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# THE HIGH-VELOCITY EDGE

## HOW MARKET LEADERS LEVERAGE OPERATIONAL EXCELLENCE *TO BEAT THE COMPETITION*

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In memory of
**Jacob Irgang (1930–1995)**,
Korean War veteran, Purple Heart recipient,
Stuyvesant High School teacher extraordinaire, 1963–1995.
*He knew his students were capable of far more*
*than even they realized.*

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# PREFACE

*The High-Velocity Edge* shows how to beat your rivals, even in the most competitive markets. True, business can be brutal. You exhaust yourself identifying market needs, hustling to develop offerings, and rushing to produce and deliver those items. No sooner is this done than someone else competes for your customers, conspires with your suppliers, and quickly bids down returns on your efforts.

Still, a few enjoy a better experience. They too have to identify needs, create solutions, and deliver to market. However, rivals chase them and never catch up. Instead, the enviable few keep hitting new milestones. They win, not from finding predation-safe positions. There are none. Rather, they discover ways to be better at what they do and develop products and processes that are better than anyone else's, operating with such velocity that pursuers are frustrated.

*The High-Velocity Edge* reveals how this is done. It shows how leaders create and sustain unassailable rates of broad-based, internally generated improvement, innovation, and invention, and how you and your organization can do so as well. And if you succeed in transforming your organization into one that is high velocity, you too can face the market with unmatchable combinations of reliability and responsiveness.

That you must compete not just by position but by velocity as well is the result of both external and internal pressures. Externally, you are always challenged by rivals in the private sector and increasingly by resource-strapped "patrons" in the public sector. Unless your organization figures out how to do more of what is better with less, you lose relevancy.

There is also internal pressure for high-velocity discovery, learning, innovation, and invention. The work of organizations is incredibly complex, and nothing complex can be designed perfectly. There are simply too many "parts"—be they the actual components of complex technical systems or the contributions of people who are expert in myriad disciplines—connected in too many convoluted, interdependent ways for a small group of smart people to plan a system that will work adequately—let alone perfectly. Since you cannot plan perfection, then you must pursue perfection.

*The High-Velocity Edge* develops the principles, with examples of their application, that leaders employ to ensure that their organization performs better than anybody else's. This book explains how to:

- Create an organization in which work is done in a way that both harnesses the best known approaches currently available and signals loudly when and where new knowledge is needed.
- Solve problems as they arise, not only to make the immediate symptom disappear but also to develop new understanding that prevents the problem from recurring.

- Magnificently multiply the impact of these local discoveries by making them systemically useful.
- Lead an organization in a manner that facilitates the constant development of great discoverers thereby enabling discovery to happen all of the time, everywhere.

The organizations in *The High-Velocity Edge* differ widely by market, core technologies, and professional disciplines. Yet they have much in common. For example, they share responsibility for managing complex systems, and they also share a specific approach for creating organizations capable of unmatchable learning and adaptation.

- Pratt & Whitney compressed the time and cost of designing jet engines despite the hurdles of developing and harnessing expertise in materials, air flow, combustion engineering, heat transfer, a jumble of manufacturing specialties, mechanics, electronic sensing and controls, and so on.
- Hospitals profoundly improved the quality, cost, and capacity of their care. Were similar achievement replicated broadly, we wouldn't be facing a national healthcare crisis.
- Toyota, once a crummy car maker in the late 1950s, raced ahead on productivity, quality, and reliability before expanding its model mix, creating new brands, regionally diversifying, and leading with hybrid drive technology. (We'll also deal with Toyota's recent struggles.)
- The U.S. Navy had one of the most successful "new product introductions" ever. In only six years, it created nuclear propulsion, which required developing new science and whole industries. Since launching the *USS Nautilus* in

1954, the Navy has had people running dangerous, complex machines in dangerous, complex situations—with perfect safety. *The High-Velocity Edge* examines the leadership that made such success possible.

- aQuantive, an Internet advertising pioneer, innovated its way from being a good but money-losing idea to a multi-billion-dollar enterprise.

One parting thought: Although the first version of *The High-Velocity Edge* was written before the financial crisis of 2008–2009, it is directly relevant amidst the current economic turmoil in two ways. One is in helping understand why failure occurred and the other is in providing guidance for recovery.

As for the first, you'll find *The High-Velocity Edge* an optimistic book in that it offers straightforward principles that, if practiced with discipline, lead to great outcomes. The stories inside are not all happy ones, however. Chapter 3, in particular, shows how the mismanagement of complex organizations leads to failure. The featured organizations may differ by product, service, and sector—financial institutions, storied manufacturers, and the like. However, many, if not most, failed for exactly the reasons explored inside—not seeing problems before they metastasized uncontrollably, and not solving problems even if they were seen with sufficient lead-time. Toyota clearly tumbled into trouble when its ability to grow the capabilities on which it depended for improvement and innovation was overburdened by the demands of rapid expansion. If anything, this emphasizes the importance of the capabilities explored in *The High-Velocity Edge* and explains why constantly nurturing them is so critical.

As for recovery, the importance of learning and adaptation cannot be overstated. During good times, organizations may have answered well enough the following questions: (1) what does the market need?, (2) what products or services can I offer?, and (3) how do I produce and deliver them adequately? Now, however, whatever answers you had to those questions before the financial crisis are no longer adequate. New needs demand new offerings that demand new ways of bringing them to market.

We've already seen organizations unable to generate new solutions to new problems. They've fallen by the wayside. More will follow.

