work system. It is a reshuffling of already existing ways of doing things or a shift of waste from one area to another. On the other hand, if we set a process target condition that includes stacking the parts in *x* time—*x* being less than the current time—we cannot immediately see how to achieve that. And when we do achieve it, then a true, creative process improvement will have been made.

As you define a target condition, you should not yet know exactly how you will achieve it. This is normal, for otherwise you would only be in the implementation mode. Having to say, "I don't know," often means that you are on the right path. If you want true process improvement, there often needs to be some stretch.

With this in mind, do not utilize a cost/benefit analysis (ROI) to determine what a target condition should be. That is the error the Detroit automakers' managerial system led them to make whenever they tried to decide whether to also produce smaller cars. First define the next target condition—a condition that you need or want—then work to achieve it within budget and other constraints. A target condition must be achieved within budget, of course, but it normally takes resourcefulness to achieve the challenge within that constraint.

Target Condition Thinking

Over time and with practice you should be able to develop a kind of target condition thinking, and Toyota's concept of "standardized work" helps illustrate what I mean. A "standard" is a description of how a process should operate. It is the prespecified, intended, normal pattern (Figure 5-25).

On the other hand, at Toyota "standardized work" means, in essence, that a process is actually operating as specified by the standard (Figure 5-26). Standardized work is a condition, and you can look at a process and ask, "Does that condition exist or not?"

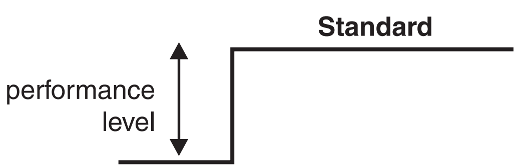


Figure 5-25. A "standard" = how a process should operate

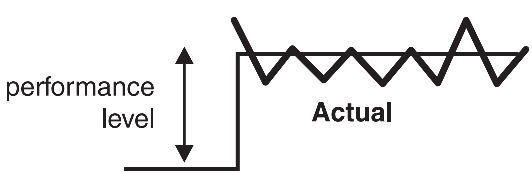


Figure 5-26. "Standardized work" = the process is actually operating as the standard specifies

At a manufacturing conference in Chicago a group of Toyota's production system specialists presented how they improved a production process at a supplier's facility. During the presentation someone in the audience asked the speakers, "Do you post standards in the production line?" In typical Toyota fashion (the student should learn for himself), the answer was brief, "Yes, we do." I noticed a lot of audience members writing this down, and envisioned them posting standards over the heads of their operators in the false assumption that this would improve something. So I asked a follow-up question: "Who are the work standards for?"

"Well," came the reply, "when it was time to post the standards in the line"—Toyota does not always post them in the line—"we had to decide whether to post them facing the operators or facing the aisle." The speaker paused for effect and said, "We posted them facing the aisle."

The aisle side is where the team leader is, and it is the team leader who primarily uses the work standard.

The key question is not, "Have we posted work standards?" but rather, "How do we achieve standardized work?" The primary intention of specifying standards at Toyota is not, by doing so, to establish discipline, accountability, or control the workers, but rather to have a reference point; to make plan-versus-actual comparison possible, in this case by the team leader, so that gaps between what is expected and what is actually occurring become apparent. In this way we can see what the true problems are and where improvement is needed.

When we are asked if we have standardized work, we usually point to a posted work standard as evidence and say, "Yes, see, we have standardized work." When a Toyota person is asked the same question, they also look for the standard, but then observe the process and compare it to the standard. If there is a difference between the two—and there often is, even at Toyota—they say, "Not yet." Toyota is achieving quality excellence, for example, not because a process is done the same way each time, *but because Toyota is striving to achieve the target condition of*

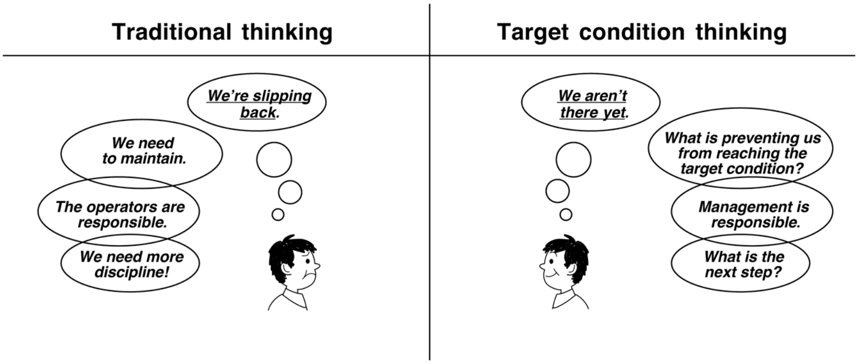


Figure 5-27. How do we think when an abnormality occurs?

the process being done the same way each time. The difference is subtle, but it's important if you want to understand and successfully emulate Toyota's success.

How we are thinking about standards is also revealed when there is an abnormality in a process (Figure 5-27). In the traditional way of looking at it, we think the abnormality means we are slipping back; that we need a corrective action and more discipline. My impression is that the Toyota way of thinking turns this around: the abnormality means we have not yet reached the target condition, and we need to keep applying the improvement kata.

So what is the difference between a standard and a target condition? In many cases not much. A good way to think of many standards is as something you are striving to achieve, and the main issue is: "How we will get this process to actually operate as described in the standard?" That is the hard work. (More on that in Chapter 6.)

So the following standards, and many others in a factory, can be seen as target conditions (Figure 5-28).

Consider what could be achieved if everyone in your company learned to think of such standards not as straitjackets, but as target conditions to strive for.

WORK STANDARDS	Takt time, correct number of operators, 1x1 flow, operator work elements, times for the elements, etc.
LEVELING	Planned sequence, maximum lot size, finished goods quantity, etc.
PULL SYSTEM	Location in supermarket, inventory quantity, kanban cards, etc.
LOGISTICS	Delivery route, stops, timing, etc.

Figure 5-28. These standards, and many others, can be viewed as target conditions

Establishing a Target Condition

A target condition is developed out of a detailed grasp of the current condition, through direct observation and analysis, coupled with an understanding of the direction, vision, target, or need. You need to adequately understand the current condition in order to define an appropriate target condition.

The first few target conditions for a production process often spring only from analyzing the process itself. Then, as you progress there, target conditions should be aligned with or based on departmental targets. However, even if departmental targets are met, you should continue defining further process target conditions, because if a process is not striving toward a challenge, it will tend to slip back. Ultimately you should be able to walk through the factory and at each process ask, "What challenge"—target condition—"are you currently trying to reach here?"

One of the most common early target conditions with production processes, as well as again and again after process changes are introduced, is to establish stability as measured by fluctuation in workstation cycles and output cycles. Most production processes I see are not operating in a stable condition yet.

With regard to production processes, Appendix 2, "Process Analysis," shows you a typical procedure for analyzing the current condition of a production process and obtaining the facts and data you need in order to establish an initial target condition for it.

What Information Is in a Target Condition?

A target condition describes a state that we want to have reached at some future point in time, on the way toward a longer-term vision. There are both technical and nontechnical target conditions, since the improvement kata has application in a wide range of situations. At least some aspects of any target condition should be measurable, however, so that you can tell if you have reached it or not.

A factor in establishing a target condition is to draw a line between the target condition and, in contrast, countermeasures or steps. A target condition should describe a desired condition, but not how you will get there (Figure 5-29). Trying to put countermeasures into a target condition is a common error that I still catch myself making. We like to jump to spelling out solutions, but this actually impedes the operation of the improvement kata. Engineers, for example, often try to define target conditions in terms of solutions because that is what they are accustomed to working with. You have to learn to hold yourself back and first define where you want to go before you get started on moving there. Countermeasures, then, are what you develop as

NOT A TARGET CONDITION	***WHY***
"Implement a pull (kanban) system" **"Introduce milk-run material delivery"**	**Too vague. A kanban or material-delivery system can in fact be a target condition, but you need to describe in detail how they should operate.**
"Apply 5S" (housekeeping and workplace organization) **"Install a barcode system"** **"Change the layout"**	**These are countermeasures, which should not be confused with a target condition. First describe how the process should operate. Countermeasures are then developed *as needed* on the way to that target conditon.**
"Minimize" "Reduce" **"Improve" "Increase"**	**Words like *minimize, reduce, improve, increase* do not belong in a target condition, because a target condition describes a desired condition *at a point in time*.**
"Two fewer operators" **"Reduce inventory by two days"**	**Reduced headcount or reduced inventory are outcomes, not target conditions. They do not describe how the process should operate in order to be able to meet customer demand with less people or less inventory.**

Figure 5-29. Examples of what is not a target condition

needed once the target condition has been defined and you are striving to move toward it, as described in Chapter 6.

As a guideline, the target condition for a manufacturing process tends to include the following four categories of information. The first three items are used in conducting process improvement day to day through the improvement kata. The fourth item is only used periodically to gauge the outcome of process improvement efforts.

1. *Process steps, sequence and times*
   What is the sequence of steps required to complete one cycle through the entire process, how long should each step take, and who is to perform that step?
2. *Process characteristics*
   Other attributes of the process:
   - Number of operators
   - Number of shifts
   - Where 1x1 flow is planned
   - Where buffers are to be held (including intended buffer quantity)
   - Lot size/EPEI/changeover times
   - Heijunka/leveling pattern
3. *Process metrics*
   These are metrics for checking the condition of the process in short time increments, in real time while the process is running, to help guide improvement efforts, such as:
   - Actual cycle time for each step, per piece, or per standard quantity of pieces (such as one tray or packing layer)
   - Amount of fluctuation from cycle to cycle
4. *Outcome metrics*
   - Number of pieces produced per (time increment)
   - Productivity
   - Quality indicators
   - Cost
   - Fluctuation in output from shift to shift

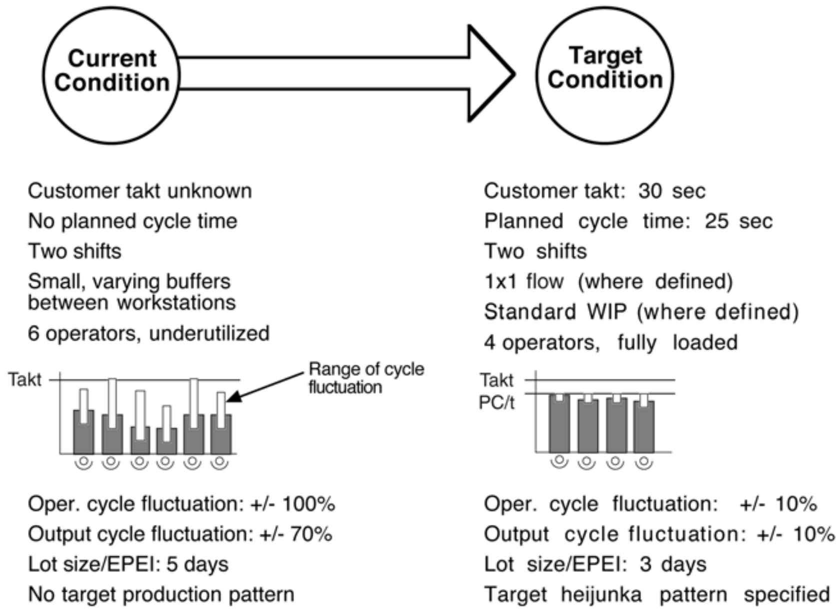


Figure 5-30. An example process target condition

In Figure 5-30 we see typical elements of a target condition for an assembly process. However, this target condition is only for illustration purposes and has too many elements that are a leap in comparison with the current condition. Moving from this current condition to this target condition would probably involve a series of target conditions.

As you can see, manufacturing target conditions tend to define how a process should be operating to a greater level of detail than is currently the practice in many factories. As we will see in the next chapter, this detail creates a condition in which learning can take place.

How Much Detail?