We'll also see organizations that might not have been leaders going into the recession accelerating now and emerging ahead. I hope the lessons in *The High-Velocity Edge* help your organization become one of those.

Thank you for reading my book. Please let me know what you think.

With best wishes,
Steven J. Spear
Brookline, MA
February 2010
Web site: http://www.TheHighVelocityEdge.com

# Chapter 9

# CAPABILITY 4: DEVELOPING HIGH-VELOCITY SKILLS IN OTHERS

It is an understandable view that leaders are responsible for setting objectives, allocating resources for the pursuit of those objectives, and establishing an emotional tone for the organizations they lead, including establishing the right combination of incentives to achieve the objectives. Leaders in high-velocity organizations do all those things; their combination of perspective and authority makes them the only ones who can. However, it is what they do in addition that sets them apart from their low-velocity counterparts. One difference, of course, is that they must be system-oriented—responsible for the design and operation of processes at levels of aggregation for which others have insufficient perspective and authority. We saw that kind of boundary-spanning responsibility exercised by the senior leadership at the Aisin plant described in Chapter 7. Quality circles and other mechanisms could have been used to make the component modules of the process self-correcting and self-improving, but only those who were more senior were in a position to make the major line reconfigurations that were described in that chapter. We'll see another example of a leader owning some aspect of a system's design, operation, and improvement in this chapter when we describe Gary Convis's experience leading Toyota's facility in Georgetown, Kentucky.

Leaders in high-velocity organizations must play yet another role: They must develop those for whom they are responsible so that the organizational capacity to be self-correcting, self-improving, and self-innovating is distributed and practiced widely and consistently. We have already seen some examples: middle and higher-level managers who were responsible for developing quality circle members at Aisin, NHK, and Taiheiyo, the standout team leader at MacDougal.

In this chapter we'll see how high-velocity organizations consider leaders to be both mentors (or developers) and process managers. Let's look over the shoulder of Bob Dallis as he learns to lead at Toyota.

## Learning to Lead at Toyota

Bob Dallis was an accomplished auto-manufacturing manager who made a huge career shift. He spent several years at a Detroit Big Three company, where he led the turnaround of an 1,800-employee assembly plant and ran a new-engine design program as well as leading an engine plant through its design, ramp-up, and first years of operation. His accomplishments before age 40, interlaced with engineering and business degrees and honors from great universities, would be noteworthy for most people in their fifties and sixties. But in the face of downsizing and offshoring—and always dreaming of helping reinvigorate American manufacturing—Dallis left for Toyota, the automaker that was most aggressive about increasing design and production in North America. Their shared objective was that, after a period of initiation, he would become a senior leader, probably at Toyota's flagship plant in Georgetown, Kentucky.

One might have expected a quick transition for someone with Dallis's credentials—perhaps a round of cursory walkthroughs and introductions. Given Toyota's emphasis on shop-floor operations, perhaps he would also do some hands-on line work and visit dealerships for direct customer contact, but soon he would have substantial managerial responsibility. However, that was not the case. Learning to lead at Toyota was a months-long effort managed by a more experienced Toyota veteran, Mike Takahashi. And although we will be following Bob Dallis, in some ways this is also Mike Takahashi's story. Bob learned a lot from Mike, and so can we.

## Learning to See and Solve Problems

Takahashi first assigned Dallis to Toyota's West Virginia engine plant, not to Kentucky, to improve the work of a 19-member group on three dimensions: ergonomic safety, efficiency, and operational availability. For six weeks Takahashi emphasized observation, seeing the reality of the "current condition"—how work was actually performed and what problems actually affected it. Then he emphasized making changes so that maximum insight would be generated about the complex system of work. This was not a matter of making arbitrary modifications but of predicting clearly what was expected to occur before those alterations were made. With cause and effect articulated—out in the open—if a modification did work, Dallis would truly understand why. If it did not work, he would at least have some idea of where he had gone wrong, having put his reasoning "on the table" from the start.

For six weeks, Dallis focused on the work of the individual operators. He implemented some changes that seemed laughably minor in comparison to his past and future responsibilities: reconfiguring line-side parts racks so that material was more accessible, repositioning the handle on a machine to reduce ergonomic strain, and so forth. Others were more substantial and required shifting work among the workstations. That meant coordinating with material handling about part delivery and with maintenance to relocate light curtains, so those changes were completed over a weekend, when the plant was shut. With those changes, Takahashi reinforced the importance of tracking actual results against predicted ones, watching with Dallis to see what the real effect would be in comparison to what Dallis had predicted. Productivity and ergonomics had gotten better, but operational availability—the proportion of the time that a machine ran without delay—declined (see Table 9-1). Of course, the employees had not sabotaged the equipment. Instead, with the group working more fluidly and productively, problems with the machines which hadn't previously seemed significant now seemed like real impediments.

So Takahashi redirected Dallis's assignment for the next six weeks. Rather than focusing on people, he was to focus on the machines, looking for ways to improve their reliability and availability. Takahashi insisted that Dallis not speculate but

**Table 9-1 Before-and-After Comparison of Assembly Line's Performance**

| | *Before* | *After* |
|---|---|---|
| Productivity | | |
| Number of operators | 19 | 15 |
| Cycle time | 34 seconds | 33 seconds |
| Total work time/engine | 661 seconds | 495 seconds |
| Ergonomics* | | |
| Red process steps | 7 | 1 |
| Yellow process steps | 2 | 2 |
| Green process steps | 10 | 12 |
| Operational availability | ≈ 90% | ≈ 80% |

*The difference in the total number of processes in the two ergonomic columns reflects the reduction from 19 to 15 in the number of process steps. Process ergonomics were rated from worst (red) to best (green) on the basis of a formula that considered the weight lifted, the difficulty of reaching, the need for twisting, and other risk factors.

wait to see real-time failures so that he could investigate problems when and where they had occurred. This seemed awfully inefficient because machine failures did not occur frequently and machines could not participate in analysis and correction the way people could, but over time, the power of this approach became more evident. In one case, a switch was in a position where workers could brush it accidentally, activating the machine before a jig was loaded. After investigating several faults in another machine, Dallis discovered that the shape of an interior bumper allowed pallets to ride up and get out of line. Direct observation of the machines, root-cause analysis and recreation of each failure, and immediate reconfiguration to remove suspected causes raised operational availability to 90 percent, but this was still below the 95 percent target Takahashi had set.

Dallis spent 12 weeks learning about the importance of observation as the basis for improvement and of using the scientific method of being clear about expectations before making changes and following up to observe the results of those changes. Having learned these skills, while significantly improving the process on which he had been working, wasn't it time for him to begin his "real" work at Toyota? Or would he first have to practice the same skills on a larger scale, given the responsibilities for which he was being prepared? Neither. Instead, Takahashi and Dallis flew to Toyota's Kamigo engine plant in Japan. Takahashi had worked there, but more significantly, it was the storied plant where Taichi Ohno had first scoped out the basic elements of the Toyota Production System and just-in-time manufacturing. For engine and manufacturing people, Kamigo is not just a destination but a pilgrimage, like visiting Kitty Hawk or the Wright Brothers' lab in Dayton, Ohio.

On arriving, Dallis learned his assignment: For three days, he would work with one operator in one machining cell. In three shifts, they had to put in place (not just plan) 50 changes to reduce the "overburden" on the employee—anything that was taking more effort than was really needed. The cell would be "on-line" with daily production demands. The Kamigo team member spoke no English, and Dallis spoke no Japanese. Dallis applied the lessons he had learned in West Virginia about using direct observation to see a process's failures and rapid experimentation to arrive at better approaches, but with far greater acuity and speed than he had done before. Despite the imposed pace, Takahashi insisted that Dallis not speculate but always ground alterations in observed data and always test against well-articulated expectations.

Dallis came to see subtleties he had not appreciated before. For example, relocating a jig was not a matter of making a single change. Whether it was to the worker's left or right, how far away it was, and the angle at which the elbow and wrist had to be bent to grasp it all mattered. He also learned that the demand for speed and the insistence on discipline were not irreconcilable if he could construct high-speed, low-cost prototypes to test an idea. As he explained to me, "If I had an idea to relocate something, Takahashi would challenge me." If something required welding, was it possible to bolt it in place to test the idea? If it could be bolted, could time be saved with temporary taping? Instead of taping, could it be held in place to see the flaws in the idea with extreme speed? "Mike," said Dallis, "was trying to get me to go quicker, quicker, quicker, making as little investment as possible in an idea so I could try it and discover its strengths and shortcomings first, before making more of a commitment. It was all about learning at maximum speed." Dallis was learning how to minimize the trade-off between speed of testing and discipline of learning.

After three days, Dallis had identified 50 problems with the cell's quality checks, tool changes, and other work. To deal with those problems, he had made 35 changes, with 15 suggestions still to be implemented (see Table 9-2).

With the shop-floor changes done, Takahashi had Dallis present his work to the plant manager and the machine shop's

**Table 9-2 Summary of 50 Changes Made by Dallis in the Machining Cell**

| | *Quality Checks** | | | *Tool Changes** | | | |
|---|---|---|---|---|---|---|---|
| | *Walking* | *Reaching* | *Other* | *Walking* | *Reaching* | *Other* | *Other Work* |
| Number of changes | 8 | 8 | 13 | 7 | 4 | 5 | 5 |
| Effect of changes | 20-meter reduction (50%) per check | 2-meter reduction | Remove trip risk; organize tools to reduce confusion, risks, etc. | 50-meter reduction per tool change | 180-cm reduction in reaching | Improved ergonomics; organization to reduce confusion and risk, etc. | Remove trip risk; simplify oil change |

*Quality checks were performed two to three times an hour and tools were changed hourly. Together, Dallis's changes cut approximately half a mile of walking per shift while also reducing ergonomic and safety hazards.

manager and group leaders. Two things struck Dallis. The first was the discipline with which he had to prepare and present the report. Dallis and the two team leaders who had been going through a similar experience in adjacent cells had to explain the changes they had made in context; the presentations took place on the shop floor alongside the work cells in question. They had to explain what they had observed of the process, the problems they had found, the causes they could assign to those problems, the changes they had made to remove the problems, what they had expected the results of the changes to be, and the outcome they had achieved. They could not simply report changes or results; they had to make very clear the entire thought process underlying their actions.

This emphasized the importance of using the scientific method to (a) solve problems, (b) build deeper process knowledge, and (c) spread what was learned by showing the discovery process, not just the solution. Dallis was also struck by the detailed questions he was asked. “The plant’s general manager, the machine shop’s manager, and its group leaders were engaged in what the ‘lowly’ team leaders said. They busily took notes during the presentations, asking pointed questions, constantly challenging our thinking.”