At production processes it is sometimes possible to define in advance a detailed target condition, because the current condition can be observed, analyzed, and understood in detail. In most situations, however, it is not possible to fully see and understand the true current condition right away, and thus not possible to define a target condition in full detail up front. For example, think of setting out to develop or market a new product. That is, you do not yet know the details about what customers want.

Caution is advised, for in situations where you cannot yet adequately discern the current condition—which is most situations—you may mistakenly feel confident that you do understand. We often don't realize what we do not know, and can thus easily slip into specifying target condition details that are actually based on conjecture.

So there is a dilemma. Before you get started, you need a target condition—but you cannot yet see a lot of target condition detail. The way out of this predicament is to begin with a well thought out but basic, less detailed definition of the target condition and add in detail as you move forward and learn about the obstacles (Figure 5-31). When in doubt, err on the side of being a little vague in defining the target condition, and narrow down and add detail as you move into the unclear territory. This leaves options open rather than specifying them too early based on suppositions.

For example, at production processes, I have had good results by making close observations, establishing an initial target condition that defines the following, and then getting going (as described in Chapter 6):

- Takt time and planned cycle time

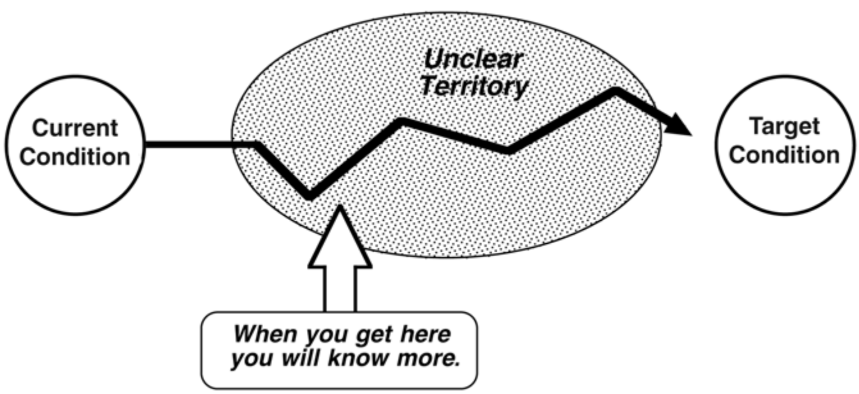


Figure 5-31. Once under way, more details become clear

- Where in the process a 1x1 flow should be achieved next (based on experienced judgment)
- The number of operators and shifts
- Process stability

For detailed guidance on defining these points see Appendix 2.

After a day or two of working at the process, we have usually learned enough about it to have defined a more detailed target condition. This frequently involves simply attempting to run the process as described in the initial target condition, as an experiment; that is, in order to see what happens. You might call this "further analyzing the current condition by getting going toward the target condition." The approach of defining initial target conditions vaguely is in widespread use at Toyota, where it is considered bad form to specify in detail something you do not yet understand.

Note that I do not mean changing the target condition as you move forward, but rather, fleshing it out. Once a target condition is established—even an initially vague one—its content and achieve-by date are not easily changed. This is done so we take time to analyze the current condition, think carefully about the target condition, and, when the going gets tough, work hard to understand and with creativity get through the obstacles that arise step by step. This way we achieve a new level of system performance, rather than simply altering the target condition.

Do or do not. There is no try.

—Yoda

Defining some terminology can be helpful here. I call an initial, vague target condition a *challenge*, and once sufficient detail has been added, I call it a *target condition*. For example, the manager of an assembly area *challenges* his team to bring the machining of some die cast components, which is currently done in batches elsewhere in the plant, into the 1x1 flow at an assembly process. As the team studies the situation, develops a concept and perhaps even experimentally moves the machining center into the assembly process, it defines the further details that characterize a *target condition*.

How Challenging Should a Target Condition Be?

Knowing what is an appropriate target condition—a challenging but achievable stretch—depends on the situation and is an acquired skill. As you gain experience in using the improvement kata, you will become a better judge of what a particular process and people are ready for next. As I began to learn about and work with the improvement kata, I thought we would tend to make our target conditions too easy. In fact, we tended to make them too difficult. Why? Because when we do not yet understand a situation firsthand and in detail, we overlook or underestimate obstacles and thus may develop target conditions that are too ambitious for the allotted time frame.

For example, sometimes we jump to introducing a FIFO (first in, first out) flow through long stretches of a value stream, with the idea that this must be good because it is much closer to the ideal state. However, if a FIFO flow has a beginning-to-end lead time of greater than, say, one day, it may generate chaos as process conditions change while parts work their way through the long FIFO route. What seemed like more flow becomes disorder, because we tried to leap ahead too quickly rather than proceeding step by step.

Another example is cutting too much inventory too soon. Here again, the thought is that cutting inventory is good because less inventory is closer to the ideal state. However, too little too quickly and you generate chaos. The trick is understanding your processes, holding the right amount of inventory in a controlled fashion, and improving those processes step by step toward appropriate target conditions, so that, as an *outcome*, inventory can be reduced.

What Is the Time Horizon for a Target Condition?

One year. Some target conditions may reach a year into the future, which corresponds with the planning or policy deployment cycle in many companies. Or the target condition may be part of a long project. However, in my experience a one-year time frame is too long for a target condition to be effective, and such long-term target conditions should be supplemented with interim target conditions. You do not have to go too far at once, and it can be faster overall and more effective to take small steps rapidly than to try to make big leaps.

Three-month maximum. I suggest that the maximum time horizon for a production-process target condition should be three months. If a target condition extends further than three months into the future, you should probably look at breaking it into more manageable increments.

One to four weeks. I have had good success guiding people to establishing target conditions that are no more than one to four weeks out, particularly when they're first learning the improvement kata. This way a person can get more practice with full cycles of the improvement kata.

The further into the future your target condition reaches, the more you will need to lay out a plan for how you intend to move from the current to the target condition. For a one-week target condition, you can get going without much of a how-to-get-there plan. For a target condition three months out, you will need a well-thought-out plan.

What Is the First Step?

As you define a target condition, it will not be clear how to achieve it, but the next step should be clear. This is like "priming the pump."

In this regard, a Toyota person once told me to always focus on the biggest problem. However, when I tried to do this, I noticed a negative effect: we got lost in hunting for and discussing what was the biggest problem. When we tried gathering data and making Pareto charts, it took a lot of time and the biggest problem category in the Pareto chart was usually "other," which put us back to debating opinions. By the time we decided what the biggest problem was, the situation at the process had changed. This effect is called *Pareto paralysis,* and I encourage you to avoid it. Pareto paralysis delays your progress as people try to determine the "right" first step to take.

Fortunately, such delay is easy to avoid, because it matters more that you take a step than what that first step is. Do not worry so much up front about finding the biggest obstacle before you begin. Take a step, and when you've done that, the learning process begins and you will see further. If you are moving ahead in fast cycles, I assure you that you will soon find the current biggest problem. It will be waiting for you.

A related point in many instances is that the next step may *not* involve a countermeasure, but rather, getting more information through observation, data, or experiment. As mentioned before, if you are unsure, then go and see; again and again if necessary. This has helped me hundreds of times. Most steps you take will not be countermeasures, but efforts to see deeper and get more facts and data.

In setting the next step, a tactic I use is to ask the same person who conducted the process analysis and established the target condition to also define the next step. This eliminates those "what is the first step" discussions. The idea is to get started and then see further (Figure 5-32).

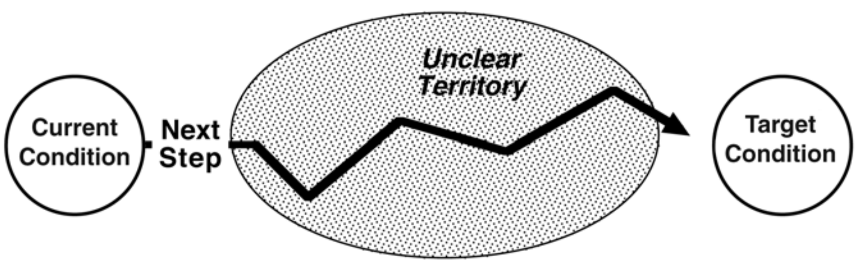


Figure 5-32. Once you take a step the learning process begins

Ready to Go

Once you have defined the target condition and the next step, you are ready to begin working toward the target condition. How Toyota does that is the other part of the improvement kata, and the subject of the next chapter.

> Something you can do immediately is an analysis to assess the stability of a production process, which can be a good way to begin grasping the current condition. Do this at an assembly or "pacemaker" process if possible. (A definition of "pacemaker process" is in Appendix 1.) With a stopwatch, pencil and paper in hand, position yourself at the last workstation in the line, select a point, and time how often a part comes by that point. Do this for 20 to 40 successive cycles, recording the time for each cycle.
>
> Then move upstream and time the cycle of each operator's work in a similar fashion. Select a single reference point in the operator's complete work cycle, which is where you will start and stop your stopwatch. Let the stopwatch run until the operator returns to that point in the cycle, regardless of how long it takes. Do this 20 to 40 times for each operator. Graph the findings for each position you timed as shown in the example in Figure 5-33. Do not calculate or use averages, which conceal process instability.
>
> Now observe the process and ask yourself, "What is preventing the process and the operators from being able to work with a stable cycle?" Process stability alone is not a complete target condition, but making these observations can be a good start to understanding the current condition and developing a target condition.

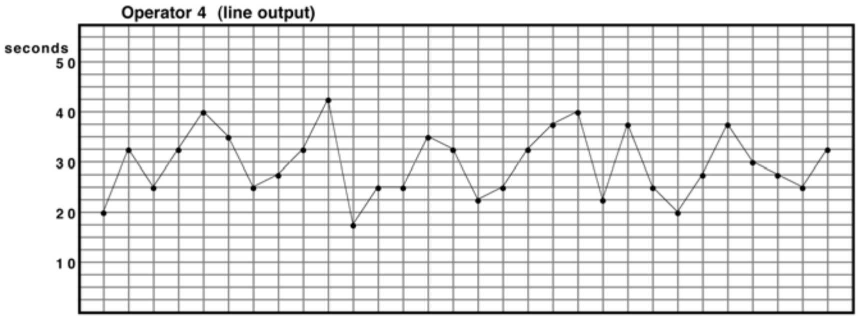


Figure 5-33. Checking process stability by timing successive cycles

Typical initial target conditions for manufacturing processes. Although there are many exceptions, the target conditions for a production process often initially progress through something like the following general categories. Within each of these categories there is typically a series of target conditions.

1. *Strive to develop a stable 1x1 flow to planned cycle time with the correct number of operators.* If the process is not stable or is unable to meet customer quality or quantity requirements, address this before trying to make other improvements. Until you are able to establish a stable process, do not worry too much about linking the process target condition to company targets.
2. *Strive for a level mix with small lot sizes.*
3. *Strive to connect the processes in the value stream to one another via kanban.*
4. *Further improvement.* This includes alignment with department targets, striving for a vision, reducing the gap between planned cycle time and takt time, moving the batch size closer to one piece, and so on.

Notes

1. Customer demand rates change over time, of course. Toyota recalculates takt time every 30 days, and reviews it every 10 days.
2. Assembly process diagrams from: Mike Rother and Rick Harris, *Creating Continuous Flow* (Cambridge, Massachusetts: Lean Enterprise Institute, 2001). Also at www.lean.org.
3. An item is produced only if a customer has ordered it. In practice this is either when an item has been pulled from finished goods inventory or, in the case of low-volume items, ordered. If a customer has not caused the card for a particular item to circulate and there are no "overflow" cards from earlier, then the assembly process would skip over that item's slot as it moves through the sequence.
4. To be able to assemble in a level fashion and still satisfy spikes in customer orders, there must be enough finished goods inventory to cover those spikes. In some cases customer spikes are so large that the required amount of finished-goods inventory would be unacceptably high. In this situation you can start pursuing the obstacle with the question, "Why does this customer's demand spike so much?"
5. In an emergency that threatens to affect an external customer, Toyota will temporarily run parts on a different machine than is specified, but not without initiating problem-solving activity that seeks to understand the problem.
6. H. Thomas Johnson makes this point when he refers to "managing by means," or MBM, a concept that he contrasts with "managing by results," or MBR. Western management thinkers tend to view the means as subordinate to results, whereas he argues for the view that the means, or process, is nothing less than results-in-the-making. See his *Profit Beyond Measure: Extraordinary Results through Attention to Work and People* (New York: The Free Press, 2000), especially chapter 2.

Chapter 6

Problem Solving and Adapting: Moving Toward a Target Condition

Setting a target condition is only one portion of the improvement kata. Working through obstacles that you then encounter as you try to move toward that target condition is the other, and where a lot of learning takes place (Figure 6-1). It is easier to set a target condition than it is to achieve it.

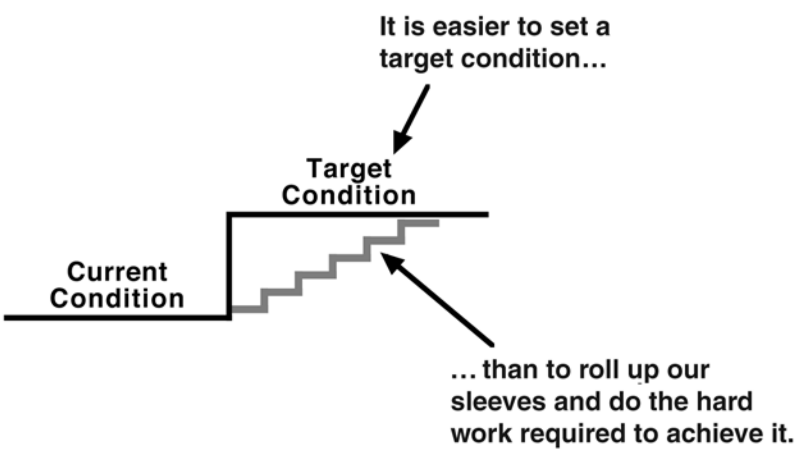


Figure 6-1. It takes work and learning to achieve a target condition

Number One: Assume the Path Is Unclear

To begin with we may need to calibrate our expectation of how the effort to achieve a target condition will proceed. We often make a plan and then intend to execute that plan, but reality is neither linear nor predictable enough for this to be an effective way to reach our target conditions. Consider, for example, landing an airplane:

Current condition:	Cruising at 30,000 feet altitude
Target condition:	Landed on the runway
Plan:	Intended flight path/trajectory down to the runway

How would you feel as a passenger if the pilot were to define the intended flight path for landing the aircraft, and after that allowed no further adjustments to it? On the way from 30,000 feet to the runway on the ground there are going to be many unpredictable wind gusts, and the aircraft will not actually reach the runway.

It is no different with target conditions—there too no one can aim so well up front as to always hit them. Regardless of how well you have planned, you will do well to assume that the way to the target condition is not completely clear; it is a gray zone (Figure 6-2).

Any step taken engenders reactions from the system, but because of interconnectedness, we do not know exactly what those reactions will be. What we are actually doing with a plan is making a prediction, and despite our best efforts, planning errors cannot be avoided. Unforeseen

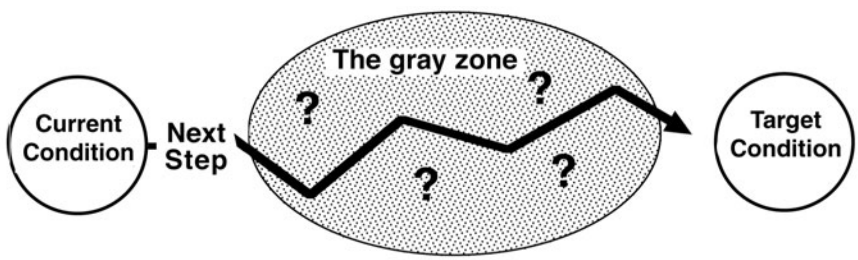


Figure 6-2. The way to a target condition is a gray zone

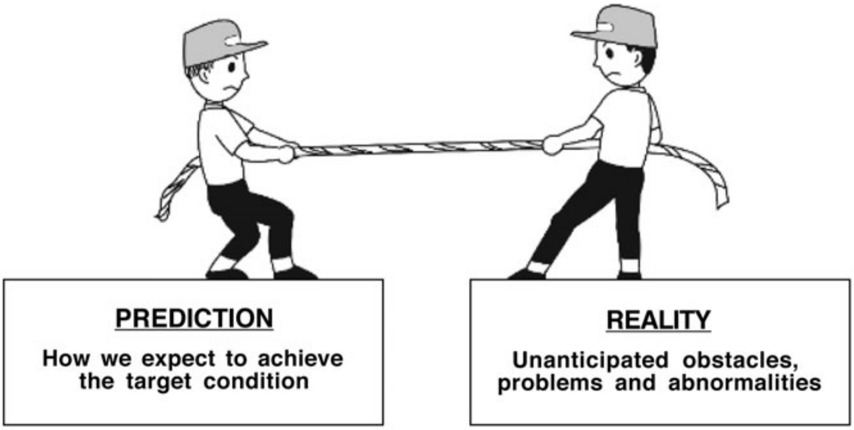


Figure 6-3. The tug-of-war between prediction and reality

problems, abnormalities, false assumptions, and obstacles will appear as we work to move forward (Figure 6-3). This is completely normal, and we should pay attention to them and make adjustments based on what we are learning along the way.

It is very difficult to make predictions, particularly about the future.

—Attributed to Niels Bohr

How Toyota Works Through the Gray Zone

Once a target condition has been established and a plan is made, Toyota then places considerable emphasis on the next step. There is no need for lengthy theoretical discussion or opinions about further activities or steps beyond that, because whenever one step is taken, the situation may be changed as a result.

What was learned in the last step may have an influence on the next step. For this reason, Toyota works toward a target condition in small, rapid steps, with learning and adjustments occurring along the way. This is the equivalent of placing one foot in front of the other, one step at a time, and always adjusting to the present situation as necessary, and is quite different than working through the predefined steps of a plan or action-item list.

By adjusting based on what is learned along the way, Toyota makes progress like a scientist. With each empirical insight, a scientist adjusts his or her course to take advantage of what has been learned.

> *I learn each day what I need to know to do tomorrow's work.*
>
> —Historian Arnold Toynbee explaining his high productivity

> *Nothing within a horizon can have a fixed definition. Every step taken alters the horizon, changes the field of vision, causing us to see what had been thus far circumscribed as something quite different.*
>
> —James P. Carse, Professor Emeritus, New York University

> *Plans are things that change.*
>
> —Fujio Cho, Chairman of Toyota Motor Corporation

Another way to visualize Toyota's way of working toward a target condition is the staircase diagram in Figure 6-4.

Here is a useful analogy: You have defined where you want to go (the target condition), but the way ahead between here and there is

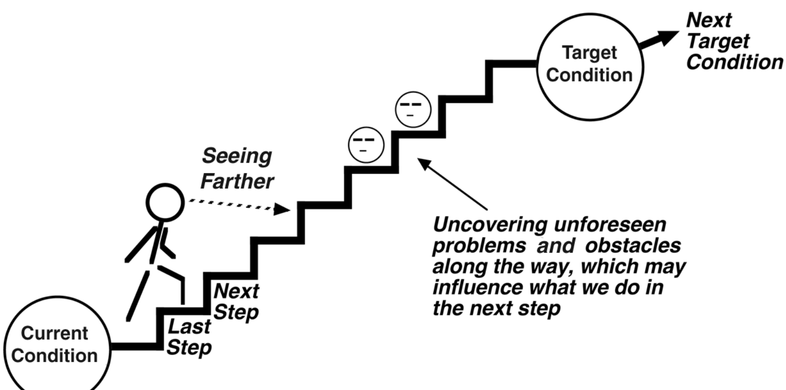


Figure 6-4. How Toyota works toward a target condition

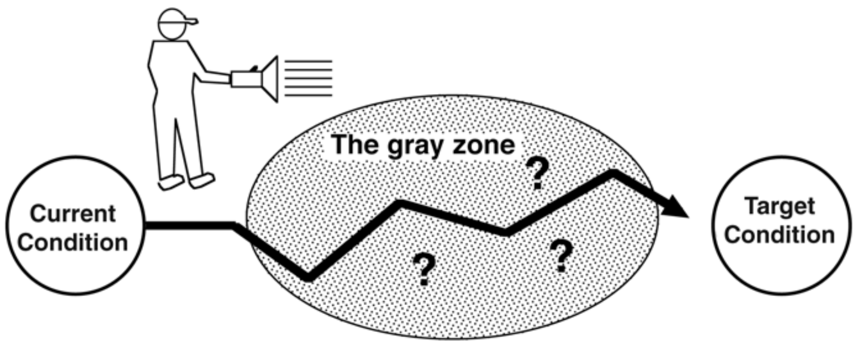


Figure 6-5. The flashlight analogy

dark. You are holding a flashlight, but it only shines so far into the darkness (Figure 6-5). To see further and spot obstacles hidden in the dark you have to take a step forward.

This Is PDCA (Plan-Do-Check-Act)

Because the target condition lies beyond the reach of our flashlight, the path to attaining it cannot be predicted with exactness. Thus, we have to find that path by experimenting. This is the scientific method, which consists of formulating hypotheses and then testing them with information obtained from direct observation.

The procedure or steps of experimentation are summarized by the well-known Plan-Do-Check-Act cycle (Figure 6-6):

1. *Plan*. Define what you expect to do and to happen. This is the hypothesis or prediction.
2. *Do* (or Try Out). Test the hypothesis, that is, try to run the process according to plan. This is often done on a small scale initially. Observe closely.
3. *Check* (or Study). Compare the actual outcome with the expected outcome.
4. *Act* (What's next?). Standardize and stabilize what works, or begin the PDCA cycle again.

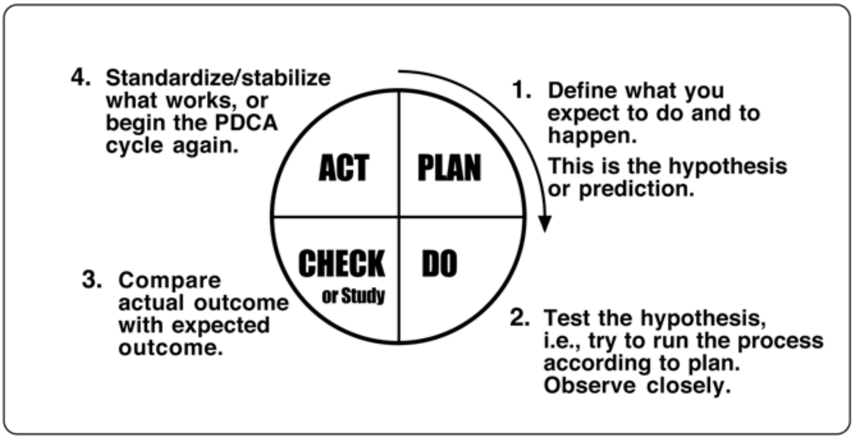


Figure 6-6. The PDCA cycle

The steps of PDCA constitute a scientific process of acquiring knowledge. PDCA provides us with a practical means of attaining a challenging target condition—it is the means for getting through the gray zone and characterizes a learning organization. But only if we use it the right way.

PDCA may have been introduced to the Japanese in the 1950s via lecture courses given in Japan by W. Edwards Deming, although at that time the terminology "PDCA" was probably not in use and Deming likely presented a version of the Shewhart cycle. This was Walter A. Shewhart's circular, or spiraling, depiction of "steps in a dynamic scientific process of acquiring knowledge," which appears in Shewhart's 1939 book *Statistical Method from the Viewpoint of Quality Control*. It is also certainly conceivable that persons in Japan already knew of Shewhart's writing and were familiar with the scientific method.