With the work at Kamigo behind them, Dallis and Takahashi visited several other plants to learn how group leaders managed a variety of improvement projects. One project involved reducing changeover times and establishing a more even production pace for an injection-molding process, another focused on reducing downtime in a machining operation, and a third sought to improve productivity and quality in final assembly. Another project focused on proactive maintenance, finding ways for operators to distinguish "normal" from "abnormal" in a machine so that maintenance would be able to solve real problems, not just take preventive actions whether they were needed or not. In all those projects, the group leaders followed the same disciplined approach of explaining the entire discovery process, both to provide instruction and to invite critiques.

Bob Dallis's takeaways from his first several months at Toyota included:

- The importance of direct observation so that problems are seen in the idiosyncratic context of person, product, process, place, and time in which they occur and are investigated while they are still hot. This is the way to improve complex systems of work while creating deep knowledge about how those complex systems actually work.
- The importance of structuring all improvement efforts so that assumptions embedded in the work and in the changes could be tested.
- The lesson "to bolt rather than weld, to tape rather than bolt, and to hold rather than tape," so there need be no trade-off between speed and problem-solving discipline.
- The importance of reporting not only your actions and their results but also the reasoning that led you to take those actions and to expect certain results (which may or may not have been what actually happened).

Add it up and we see that Dallis was being introduced to the first three of our four capabilities—process design and operation, problem solving that is also knowledge building, and knowledge sharing. In fact, as we will see, he was also being introduced to Capability 4, learning to lead others through his relationship with Takahashi.

## The "Process" of Leadership

Dallis found that these practices of observation, experimentation, and speed were ubiquitous in Toyota, used not only for manufacturing but also for intangible processes such as training. In preparing Dallis to be a Toyota manager, Mike Takahashi was applying the very process he was trying to instill in Dallis. For example, before Takahashi ever met Dallis, he had plenty of data—résumés, references, and anecdotes—concerning Dallis's career and accomplishments. But he had never *seen* Dallis in action. Just as he didn't want Dallis to speculate about what to do on a manufacturing process before seeing it in action, he was not prepared to "develop" Dallis until he had seen him in action. Therefore, following his own formula, he first observed Dallis at work in a fairly controlled situation (in West Virginia). It was a familiar technical setting (an engine plant), but on the simpler side of things (assembly, not machining). There were only 19 in Dallis's group and the experience itself was professionally safe. Dallis could make mistakes, be corrected, and be directed, but not in front of people he might later be leading in Georgetown, Kentucky.

Takahashi had reduced the complexity of the situation so he could focus on how Dallis solved problems and how he involved the people with whom he was working. Because he was seeing Dallas in action frequently, he was able to adjust his coaching appropriately by seeing problems with the training process and quickly trying changes rather than trying to think his way through a whole high-level training program in advance; in other words, there was the familiar emphasis on rapid discovery rather than planned design. It was the equivalent in Takahashi's own work of holding rather than taping rather than bolting rather than welding.

In short, to enhance Dallis's ability to learn about processes and his own ability to learn about Dallis, Takahashi took an incremental but intensive, immersive, high-speed approach to Dallis's development, much as he had had Dallis break down shop-floor processes into their microelements. He might have thrown Dallis into an unfamiliar environment—paint rather than power train—or started in Japan with its attendant language and cultural differences, but that would have introduced too much novelty. If Dallis struggled, what would it indicate? With so many factors in play, drawing conclusions about what caused the trouble would be terribly difficult. Table 9-3 shows the process of introducing novelty in small increments.

Although Dallis took away many important lessons about problem solving and knowledge sharing, the lessons he learned about leadership were the most compelling. Each level of the management hierarchy was part of a cascade that developed the problem-solving process-improvement skills of the people for whom it was responsible. Consider the colleagues he met at Kamigo. First there was the team member with whom he worked for three days. Dallis discovered that this frontline operator was not only capable of doing work in what must have been an already finely tuned, slack-free environment—after all, this was Ohno's old stamping grounds—but was also able to be an active participant in making improvements to such a well-tuned system. Then there were

**Table 9-3 Introducing Novelty in Small Increments***

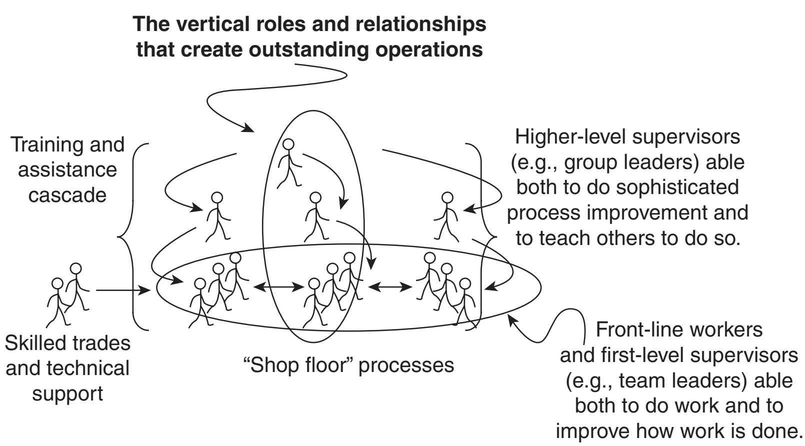
| | *Last Employer* | *West Virginia* | *Kamigo* |
|---|---|---|---|
| *Product* | Engine | Engine | Engine |
| *Management system* | Old employer's | **Toyota's** | Toyota's |
| *Processes* | **Assembly** and machining | Assembly | **Machining** |
| | | First: Work methods<br>**Second: Machine problems** | First: Improve work-space and methods<br>**Second: Learn about machine improve-ments** |
| *Plant workforce's experience and process knowledge* | Less than 10 years | Less than 10 years | More than 30 years |
| *Problem-solving support from skilled trades* | 1-week lead time for changes | Changes tested within a day's time | **Several changes tested every hour** |
| *Familiarity of plant* | Dallis's work site | Known by Takahashi | Takahashi's former work site |