During his 1950–52 lecture activities in Japan, Deming provided training for engineers and statisticians, and gave lectures for top management. It is interesting to note that he presented the statistical techniques as *management* tools and emphasized overall managerial concepts like the Shewhart cycle. In other words, Deming's lectures

Figure 6-7. Toyota added Go and See to the center of the PDCA cycle

were delivered in the context of a way of thinking and managing, rather than simply as techniques. This is clearly also the fashion in which Toyota adopted PDCA, where it became a strategic approach and a basis for improvement and leadership at all levels.

Toyota later added the words "Go and See" to the middle of the PDCA wheel (Figure 6-7), because Toyota considers this to be important in all steps of PDCA. No matter how confident you are, you must always go and see the actual condition for yourself in order to understand it, because the situation is always changing as you move forward. If you were to only go and see one time, for example, you would become progressively more removed and distant from the real situation. The words spoken most often at Toyota may well be, "Show me."

I came across a good example of the necessity to go and see at an assembly process in Portugal. The engineers in the office said they knew from their calculation of machine capacities which workstation was the bottleneck in the assembly process. However, in the actual process on the shop floor, an entirely different workstation was the current bottleneck. The current real situation and problems in the process were not the same as those the engineers in the office were assuming based on their data. This is the reason that Toyota makes a distinction between facts and data, and prefers facts over data wherever possible.

Key Points About PDCA

We have known about PDCA for a long time, but we are not yet using it as does Toyota in its improvement kata. To start developing a deeper understanding, consider the following four points from the arena of scientific experimentation, discovery, and learning.

1. *Adaptive and evolutionary systems by their nature involve experimentation.* Since the way ahead is a gray zone, if we want progress, we must experiment. A target condition, for example, is only a setup for conducting experiments.

Hypotheses are nets: only he who casts will catch.

—Novalis (Friedrich Freiherr von Hardenberg) as quoted in *The Logic of Scientific Discovery,* by Karl Popper

2. *Hypotheses can only be tested by experiment, not by intellectual discussion, opinion, or human judgment.* This is what I call testing over talking. When you hear statements like, "I believe . . ." or "I think . . ." it is often better to stop talking and take a step; to test as quickly as possible, usually on a small scale first, so you can see further based on facts and data.

Neither the voice of authority, nor the weight of reason and argument are as significant as experiments for thence comes quiet to the mind.

—Roger Bacon

The moment of experience is the firmest reality.

—Composer Benjamin Boretz

3. *In order for an experiment to be scientific it must be possible that the hypothesis will be refuted.* This point is a little more difficult to understand, but it gets us closer to what Toyota is doing. The visiting executive who reviews an assembly process's heijunka leveling scheme and simply nods his approval, as mentioned in the last chapter, rather than asking, "What is currently preventing you from operating this way?" has not yet internalized this point. Neither has the plant manager who is planning to implement pull systems across his entire 6,000-person facility.

If we assume that at any time anything we have planned may not work as intended, that is, that it is always possible that the hypothesis will be false, then we keep our eyes and minds open to what we learn along the way. Conversely, if we think everything can work as planned, then we too easily turn a blind eye to reality—like the engineers at that factory in Portugal who thought they knew what the process bottleneck was—and tend to simply push for greater discipline in carrying out the plan. If we expect that everything can work as planned, then the effect is that we stop improving and adapting.

The game of science is, in principle, without end. He who decides one day that scientific statements do not call for any further test, and that they can be regarded as finally verified, retires from the game.

—Karl Popper

4. *When a hypothesis is refuted this is in particular when we can gain new insight and further develop our capability.* Envision a scientist in a laboratory wearing a white lab coat and heavy gloves, who is slowly pouring two beakers of clear liquid together under a fume hood. The scientist has predicted that combining these liquids will produce a blue liquid. If the resulting mixture does, in fact, turn blue, then the experiment was a confirmation of something the scientist already believed, and the scientist has not really learned anything new. If a hypothesis is not refuted, then the experiment was only a confirmation of already held ideas. Or, put in other terms, if there is no problem, there is not much improvement.

   On the other hand, if the mixture of the two liquids explodes and the scientist is covered in ash and holding two cracked beakers—an unexpected outcome—then he is about to learn something new.

Problems cannot be solved at the same level of awareness that created them.

—Attributed to Albert Einstein

There is no such thing as a failed experiment, only experiments with unexpected outcomes.

—R. Buckminster Fuller

We learn from failures because they reveal boundaries in our system's current capability and horizons in our minds. This is why Toyota states that "problems are jewels." They show us the way forward to a target condition. You need to miss the target periodically (again, preferably on a small scale that does not affect the customer) in order to see the appropriate next step. This is a fascinating point when you consider how much we as leaders, managers, and executives try to make it look like everything is going right and as planned. The main reason for conducting an experiment is not to test if something will work, but to learn what will *not* work as expected, and thus what we need to do to keep moving forward.

Learning to Ask a Different Question

As we take steps toward a target condition, one comment you sometimes hear is: "Let's see if this will work." This, erroneously, seems like a reasonable question since we are talking about experimenting. However, the question actually represents a circular argument, which is why it is utilized when people have a vested interest in preserving a status quo. Simply put, very few things work the first time, or even the second time.

I used to struggle with this question. We would go to the factory floor to try something and several people would fold their arms and say, "Well, let's see if this works." Of course within a short time the test failed. They were right, I was wrong, and the experiment would be over. At the first signs of problems, difficulties, or a failed step, it was announced that, "Well, that doesn't work," and often, "Let's go back to the way we did it before because we know that works."

Eventually it dawned on me how to deal with this question. Now, when arms fold up and people say, "Let's see if this will work," I say, "I can save you the time. We already know it probably won't work.

Despite our best efforts to plan this, we know that within a short time there will be 'charred and glowing pieces' lying around. We just don't know in advance when, where, or why it will fail."

At this point the arms usually start unfolding a bit, and I follow with, "What we should be asking ourselves is not will it work, but, let's see what we need to do to make this work." After calibrating a group's thinking in this way, I am always impressed with the smart ideas people from all levels come up with to get us closer to the target condition.

Toyota Is More Interested in What Does Not Go as Planned

The thinking reflected in Figure 6-8 is fundamental in Toyota's improvement kata.

Interpretation: if there is no problem, or it is made to seem that way, then our company would, in a sense, be standing still. Toyota's management wants the organization to see and utilize small problems in order to exploit the potential they reveal, and before they affect the external customer. If people are threatened by problems, then they will either hide them or conduct poor problem solving by quickly jumping to countermeasures without sufficiently analyzing and understanding the situation. The idea is to not stigmatize failures, but to learn from them.

To function in this way, the improvement kata should be depersonalized and have a positive, challenging, no-blame feeling. Toward that end, at Toyota an abnormality or problem is generally not thought of or judged good or bad, but as an occurrence that may teach us something about our work system. This can be somewhat difficult for westerners to understand: something can be a problem—a situation that we do not want—without it necessarily being considered good or bad. This is akin to the difference between "understanding" and "accepting." Trying to understand a situation and why it happens does

"NO PROBLEM" = A PROBLEM

Figure 6-8. A different way of thinking not mean you have to accept it. Making this distinction will make you a better problem solver. Interestingly, if you look up *problem* in the dictionary, you won't find the negative connotation that we often assign to this word.

For example, at a Toyota assembly plant, I once was told that the normal number of andon pulls is typically around 1,000 per shift. Each pull is an operator calling for assistance from their team leader because the operator is experiencing a problem; a cross-threaded bolt here, a task that took a little too long there. Naturally, the number of andon pulls per shift varies, and I once heard of it dropping to only 700 pulls/shift. When I ask non-Toyota managers what they would do in this situation, I often get the answer, "We would celebrate the improvement."

According to my source, what actually happened when the number of andon pulls dropped from 1,000 to 700 per shift is that the Toyota plant's president called an all-employee meeting and said, "The drop in andon pulls can only mean two things. One is that we are having problems but you are not calling for help. I want to remind you of your responsibility to pull the andon cord for every problem. The other possibility is that we are actually experiencing fewer problems. But there is still waste in our system and we are staffed to handle 1,000 pulls per shift. So I am asking group leaders to monitor the situation and reduce inventory buffers where necessary so we can get back to 1,000 andon pulls per shift." This is quite a contrast to our current thinking.

Another example came while touring a U.S. vehicle assembly plant in Detroit with a group that included a former Toyota executive. At one point the plant manager remarked proudly, "Our vehicle assembly line runs three shifts and it never stops." To which the former Toyota executive responded with some irony, "Ah, they must all be perfect."

We hear about Toyota's successes, but not about its thousands of small failures that occur daily, which provide a basis for that success. Toyota makes hay of problems every day, where we tend to hide little problems until they grow into big and complex problems that are then difficult to dissect. Toyota has mastered the art of recognizing problems as they occur, analyzing their nature, and using what it learns to adapt and keep moving toward its target conditions.

Focusing On Process Instead of Blame

Toyota's approach of not stigmatizing failures, but instead utilizing them to learn and move forward, has an interesting effect: thinking that an abnormality or problem is neither positive nor negative shifts the focus from the individual to the process. We know that the vast majority of problems are caused by the system within which people work, rather then by the individuals themselves. Therefore, Toyota maintains a no-blame focus on the process, instead of on the people around the problem. The assumptions are:

- People are doing their best.
- A problem is a *system* problem, and if we were the other person, the same problem would still have occurred.
- There is a reason for everything, and we can work together to understand the reason for a problem.

An elegant question in this respect that I learned from Toyota is, "What is preventing the operators from working according to the standard?" I encourage you to utilize this question as you strive for a target condition, because it alters your thinking and changes where you look when a problem occurs.

Be hard on the process, but soft on the operators.

—Toyota

Note, however, that while an abnormality, problem, or unexpected result itself is not necessarily viewed as good or bad, and the system is considered the problem, Toyota does put intense and critical attention on both the problem and how people deal with it. Do we give it sufficient urgency and attention? Do we follow the improvement kata? We should not confuse Toyota's "no blame" culture with an easygoing "no worries" culture, as depicted in Figure 6-9.

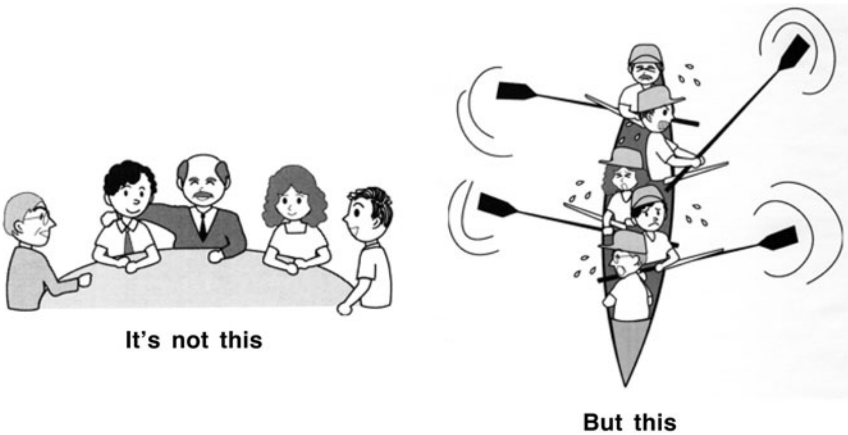


Figure 6-9. Not stigmatizing failures does not mean "no worries"

How Toyota Utilizes PDCA

So what actually constitutes one PDCA cycle in real life? Consider the process of getting up and going to work, and a target condition of being in the car and ready to drive to work 60 minutes after waking up. Here is one possible PDCA cycle for that process:

Plan: Be in the car 60 minutes after waking up. (Target condition)
Do: Wake up and go through the morning routine, get into car.
Check: Once in the car check how long it took.
Act: (Next step to be determined)

As we sit in the car and check how long the morning routine took, we find that the total time was 64 minutes, or four minutes over the target condition. What have we learned about the process from this experiment? As depicted in Figure 6-10, not much! The total time taken was over 60 minutes (too long), but we cannot tell where in the morning routine the problem lies. Furthermore, it is too late to make an adjustment that would allow us to still achieve the target condition.