*Items in **boldface** refer to something novel.

the team leaders who were having a similar training experience in cells near Dallis. To get to that position, they would already have to be capable of supporting team members (frontline workers) in doing their daily work. However, they were also exceptional problem-solvers in their own right. On the first day, Dallis was delighted to demonstrate seven changes that he had put in place, only to learn that one team leader had nearly 30 to explain, while the other had more than 30.

Then there were the group leaders at Kamigo who participated in the wrap-up. They displayed detailed process knowledge and knew how to help Dallis and the team leaders learn even more from their experiences by asking them challenging Socratic questions: How did you observe? What did you see? Why did you do this? Why did you try that? What did you expect? What did you get? What was the gap? What do you think might have been its cause? What might have you done differently? The constant challenges that these group leaders and the production and

**Figure 9-1 Managerial cascade of training and assistance and the supporting infrastructure**



plant managers were able to provide and that Takahashi provided ceaselessly were part of the development program.

We can draw the following conclusions, summarized in Figure 9-1:

- Frontline workers, like the one with whom Dallis worked for three days in the Kamigo plant, were so accustomed to change that production could continue even when a non-Japanese speaker was making changes in how work gets done several times an hour.
- First-level supervisors (the team leaders who were receiving the same training as Dallis) were capable problem solvers in their own right, able to conceive and execute many changes in rapid succession.
- Second-level supervisors (the group leaders who explained their discoveries) were capable of facilitating larger-scale process innovations that were at the very least akin in scale, scope, and impact to what Dallis—an exceptionally accomplished manager—had done during the first 12 weeks of training.
- Senior management within Toyota was building the process-innovation capabilities of those less senior, much as Takahashi had been doing for Dallis.

Dallis now saw important contrasts. So many people had characterized Toyota by emphasizing a handful of shop-floor tools for managing the flow and transformation of materials—value-stream maps, pull systems, standardized work, production cells, and "5S" workplace orderliness. These are aspects of managing the horizontal flows of material from receiving through shipping. However, Dallis came to appreciate how sharply this contrasted with the top-down cascade of training and support, the daily development of people's skills in designing, operating, and improving systems, as shown in Figure 9-1. This is how Toyota created operating velocity and improvement-and-innovation velocity. If one contrast was between Toyota's practice of developing people and its imitators' inordinate emphasis on product and process, there was also a contrast between how many companies thought about responsibility and how it was carried ou at Toyota. Dating back to Frederick Winslow Taylor and before, there is the view that management is responsible for designing systems, solving problems, and ensuring "compliance" with procedure, leaving it to subordinates to work around problems until something goes so badly that management can't ignore it any longer. That wasn't the way at Toyota.

## HOW I LEARNED TO LEARN

My own experience during the six months that I worked at Toyota was that my managers led me by directing me to situations in which I could learn, just as Takahashi did for Dallis. For instance, in my first days at Toyota, I was assigned to a team responsible for developing a first-tier supplier of stamped parts. I asked my boss, Mr. Ohba, what I was supposed to do. He said, "Go find out what they make." (It was not until later that I realized I was learning to observe a system at the four levels—output, pathways, connections, and activities—and according to the two criteria—specified in design and operated with built-in tests—that we encountered in Chapter 6).

I came back later that day with a list. "How did you get the information?" he wanted to know. I explained that I had interviewed managers, including the plant manager and the sales manager. "You don't really know," he said before turning to other matters. I came back the next day with a different list. "How do you know this is what they make?" he asked again. I explained that I had gone to the supplier's accounting department to see what had been invoiced as shipped. I had figured that those guys would not invent phantom shipments. "You still don't know," he told me. I went back to the plant the same day and returned some hours later with a third list. "How do you know this is what they make?" he asked yet again. This time I had not counted on invoices; I had asked accounting to let me see what Toyota had actually paid for. I did not think they would pay for materials they had not received. I should not have been surprised when he said, "You still don't know."

The next day I came back once again. It had taken longer than the previous tries, but the list was quite different. Ohba asked, "How do you know this is what they make?" I was ready this time. "Well, here's what I did," I said, thinking to myself, "I'm on to your tricks and games."

I explained that I had stood at shipping and, as each box was about to be loaded onto the truck for delivery, I had written down the part number. Not the number on the kanban card (the shipping label), mind you; I had checked the part number stamped into the metal. I had done that for both shipments. I had also confirmed that for each part there was a stamping die in the plant that could make it. Not that I had ever suspected that the supplier was reselling parts made by someone else, but now I *knew*. I told Ohba, "I know there are still some holes; there may be ones I didn't see yet, but these are what they make, I'm pretty sure."

Ohba nodded his head for a moment and looked at my list again. The he looked at me and said, "Well, that's probably not wrong. But I have another question: How are these parts made?"