When I use this waking up and going to work example as a classroom exercise, participants invariably begin making improvement suggestions right away, such as setting the alarm clock four minutes

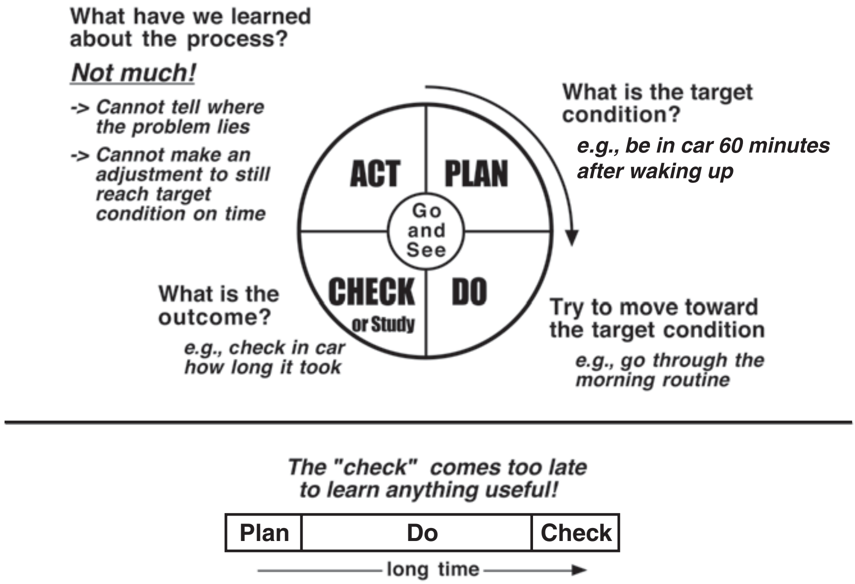


Figure 6-10. Only checking outcomes produces little learning

earlier or taking less time to shower, even though they have no further information about the problem. The urge to go directly to proposing and implementing countermeasures is surprisingly strong in us, and is fostered by our prevailing outcome- or results-based managerial system.

There are two things wrong with this PDCA experiment: (1) The "check" comes too late for us to learn anything useful about the process, or to make adjustments on the way. (2) The target condition specifies only an outcome, which means that it is not actually a target condition at all.

History shows that many seemingly large and sudden changes developed slowly. The problem is that we either fail to notice the little shifts taking place along the way or we do not take them seriously. In contrast, Toyota states clearly that no problem is too small for a response. For an organization to be consciously adaptive, it would ideally recognize abnormalities and changes as they arise and are still small and easy to grasp.

Consider, for example, the dieting quote, "I got fat slowly, then suddenly." If you are gaining unwanted weight and notice it when you're one pound overweight, you can see the causes, correct easily, and hit your target. On the other hand, if you only notice the gain, or take it seriously, after 15 pounds, then the situation is much more difficult.

Turning back to the getting-up-and-going-to-work process: to be able to experiment in shorter cycles, we need a more detailed target condition. A target condition generally includes the following information:

- The steps of the process, their sequence and their times
- Process characteristics
- Process metrics
- Outcome metrics

Ensuring that there are both process metrics and outcome metrics allows Toyota to have shorter and finer PDCA cycles (Figure 6-11). There is a longer overall cycle that checks the outcome, and, more important, many short PDCA cycles that check process metrics along the way. If that sounds too complicated, it simply means this: every step on the staircase toward a target condition is a PDCA cycle (Figure 6-12). Each step is a hypothesis, and what we learn from testing that hypothesis may influence the next step.

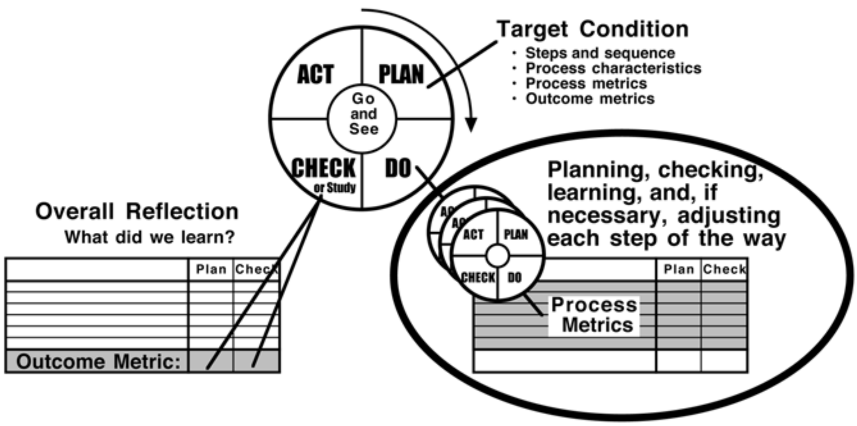


Figure 6-11. Outcome metrics and process metrics

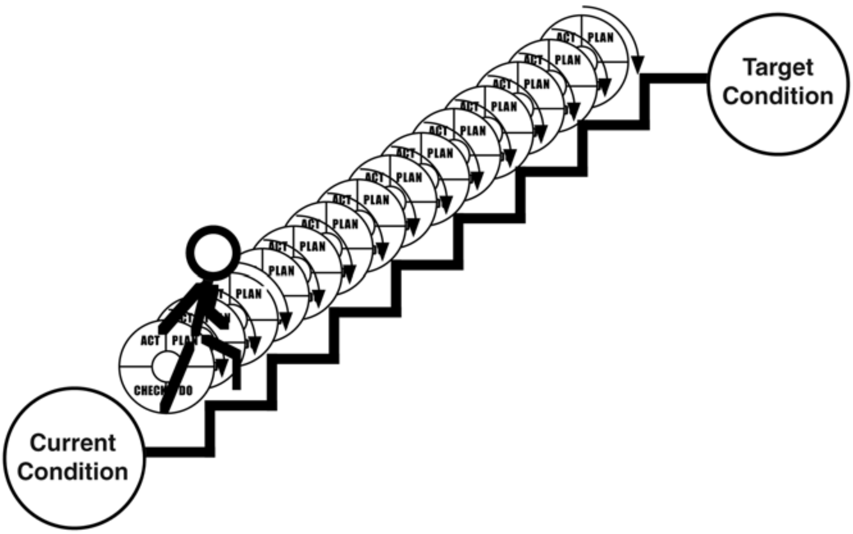


Figure 6-12. Every step = a PDCA cycle

With the shorter PDCA cycles that check process metrics, we have now reached the level in an organization—the fractal—at which continuous improvement, problem solving, and adaptation can be done effectively. For example, natural selection may favor one family of birds over another, but this is played out at the detail level, such as the length of their beaks or other attributes. We can have a vision of ending hunger, but achieving that will involve details like trucks having gasoline, roads being passable, and so on. We may want to develop and offer an electric automobile, but it is at the detail level that this desired condition will or won't be achieved.

Interestingly, the detail level is something that many popular management concepts—such as management by objectives as we practice it, employee motivation schemes, and so on—do not reach. This may explain some of the difference in the improvement and adaptiveness performance of Toyota versus its competitors.

Of course, to work this way you will have to define in advance the expected result of any step. This then puts you in a position to recognize abnormalities early and make the necessary adaptations and improvements on the way to a desired condition.

		Plan minutes	Actual minutes
Steps, sequence, times	Alarm rings / Snooze-button cycles	5	
	Start coffeemaker	3	
	Bathroom routine	15	
	Get dressed	10	
	Make breakfast	7	
	Eat breakfast and read newspaper	10	
	Clean up breakfast	5	
	Check calendar and briefcase contents	3	
	Leave house and get into car	2	
	Outcome metric:	60	

Figure 6-13. Experiment setup for the getting-up-and-going-to-work process, including steps, sequence, process metrics (step times), and an outcome metric

Let us put together a more effective experiment for the process of getting up and going to work, beginning with a better target condition that looks like the chart in Figure 6-13.

Now we have set ourselves up to make checks and learn and adapt along the way. As you can see in Figure 6-14, the step "Make breakfast" has taken four minutes longer than the planned time. Now we not only know where the problem is, but we can also make adjustments to the remaining steps to allow us to still achieve the 60-minute outcome.

Compare this approach to the first experiment, which only checked the outcome. Adding process metrics and short PDCA cycles is like putting on a pair of glasses and seeing clearly for the first time. It is no wonder that process operators sometimes get annoyed when managers visit a process for a short time, create performance incentives, drop some random suggestions for eliminating waste, and then head back to their offices.

Steps, sequence, times		Plan minutes	Actual minutes
	Alarm rings / Snooze-button cycles	5	5
	Start coffeemaker	3	3
	Bathroom routine	15	15
	Get dressed	10	10
	Make breakfast	7	11
	Eat breakfast and read newspaper	10	
	Clean up breakfast	5	
	Check calendar and briefcase contents	3	
	Leave house and get into car	2	
	Outcome metric:	60	

Figure 6-14. A clearer view of what is happening

In the getting-up-and-going-to-work example, we are still not yet ready to introduce a countermeasure, because we do not yet know what it is about making breakfast that caused the problem. The next step would be to pay close attention to the current breakfast-making routine and ask, "What is preventing us from making breakfast in seven minutes?"

Consider a manufacturing example. Say a process target condition includes producing 32 boxes of product over two shifts. If we check the outcome at the end of each shift and find a shortfall, we will have difficulty tracing and understanding the cause. A variety of small problems will have occurred during the shift (think of those 1,000 andon pulls per shift at a Toyota assembly plant), and the context that caused those problems is gone. We are not adaptive and also have few options now to make up for the shortfall in time for delivery to the customer.

On the other hand, each box or associated kanban card represents 30 minutes of production time and can be used as a process metric—an

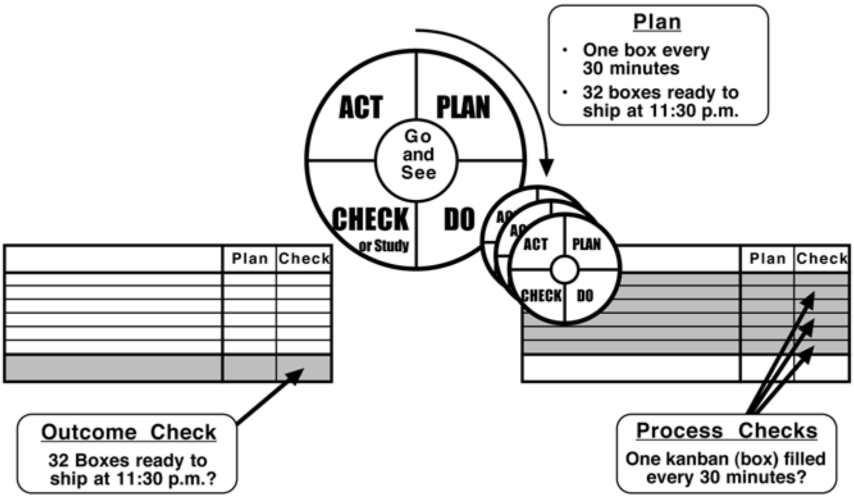


Figure 6-15. Kanban cards can be process metrics

early warning indicator (Figure 6-15). We can check every 30 minutes, and if there is a shortfall on one of those checks, the root cause trail is still hot and we can still make up for the shortfall.

This is an interesting contrast to how we work in our factories. In many cases we instruct the operators to call for a logistics pickup when a pallet of boxes is finished. Not only is this too infrequent for effective PDCA, but the logistics person comes by when the boxes are actually ready rather than when they are *supposed* to be ready. In this setup there is no experiment whatsoever. Why do we work this way? What are our assumptions? How do these assumptions differ from Toyota's assumptions?

If we want to check in short increments and utilize the information, then support personnel must be able to respond appropriately. For example, many of our factories have whiteboards for checking hourly production at their processes, which look exactly the same as such boards in a Toyota factory. But in many of our factories the comments written on these boards are used more to justify why a target production quantity was not reached, rather than to trigger quick response during the shift. A good example of copying a technique rather than the thinking behind it.