## A Toyota Leader in Action

Some years ago I had a chance to shadow Norm Bafunno, a senior manager at Toyota's assembly plant in Indiana. That plant does an exceptional job of manufacturing top-rated products; it has proved itself capable of rapid expansion in production capacity, flexibility in terms of the product types it can make, and quick assumption of responsibility for testing new manufacturing equipment and developing new manufacturing techniques in preparation for the launch of a new model.

Bafunno, like the others there, had specified his work: what he was going to do, when, with whom, where, and with what expected outcome. If something ran early or late, an explanation was called for: What had unexpectedly happened along the way? Typically, his morning began with meetings on safety, production, and similar issues. Then he would visit one of the several improvement projects being undertaken in his plant or at nearby suppliers. The basic format of each visit was the same: Those involved in the project explained how the process they were trying to fix had worked at the time of the senior manager's last visit, the problems that had been experienced then, the root-cause analysis that had been conducted, the countermeasures that had been tested, the target condition that had been predicted, and the actual results that had been achieved. The presentation always made explicit the experimental design of the improvement efforts.

Here are my reflections on watching this leader in action:

- Visiting these projects was part of Bafunno's daily work. He visited each project every two weeks or so, not quarterly or for annual reviews.
- The review occurred where the problem was being solved, not in a conference room, office, or off-site location.
- The entire hierarchical chain that linked Bafunno to the group leaders who headed the improvement effort came to the review.
- Everyone in attendance took notes and asked questions about the problem, the attempted solutions, and the results.
- Toward the end, Bafunno would always say, "Thanks for the [technical] explanation you've just given, and congratulations on the results you've achieved. But let me ask you, aside from what you accomplished [with the process], what did you learn?"

This is the quintessential Toyota leader question. It comes from the most senior level and cascades down to the front line. It is asked regularly and is based on a manager's direct experience with the person doing and improving the work. It emphasizes the importance of continually building knowledge and expertise.

## Leader as Capability Developer

I've been fortunate that so many people have been willing to share their experiences with me over the years. What is striking about Toyota is that when I ask people to describe a seminal experience with a leader, almost all the stories revolve around the leader doing something that helped develop the storyteller. The story is almost never about the tough call or the brilliant move the leader made; I didn't encounter the common view of managers as decision makers who tell others what needs to be done. When Toyota people tell these stories, it is not a dispassionate, academic recollection. Inevitably, at some point midway through the telling, they have to stop and collect themselves because the experience still has deep emotional resonance even though it happened even decades before. Here are some examples.

Ken Kreafle was with the Georgetown plant from its earliest days. He shared his story with me:

> I remember when I was running a paint shop for the first time. We were told a senior manager from Toyota City was going to visit. We spent a day

searching for the finest example we could find of a painted vehicle. We pulled it off the line, set it up in an undisturbed part of the facility, lit it with bright lights, and roped it off so no one would touch or otherwise mark or mar it. The only thing that made it different from a Hollywood big shot on Oscar night is that we didn't actually have a velvet rope or a red carpet, but not for lack of trying.

The Japanese manager who was my "coordinator," mentor, guide, and coach asked me what we were doing. I explained that we wanted to show off the best example of our work. We had a lot to be proud of. It was the early years of the plant, we were Toyota's first greenfield site in the United States, and we had worked very hard to get the plant up and running with what had started as an inexperienced workforce.

He said, "That is not the one he wants to see." We didn't understand. "What does he want to see?" He said, "I'll show you." He closed his eyes, turned on his heels, and pointed. When he opened his eyes, he said, "That one!"

"That one?" we asked. He had taken a body at random.

"That's not all," he continued. "He'll want to see what you found wrong with the car."

We did not get the point at first, but over the next several hours we were scouring that car for every slight imperfection, scratch, dust spot, and blemish. Not just on the visible areas like the hood, trunk, and fenders. We were crawling under and in the car, places you would only see if the car were on a lift or disassembled (or not yet assembled, like this one was). By the time we were done, marking each flaw with a Post-it, the car looked like an especially large piñata.

"Now," our coach added, "you're *almost* ready. When he gets here, he'll not only want to see what you found, but also what you think caused those defects and what you think you can do to prevent them from happening again." The next day, when he showed up, I couldn't believe it. I had worked for one of the Big Three. When an executive came, it was all about showing him the good news, and the questions were all about the numbers. Did we meet our targets? What was our scrap, our overtime? It was all stuff that got measured right on the bottom line but that we couldn't touch directly. Not this guy. He wanted to know all about the process and more, all about what we knew about the process, the stuff that eventually reached the bottom line but the stuff that we *could* touch directly. When we got to a bump or a mark that we couldn't explain, we didn't leave it there. We walked back and forth between the car we had examined and the line, trying to find the link. I'll never forget it.

Kreafle recounted a story with another leader:

Then there was my first annual review with Mr. Cho, now Toyota's chairman but then the president of Toyota Kentucky. When we started the year, he asked me to lay out the agenda for our department. I did, but he kicked it right back to me, asking, "Where is the business case for these changes? Even if we hit these goals, are they enough to succeed?" We spent the next hour working our way backward: what the market demanded of us to be a top competitor and how that translated to quality, productivity, lead time, and all the measures relevant in my department. Then we set some marks for where we had to be to be top in our class. It seemed impossible, but every day we went at it, trying to hit those measures.