The right heart. Frequent process checking is sometimes interpreted as a means for policing people to keep them working hard (Figure 6-16). Ironically, this would create an artificial situation that obscures the true condition and inhibits our ability to improve. For example, if people tighten up and alter their behavior when the leader approaches, then the leader loses sight of the true condition. To improve in the Toyota style we will need to adopt the right heart: we are checking for problems because we *want* to find the problems.

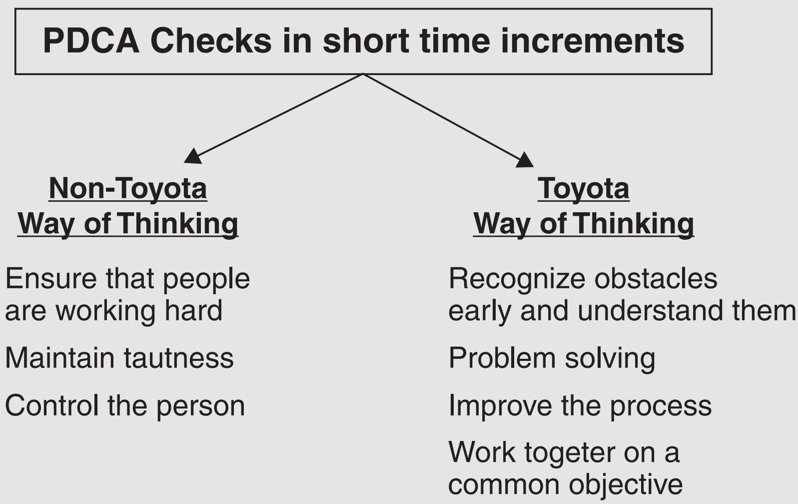


Figure 6-16. How you think will affect how people react

Rapid Cycles

Since it is the refuted hypotheses—the problems, abnormalities, and unexpected results—that show us the way forward, Toyota is highly interested in seeing the next problem or obstacle as soon as possible. Since we can only see the next obstacle when we take a step (one PDCA cycle), we should take that step as soon as possible.

As mentioned in Chapter 2, at Toyota you are generally taught to strive for single-factor experiments, that is, to address one problem at

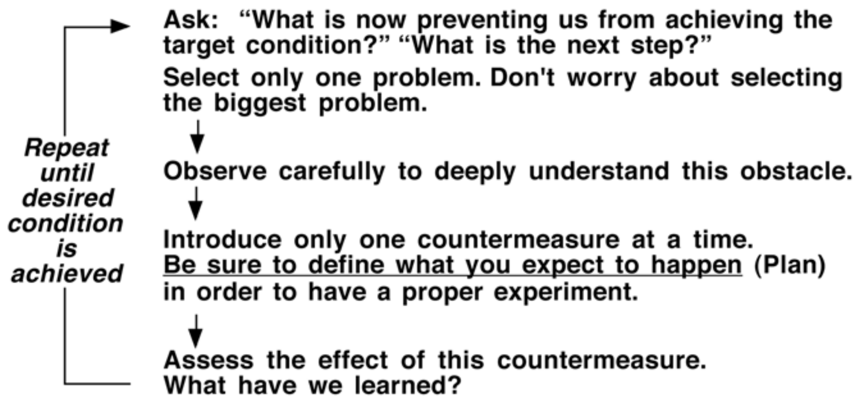


Figure 6-17. Experimenting in rapid cycles

a time and only change one thing at a time at a process. This helps us see cause and effect and better understand the process. But this would be too slow if each cycle takes a long time.

For these reasons, individual PDCA cycles are turned as quickly as possible, sometimes even taking only minutes for one cycle, along the lines articulated in Figure 6-17.

The desire to turn rapid PDCA cycles has an influence on the nature of the steps that we take toward a target condition. The idea is to not wait until you have a perfect solution, but to take the step now, with whatever you have, so we can see further (Figure 6-18). A provisional step now is preferable to a perfect step later, and investing in prototypes and experiments up front, which may seem like extra expense, often reduces overall cost in the long run.

One example is from the factory in Germany, mentioned in Chapter 5, where part of the target condition for the assembly process was a planned cycle time of 16 seconds. The pair of observers timed 20 successive cycles asked themselves, "What is preventing us from having a part come by this point every 16 seconds?" They noticed that the operator had to periodically walk away from the line to get trays of parts, which caused instability in the line cycle time.

The next step proposed by the two observers was to develop a better logistics concept, whereby the parts would be brought to the operator. But how long will it take before this can be done? If we wait

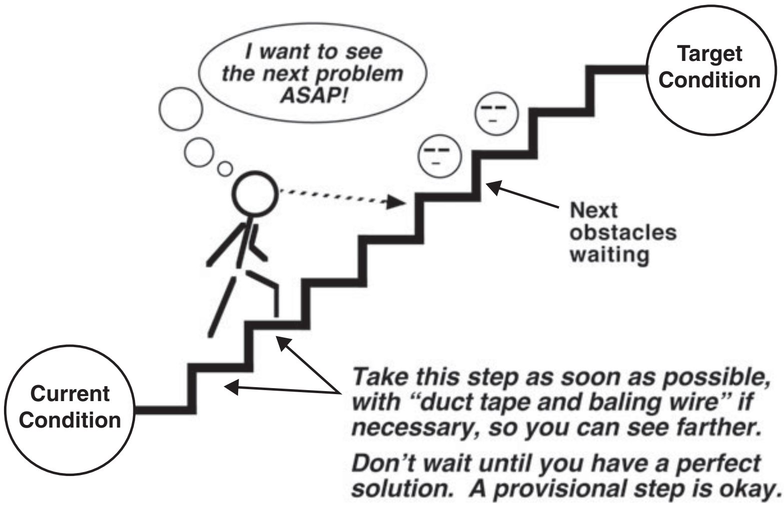


Figure 6-18. Do it now, with whatever you have on hand

until the material handling department develops cyclical material routes with point-of-use delivery, that will take weeks, at least, during which time we would not eliminate this variable (Figure 6-19). Make a logistics concept and plan, okay, but don't wait for that to be completed. If possible, make the change right now in a temporary fashion, so you can then see the next problem and keep moving forward.

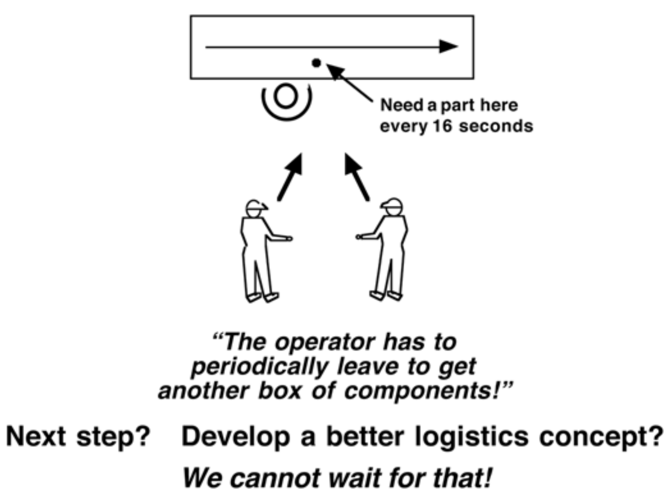


Figure 6-19. Don't wait to take a step

Another example comes from a factory that makes hydraulic cylinders for a nearby customer factory that assembles earth-moving equipment. Finished hydraulic cylinders come in a variety of sizes and are packed on pallets by size, one size per pallet. Each pallet has a special fixture to securely hold several cylinders, but only of one size. Therefore, the minimum shipping quantity for each cylinder size is a one pallet quantity. The customer, however, only requires two cylinders of any size at a time, and thus has an aging inventory of several opened pallets of cylinders in its receiving area.

A proposal for the next target condition closer to a 1x1 flow between the two factories was to ship only pairs of cylinders the customer actually needed. This would require a different fixture, so that several pairs of different size cylinders could be packed on one pallet. However, such a fixture would have to be designed and built, which would take several weeks.

In the Toyota way of thinking, this delay is not acceptable, and a provisional fixture solution—even if it temporarily adds some waste—would be introduced as quickly as possible. Not only can Toyota then see the next obstacles to achieving a 1x1 flow between the factories, but the fixture idea can be fine-tuned before expensive fixtures are fabricated. Perhaps even smarter solutions will be developed and fancy fixtures will not be needed after all.

Many years ago I learned the hard way the benefits of fine-tuning a provisional step rather than going right into full implementation. At a large automobile supplier factory, we had designed a new assembly process and needed some flow racks for parts presentation at the line. When I showed the maintenance department—which fabricates such things in this plant—our sketches of the racks, I was told building them would take three weeks. However, since our project had some priority, the maintenance department agreed to fabricate the racks over the weekend as a favor.

Monday morning our racks were there exactly as we had specified them. They were made out of angle iron, with some of the finest welds I have seen, and nicely painted the same blue color as other equipment in the plant. Once we had the racks at the line, we started our production trials. Of course, the trials led to many little adjustments in the line, which included shifting some work elements from one operator to another. This meant that the associated parts would now have to be moved to a different flow rack. We also found the need for adjustments to the flow racks as we moved things around, changed reach heights, and so on.

Imagine the good cheer with which I was greeted at the maintenance department when I now brought back the beautiful, weekend-made flow racks for some changes. This time it did take three weeks. Clearly, we should have started with some provisional racks, even though up front that seemed like extra time and expense, and worked up to something more fancy if necessary when the situation stabilized.

Again, we often leap ahead with too much faith in our planning, and thereby fail to leave room for learning and adaptiveness.

Keeping an Open Mind

The next step may not be what you expect, so you need to be as open-minded and scientific as possible as you go through PDCA cycles. It is difficult to not be biased in looking at a situation, and it is probably a lifetime's effort to teach oneself to view occurrences without preconceived notions about those occurrences.

The Results

We have misunderstood why Toyota is more successful than other organizations in achieving the challenges (target conditions) it sets for itself. It is not primarily because Toyota people have greater discipline to stick with a plan or experience fewer problems, as is often thought. Rather, they spot problems at the process level much earlier, when the problems are still small and you can understand them and do something about them (see Figure 6-20). Toyota's success is not due to sudden innovation or having airtight plans, but about the ability to execute more effectively in the face of unforeseeable obstacles and difficulties.

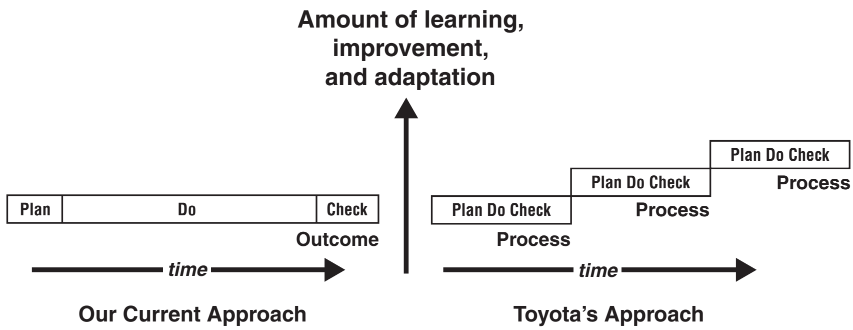


Figure 6-20. Short PDCA cycles = more learning

In contrast, we find out late that a plan has failed (although frequently this is not even admitted). Information about the little problems along the way was never picked up and acted upon. What do we then assume is the cause of the plan failing? Poor planning, poor discipline in execution, and human error.

What do we think is the solution? Make a new plan. Plan better. More discipline in implementation. More countermeasures. Motivate people to be more careful or work harder. We may apportion blame, to increase pressure on people to be more careful, or even replace people. Unfortunately, none of this addresses the actual causes of the plan failing. I once heard a colleague summarize our approach as: "It's always 'no problem' until the end, and then we have a big problem."