At the end of the year, it came time for my annual review. At Toyota, reports are pretty simple: For almost every measure it is red, yellow, or green. As I started going down the sheet, I started looking at all the red, the preponderance of yellow, and a paltry amount of green. I had known all along where we were, but this was the first time I had confronted the reality of how far we were from the objectives we had set many months before. Right before my meeting, I stopped for a minute and called my wife. "I'm going for my review right now," I explained. "I may be out of a job this afternoon." With that, I walked into his office.

I started by apologizing. He listened for a while and asked why I was being so contrite. What had I done wrong? I started to show him my summary sheet, all the red and yellow and the marked lack of green. The year was pretty much a failure as far as I could tell.

"No, the year was a success."

"Excuse me?"

"You made a lot of progress—"

"But," I interrupted, "the goals we set when we started. . . ."

"Those were what we had to achieve to absolutely delight the market. Those are real targets. We set those so we wouldn't fool ourselves into thinking we are better than we actually are. We weren't good enough then, and we still aren't good enough. But we are much better. And I know what is going on in paint. We are going to be even better yet. Don't worry. The year was a success. We're just not done."

## Process-Excellence Boot Camp

In any sophisticated organization, one would expect to find experts in particular technical specialties. At an auto company, for instance, there would be experts in styling, design, power trains, and so forth. Within the manufacturing portion, there would be experts in stamping, forging, molding, welding, paint, assembly, and so on. At Pratt & Whitney there are experts on various parts of a jet engine—compressor, combustion, and turbine blades—and the various disciplines required to make those elements work—materials, aerodynamics, controls, and the like. High-velocity organizations that outpace, outrace, and outdistance the competition have all these same experts—and something more. They have people whose specialty is the art, science, and discipline of processes: the harmonious integration of specialties and functional pieces into coherent wholes.

We've already visited Aisin several times in this book. Aisin has an organization called the Operations Management Consulting Division (OMCD). Think of it as the home of the Toyota Production System experts of the organization, a place where people have a chance to step outside their normal line responsibilities and have a deep, intense boot-camp experience in designing, improving, and innovating processes and—equally important—teaching others to do the same thing.

At the time I was studying Aisin's OMCD, it had three general managers, three assistant managers, and 88 other members. Some of them were technical experts who were past 55 years old and permanently assigned to OMCD. Some were at OMCD for a two- to three-year stay, during which they deepened their TPS knowledge before returning to their home plants. The rest of the 88 had graduated from Aisin College, a developmental program for those hired into Aisin with no advanced education. OMCD members participated in improvement activities that lasted from one to three months. Upon completion of their tenure there, the temporary members were reassigned to Aisin plants as TPS promotion experts, a resource something like Alcoa's environmental, health, and safety experts whom we met in Chapter 4, available to advise and assist at every level and scale of aggregation—plant, location, business unit, and corporate.

According to Aisin's OMCD head, Mr. Torii, the three-year curriculum had a logical progression. In the first year, students focused on process improvements, smaller-scale work like that done by Bob Dallis in West Virginia and Kamigo. In the second year, they advanced to system-level projects, progressing from component work methods to problems of connections and pathways, the interfaces and architecture of work systems. For instance, they might have participated in the line redesign at the Aisin plant, which I described in Chapter 7. In the third year, the students would oversee improvement activities, both to solidify their own knowledge and to practice transferring similar skills to others, much as Mike Takahashi had done with Bob Dallis and as Dallis was learning to do with others.

As a training ground for process experts and a supplier of process expertise, Aisin's OMCD played several critical roles. It evaluated the effectiveness of each production line, established performance-improvement goals, and supported improvement efforts by identifying opportunities for fruitful change. Each of those activities was a venue in which people could hone their problem-solving skills while removed from their positions of operational responsibility.

Toyota, of course, has its own Operations Management Consulting Division. Toyota's OMCD supports plant-improvement activities and provides a venue in which people can become more expert through frequent problem solving. For example, during one of my research trips, one of my hosts was Mr. Numa, who had worked for Toyota for 16 years, much of it in the quality-control division, and was in his first year at OMCD. He had projects at three sites where he developed his own problem-solving skills and practiced developing those skills in others.

## Leader as Process Owner

Gary Convis is someone with a unique perspective on Toyota. He worked at Big Three firms for nearly two decades before coming to NUMMI. There, he worked with and was responsible for people who, like him, had seen what it was like to work in a low-velocity environment like the one I described in Chapter 3 and who now knew what it is like to work in a high-velocity organization. Convis helped launch Toyota's Georgetown, Kentucky, plant and became the first non-Japanese president of a Toyota manufacturing site.

Convis described to me an occasion on which he had had to take charge of a process change, not because others were unwilling or incompetent, but because of the number of boundary-spanning issues involved. As with many of Toyota's problems, this one resulted from its success. The Georgetown plant had to increase its productive capacity because of increasing demand. What is the solution for such a problem? In part, you continue to make progress on the way people work with machines, seeing if more speed can be squeezed out. However, there may be limits with existing equipment, or the speed of improvement may not match the speed needed for growth. Georgetown had reached the point where it needed more equipment, but where to put it? Expanding the plant was neither a low-cost nor a quick solution. That pointed to the next question: Where was space used unproductively? The answer: in parts storage.