While taking problems at face value is a basis for Toyota-style continuous improvement and adaptation, inside many other companies I find way too much of either sweeping little problems under the rug or placing blame, both of which inhibit the ability to see reality and adapt to actual conditions. When you combine hiding problems with the popular idea of trying to manage from afar via targets and managerial accounting metrics, it means that even less accurate information gets through to managers, who thereby either fail to lead in the making of appropriate adjustments—small course corrections—or try to do it too late.

A lot has been said and written about learning organizations. With the way it applies PDCA, Toyota has developed a learning organization in a pragmatic way.

1. **What is the target condition?** ***(The challenge)***
2. **What is the actual condition now?**
3. **What obstacles are now preventing you from reaching the target condition?**
   Which one are you addressing now?
4. **What is your next step?** ***(Start of next PDCA cycle)***
5. **When can we go and see what we have learned from taking that step?**

Figure 6-21. The five questions

The Five Questions

The five questions in Figure 6-21 are a summary of Toyota's approach for moving toward a target condition, and are perhaps the most useful information in this book, now that you know what they mean. They are highly effective in practice.

The five questions come into play once you are "on the staircase," that is, in the PDCA phase of the improvement kata, after a target condition has been established. The questions build upon one another. The better you've defined the target condition, the better you'll be able to assess the current condition. The better you assess the current condition, the better you can recognize obstacles. The better you recognize obstacles, the better you can define your next step. Note that *before* a target condition has been established, the order of questions 1 and 2 is reversed from what is shown here.

This sequence of five questions is a device to give you a routine and mental pattern for approaching any process or situation, and to help you learn the improvement kata. The questions distill part of the improvement kata down to a point where it becomes accessible and usable by anyone. They are a "minikata," if you will, perfect for practicing. I keep the five questions in mind any time I visit a process, and apply them to many other activities as well. I highly recommend that you use and internalize them.

What Toyota Emphasizes in Problem Solving

Despite what the words "problem solving" might lead us to think, the primary focus in problem solving at Toyota is not solutions, but understanding the current situation in a work system so deeply, firsthand, that the right solution (called a countermeasure) becomes obvious and practically falls in your lap. Most of the effort of problem solving at Toyota is placed in grasping the situation—deeply understanding the conditions that led to the problem—as opposed to hunting for solutions.

We often mistakenly think that good problem solving means *solving the problem*, that is, applying countermeasures, and we may even propose and apply several countermeasures in the hope that one of them will stop the problem. In contrast, in Toyota's way of thinking if the solution to a problem is not yet obvious, it means we have not yet understood the situation sufficiently. Time to go and see again (Figure 6-22).

An example: A factory that makes precision-cast turbine blades for aircraft engines was experiencing a quality problem. One of the last processes in the turbine-blade value stream is a spray-coating line, much like a paint line, and some blades were coming out of the coating process with dents from banging against one another. Due to the damage, these expensive parts would have to be scrapped. Engineers quickly put forth a number of potential countermeasures, such as

	Toyota	Us
Focus	Learn about the work system. Understand the situation.	Stop the problem!
Typical Behavior	Observe and study the situation. Apply only one countermeasure at a time in order to see cause and effect.	Hide the problem. Quickly move into countermeasures. Apply several countermeasures at once.

Figure 6-22. What does "problem solving" mean?

hanging the blades farther apart on the coating line chain conveyor, putting a protective shield between each blade, and so on.

One engineer took a different approach and simply observed the coating process in action. After about three hours of watching he noticed something at a point in the process where the chain conveyor makes a 90-degree turn. As the turbine blades went around this corner, some of them would rotate counterclockwise a little and slightly unscrew the hook upon which they were hanging. When the hook became unscrewed far enough, it allowed the blade to swing and on occasion contact the neighboring blade. Once the engineer understood the problem, then the right countermeasure became obvious: prevent the hooks from unscrewing.

Few of us actually take the time to keep observing a process until the cause of a problem becomes clear. We tend instead to reward firefighters and expediters who temporarily fix a problem. We will explore Toyota's thinking about problem solving in more detail in a case example in Chapter 8.

It Keeps Going

Once you begin working with the improvement kata at a process, there is no end (Figure 6-23). If the target condition is achieved with some consistency day in and day out, it may be time to develop the

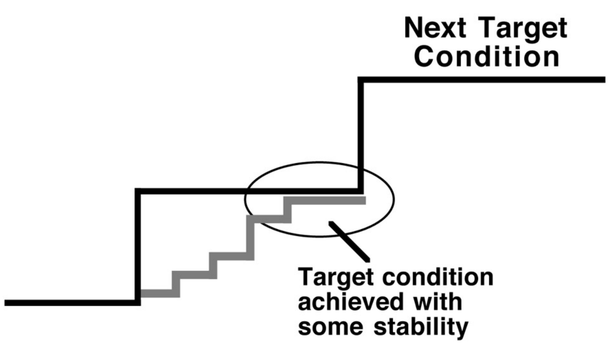


Figure 6-23. Reaching one target condition sets the stage for the next target condition

next target condition for this process. Without a target condition (challenge) to strive for, a process will tend to slip back.

This is the time to make an overall reflection, to summarize what was learned in this complete improvement kata cycle in preparation for the next. While you are working to achieve the current target condition, you will usually begin to see elements of what should be the next target condition. If not, then you're probably not struggling enough with process details.

You may not arrive at a target condition 100 percent. For example, it is unlikely that a production process can ever be 100 percent stable. At production processes you may reach a state where you are just reacting to deviations and abnormalities, rather than still striving to reach a challenging target condition. A question I sometimes ask myself is: "Are we still working under a challenge here?" If not, then it may be time to define the next target condition.

Occasionally you will not achieve a target condition on time, but this is sometimes acceptable. Why? Because we learn the most from failures.

For a few years I chaired a manufacturing conference in Munich, and one year several speakers, in presenting improvements they had made, ended their presentations with a photograph of the award—a trophy or plaque—they had won. After this happened a few times in a row, I felt compelled to point out that sure, Toyota too would show its awards, but this would not be the last slide in its presentation. Toyota's last slide would describe the next challenge. It is okay to celebrate successes, but we should always be looking ahead and focusing on a target condition and the next step. If we decide to use awards, then they should not be seen as an end, but rather as a beginning, a doorway to more learning.

The benchmark to beat is yourself and your current condition.

Summary of Part III

Part III explains Toyota's improvement kata, the fundamental approach for continuously improving and evolving throughout the organization. The improvement kata cannot be described in a few sentences, but now that it has been explained in Part III, it can be summarized with the simple diagram in Figure P3-3.

The improvement kata operates within an overall sense of long-term direction, which may represent an ideal state that might not ultimately be achievable. It is a direction giver. From day to day, however, the improvement kata often operates within the scope of a nearer and more specific target or need.

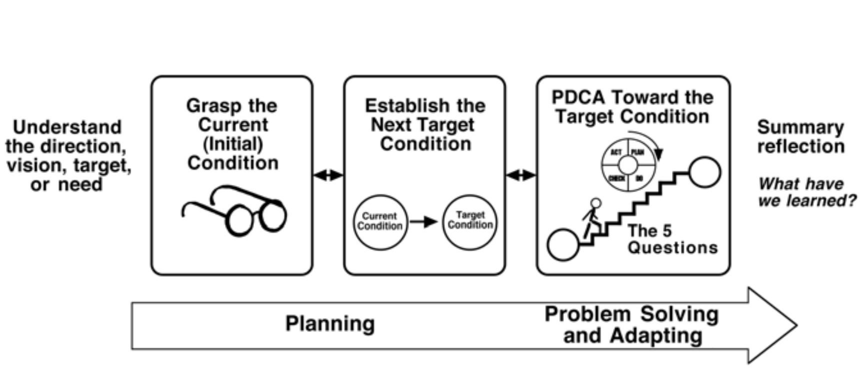


Figure P3-3. The improvement kata

With the direction in mind, the improvement kata itself is then often applied at the process level. It begins with developing an understanding of the current condition at the process, which typically requires firsthand observation and analysis of the situation.

With a good grasp of the current condition established, and the overall direction or target in mind, the next target condition for the process is described. In other words: "How do we want this process to be operating?"

Once the target condition is defined, a series of PDCA cycles toward that condition begins. These cycles uncover unforeseen obstacles, which are what need to be worked on in order to achieve the target condition. It is in particular here that learning and adaptation take place, based on feedback from the PDCA cycles.

These three stages of the improvement kata build upon one another. The better your analysis of the current situation, the more precise your definition of the target condition will be. The more precisely you define the target condition, the better and more quickly you can recognize obstacles to it.

Once the target condition is achieved, these stages of the improvement kata are repeated, of course, since the long-term vision has not yet been reached. Before that is done, however, an overall summary reflection on what has been learned in the last pass through the improvement kata takes place.

Note that the horizontal axis in the diagram is not to scale. Adequately grasping the current condition, for example, may take a long time. In reality the stages of the improvement kata also overlap. As you try to establish the target condition, you will often find you need more information on the current condition. As you PDCA toward the target condition, you may gain insights that allow you to add detail to the target condition.

The improvement kata is presented here via examples primarily from manufacturing, which is where the research took place, but the same routine can find application in many situations. By learning about Toyota's improvement kata, we are no longer copying Toyota's solutions. Now we are learning the procedure, repeatedly applied, by which Toyota develops its solutions, and how those impressive Toyota statistics mentioned at the start of Chapter 1 are achieved.

Adaptive Persistence

By embedding the improvement kata into daily work, Toyota has done something elegant: it has developed a practical and universal method for evolving along unforeseeable routes toward only generally defined long-term visions. This could be called "Adaptive Persistence," a fitting phrase coined by Richard T. Pascale in his famous 1984 *California Management Review* article.

To paraphrase Mr. Pascale, Toyota's continued success is not due to perfect up front decisions and plans (that is, perfect aim). Many priorities become clear only as you strive to move toward something, rather than through advance planning. Thousands of PDCA cycles toward target conditions contribute incrementally and cumulatively to Toyota's cost, quality, and market position. Toyota finds the path along the way based on what is being learned along the way. In hindsight, then, what seems to be strategy emerges.

Toyota does not really have any solutions to offer us, but rather a means for us to sense situations and develop appropriate, smart responses. Toyota's executives, managers, and leaders are operating on the basis that organization survival arises from adaptation to unfolding events, on the way to a desired condition. They do not think of good versus bad situations, but of problems as something to be expected and as opportunities to more deeply understand and further develop our work processes. Toyota's strategy for moving toward a vision is target conditions + PDCA; which is to say, the improvement kata. Furthermore, Toyota's executives, managers, and leaders see as perhaps their main task teaching people the improvement kata in a learn-by-doing mode, which will be the subject of Part IV.

A Way of Thinking and Acting

It is important to realize that the improvement kata is about behavior routines (Figure P3-4). It is a routine of thinking and acting that harnesses our human capability to improve and to solve problems. When we view and interpret what Toyota is doing in this light, it becomes easier to grasp, and we can go further in our own efforts to compete on a similar basis.

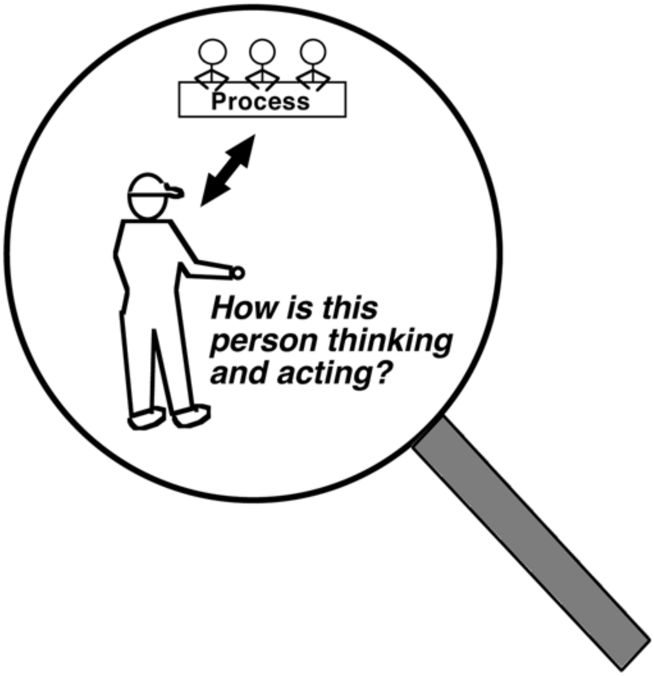


Figure P3-4. The improvement kata is about behavior routines

I did not know these things in my early days of trying to benchmark Toyota, and in hindsight it showed in my efforts to communicate with Toyota people. For example, in the early 1990s, I was involved in a lot of setup-time reduction projects at stamping processes in Detroit. During a trip I made to Japan at that time Toyota people would ask me, "How are those setup-time improvement projects going?" I would of course proceed to tell them about the most successful projects, where teams were able to reduce setup time by 70 percent or more. Yet our Toyota hosts never seemed impressed with what I was saying. They would sort of shrug and soon change the subject. I assumed I was not improving enough for their standards and that I needed to generate even greater setup time reductions.

Today I can understand better what was happening in those conversations: that we were operating with two different mental models. I was not presenting my setup-time improvement efforts in a format

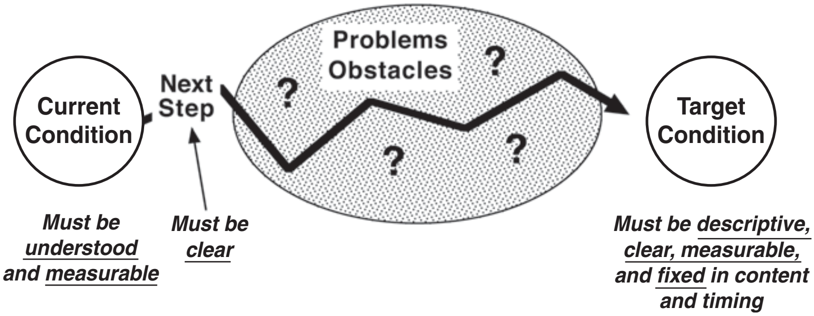


Figure P3-5. The improvement kata is a mental model

that the Toyota people could relate to or understand (as depicted in Figure P3-5). While I was explaining outcomes—how much improvement we had achieved—what they wanted to hear was something like, "The original condition was *x*. We set a target condition of *y*. We achieved *z*, and learned the following in the process." The degree of improvement was actually not that important to them. What they were interested in was what we were striving to achieve, why, how we were approaching it, what we were learning, and how we were teaching people.

Sometimes I wish I could go back and redo some of the conversations that I had on those Japan trips. But then maybe they served their purpose, since we learn from problems.

What Kind of Discipline Is Needed?

Sometimes managers and senior leaders remark that "we just need more discipline." The thinking seems to be that if people in the organization would adhere more closely to their work standards and do what they were supposed to do, there would be fewer problems.

Unfortunately it does not work this way. Keep in mind the second law of thermodynamics, or entropy, which states that even if we follow the work standard, a work process will tend to slip toward chaos if we leave it alone. No matter what, there will be problems that the operators, if left alone, will have to work around. The process will decay.

Discipline is needed, certainly, but not in the way we have perhaps been thinking. The kind of regimen we need is for everyone—and especially executives, managers, and leaders—to follow and stick to an improvement kata; to a thinking and behavior routine for how we go about improving and adapting. At this point it should become clear to you that (1) Toyota's success is about behavior routines; (2) if you want to emulate Toyota, then changing people's behavior patterns is the task; and (3) this is a different undertaking than trying to implement tools, techniques, or introduce a series of principles.

For many of us, the improvement kata is different than our current way of thinking, and it takes practice to change that way of thinking. But once you do get it, the improvement kata in itself is not that complicated. This makes sense too. Since Toyota wants to have everyone in the organization involved in continuous improvement and adaptation, they would not utilize a method that is only accessible to specialists.

The pattern of the improvement kata also simplifies a manager's or leader's job. Once leaders have learned the behavior pattern, they can be clear about what they need to do in any situation—how to proceed—to manage people. A leader using the improvement kata also does not need to know the solution to a problem, and in fact it is detrimental for the development of people in the organization to be given solutions by their leaders. What the leader needs to know is *how people should go about understanding a situation and developing solutions*. The leader should have firsthand experience with the improvement kata pattern, and know how to guide people through it so they learn it.

Learning about the improvement kata has given me a more effective way of engaging and leading groups of people, and I am more relaxed in the face of uncertainty because I know how to proceed. Take the case of the stereo speaker factory mentioned in Chapter 5, where getting the time it takes to hammer in brass inserts to be the same whether there are eight or as many as 18 inserts was part of the target condition. An initial response and push-back you may often get in response to a challenge like this is a somewhat provocative, "Well, please tell us how you think that is supposed to be possible!"

In the past I would try to answer that question by describing possible solutions. Not only would I fail at that, I would also be failing to tap and develop the capability of others. Today I answer such questions easily by saying: "I don't know, and that is how it is supposed to be. If we already knew the answer, it would just be an implementation question, and anyone—including any of our competitors—could do that. I don't know the solution to the problem, but I know how we can go about developing a solution."

> *I was gratified to be able to answer promptly and I did. I said I didn't know.*
>
> —Mark Twain, *Life on the Mississippi*

Toyota's improvement kata involves teaching people a standardized, conscious "means" for sensing the gist of situations and responding scientifically. This is a different way for humans to have a sense of security, comfort, and confidence. Instead of obtaining that from an unrealistic sense of certainty about conditions, they get it from the means by which they deal with uncertainty. This channels and taps our capabilities as humans much better than our current management approach, explains a good deal of Toyota's success, and gives us a model for managing almost any human enterprise.

> *... it is my impression that, after many contacts with Toyota employees, they view new situations in daily life—whether new problems, solutions elsewhere, partial solutions to the present problems, or chance events—as potential opportunities to improve competitiveness more often than those in other firms.*
>
> —Takahiro Fujimoto[1]

Comparison with Our Current Management Approach

If the process level is the fractal at which continuous improvement and adaptation can occur most effectively, then organizations that are able to improve constantly and systematically at this level should, in crowded market situations, realize a competitive advantage. If so, then this has implications for both management and management education.

Many companies experience a subtle disadvantage when it comes to continuous, incremental improvement and adaptation, because they rely heavily on managing by setting outcome targets, reporting of metrics, incentive schemes, and ROI-formula-based decision making. The evidence is mounting that, by themselves, management by objectives—at least as we currently practice it—and formulaic decision making do not make an organization sufficiently adaptive and continuously improving for long-term survival in highly competitive markets.

One problem is that reported numbers arrive after the fact, are manipulated to look better than they are (because of incentives), and, as Professor H. Thomas Johnson points out, are only abstractions of reality. Metrics are abstractions made by man, while reality is made by nature. Only process details are real and allow you to grasp the true situation.

Many executives and managers—reinforced by their MBA education—put their faith in those quantitative abstractions, pursue financial outcome targets, and in many instances have lost connection with the reality from which those abstractions emerge. Decision makers are poorly informed about the actual situation, and as a result they make incorrect assumptions, set inappropriate targets, and do not see problems until they have grown large and complex.

Managing from a distance through reported metrics leads to overlooking or obscuring small problems, but it is precisely those small problems that show us the way forward. Overlooking or obscuring small problems inhibits our ability to learn from them while they are still understandable, and to make timely adaptations in small steps. Over time this can adversely affect the company's competitive position.

I meet many managers, executives, and academics who continually hunt for the right mix of performance metrics that will stimulate Toyota-style continuous process improvement. This may seem logical from the perspective of the current management paradigm, but those metrics simply do not exist. There is no combination of outcome metrics and incentive systems that by themselves will generate continuous improvement and adaptation.

Setting targets and performance metrics alone usually does not generate the desired behavior or result in real improvement of work process. And how could it? The people trying to achieve the quantitative targets are not taught or guided by any sort of improvement kata. My colleague Robert Austin has studied this phenomenon and makes it nice and clear with the following comments:

> *The manager relies on signals that he or she assumes are good results measures. In fact, the employee knows ways to make signals look good that the manager hasn't thought of and that have nothing to do with results.*
>
> *Another lousy feature of such systems is that they punish workers who have too much integrity to game the measures.*[2]

If we want our organization to be adaptive and continuously improving, we should develop ways of maintaining more focus on the details of the real situation in real time. Toyota's improvement kata does this well. It provides a means for people to work empirically and creatively toward objectives that may not be easily or readily achievable, and that would often not initially pass one of our formulaic ROI decision-making calculations.

Toyota's shop floors are not connected to the IT system. Managerial accounting control systems can exacerbate the negative effects of managing from a distance via metrics, since reported data arrives late and leaders interact even less with the reality of the situation. This is why accounting control systems have little or no place on factory floors at Toyota. Factory leaders at Toyota do not refer to accounting reports to get an understanding of a situation. They are taught to go and observe the situation firsthand. In order to develop and guide good improvement practice, Toyota leaders interact with the unfolding situation at the process level, by following the improvement kata.

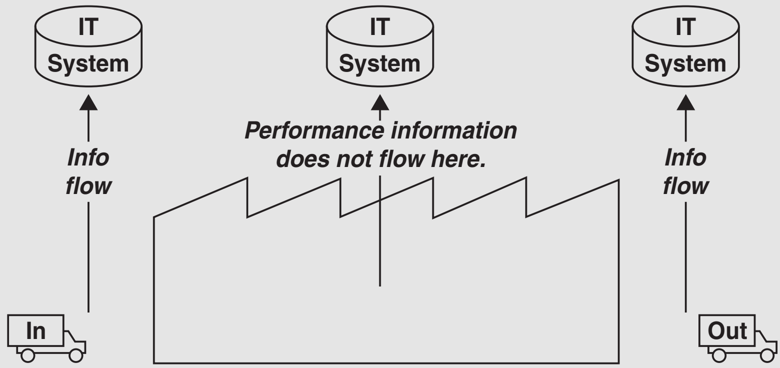


Figure P3-6. IT systems have little place on the factory floor

The factory in Figure P3-6 is treated like a "black box," but of course a large amount of process performance data is utilized in Toyota plants; on thousands of charts, boards, documents, alarms, etc. However, this data is maintained near the place of occurrence, and leaders have to go to the process to get the information they need and understand the situation there. To manage an organization with the improvement kata, many leaders may have to organize their workdays differently. There is an organizational impact.

In summation, the improvement kata gives people a means for working together. Consider, for example, some managerial concepts of the late twentieth century proposing that managers and leaders should seek out and respect the ideas of their subordinates. I have witnessed dozens of organizations that sincerely tried to employ this logical but vague advice and got nowhere with it, or worse. In an unmanaged—or "self-directed"—environment, the scope of ideas about what to do is often so wide-ranging and even conflicting that it frustrates progress. In contrast, when groups of people strive for a target condition—not just an outcome metric—and also have a common routine for working to achieve it, then they are brought into a channel that focuses their thinking and taps their capability. Not only does this make it more practical to seek out and respect other people's ideas, it makes it natural to do so.

Here is an interesting observation to consider. At Toyota, how to act in going through the improvement process is defined by the improvement kata, whereas the subject matter is open and varies depending on what one is working on. To a degree this is the opposite of how we so far have been trying to emulate Toyota: we defined the subject matter, the production techniques like kanban or heijunka that were to be implemented, but left "how to act" up to everyone to decide for themselves.

How does Toyota ensure that everyone in the organization learns and follows the improvement kata? That is the subject of Part IV.

Notes

1. Takahiro Fujimoto, *The Evolution of a Manufacturing System at Toyota* (New York: Oxford University Press, 1999).
2. Jim Austin, "Robert Austin: An Interview," *Science Career Magazine* (April 26, 2002).