This might seem surprising in light of Toyota's reputation for small inventories that turn over very quickly, but there is still line-side storage of the minimum number of parts needed to tide production over while material is replenished. In certain areas, those parts are big and even minimal storage requires a big footprint. Consider body weld. If a station needs one or two beams per cycle and each beam is 2 to 3 feet long by a few inches wide, that requires a few square feet of floor space. Keep enough on hand for even a small portion of an hour's worth of work before material handling returns with a refill, and the footprint is several feet by several feet. Multiply that by the many workstations in the shop and you have consumed a lot of space for storage. Factor in that the parts come in sets of 5 or 10 at a time and that each set has a carrier and the work area gets even more congested.

Probing questions were asked: Why do you need carriers for several parts? Can't parts be conveyed in lots of one? Why must the parts be carried and stored horizontally, consuming even more space? (These parts could not be stacked, so the more there were on a conveyer, the wider that conveyer had to be.) That inquiry helped establish a goal of transporting one piece at a time; even when several traveled together, each would have its own small conveyor. Added to that was the objective of moving and storing them vertically, not laid flat.

These objectives were not as easy to reach as they sound. Working from the point of customer contact—the line-side location where the parts were used—it meant reconfiguring workstations to accept material presented in a different fashion (the domain of production engineering) and reconfiguring the way in which the pieces were accessed and handled by operators (the realm of the production supervisors and managers). When material handling moved long beams upright, they had a tendency to wobble. Could they be transported vertically without danger of being damaged? Transport would have to be altered, as would the way in which parts were loaded at the suppliers and unloaded at Toyota. There were a lot of organizational boundaries over which collaboration and coordination of effort and innovation would have to be managed. This made it Convis's job.

What makes the situation so different from what might take place in other organizations is that Convis himself felt that this was his job. He never saw it as something "below his level," nor would he have concluded that if moving parts vertically instead of horizontally was going to be this much trouble, then it just wasn't worth it. This points out another critical difference between the manager in a high-velocity organization and his or her counterparts elsewhere. If a problem makes it way up to his or her level, the high-level manager has to be part of its resolution. Either the problem spans boundaries over which no one else has authority and responsibility, or it doesn't, but it is challenging enough that it could not be resolved at lower levels. Either way, the senior leader has to be a process improver, which depends on seeing problems when and where they occur.

## Who Is in Charge of Whom?

If the goal is to design work to see problems and then solve them where they are seen, a leader must be in a position to see problems as they arise. The higher the level of authority, the harder it can be to do this because much of the work itself is less tangible. "Normal" may be harder to define, which makes departures from normal harder to see. Convis reflected that one of the most difficult conceptual challenges is finding abnormality in things that one cannot see. They may be intangible, they may just be far away. Nevertheless, if they go wrong and the problem is not detected, they cause trouble. If they are seen as they start to go wrong, their effects may be mitigated quickly and the organization may learn from their occurrence.

In most organizations, the more senior person tells a less senior person what to do and the less senior person confirms that what has been mandated has been completed. This system is inverted when the objective is to ensure that problems are seen and solved where they occur by and with the people affected by the problem. If those less senior people cannot solve the problem, they have the right and the responsibility to pull on someone more senior for help and he or she is obliged to provide that help.

Put bluntly, the most senior manager is the most subordinate person. Everything is done in support of shipping product to customers. Problems pull support from successively higher levels; in effect, the senior person's pace of work is determined in large part by the needs of people many years and many ranks his or her junior. The same thing is true in a design or service situation. There is much that the senior leader must do in terms of directing, expanding, and contracting people's behavioral latitude: We're working on this, not that; you're needed here, not there. However, in an organization managed to see and solve problems, it is the occurrence of problems and, more to the point, the occurrence of problems that cannot be reconciled that determines where a manager's efforts are directed. And that's just what we saw earlier in this chapter in the attitude of the visiting senior manager who didn't want to see the perfectly painted car. He wanted to know where the struggle points were so he could do his job—helping those below him improve their own work.

Convis has addressed this point:

> I remember when Mr. Higashi became the second president at NUMMI, following T. Toyoda, I was promoted to VP of manufacturing. Mr. Higashi had exactly the same philosophy I had heard from Mr. Ikebuchi and T. Toyoda. He said this to me during one of my earliest meetings with him:
>
> "Everyone knows you're the boss. But I want you to manage as if you had no power over your subordinates." He explained that I couldn't just mandate things. He wanted me to go out on the shop floor and sell my ideas. To do that, I had to get out of the office and down on the production line. That's the only way to understand the issues.

In Chapters 6 through 9, we've looked in detail at Toyota in order to see examples of the four capabilities that characterize high-velocity organizations. Those organizations are quick to meet customers' needs; they reach that speed with an intense commitment to specifying how work is expected to proceed to ensure that the best known approach is used. However, they couple that commitment to specificity with building tests into the work (Sakiichi Toyoda's *jidoka* principle) to ensure that problems are seen when and where they occur. When problems are seen, they are swarmed, investigated, and solved—not just to make them go away, but to replace the process and/or system ignorance that allowed them to occur with useful

# CHAPTER 10

# HIGH-VELOCITY CRISIS RECOVERY

## The Crisis That Wasn't

On Tuesday, February 4, 1997, The *Wall Street Journal* reported the following:

> TOKYO—Production at Toyota Motor Corp.'s plants in Japan, which build 16,200 vehicles a day, has virtually ground to a halt and could be suspended for up to a week or more after a fire at a brake maker's plant cut off the supply of three brake and clutch parts.

The crisis was huge. The incinerated factory, which belonged to the Toyota supplier Aisin Seiki, made P-valves, which control fluid flow and pressure in hydraulic brake lines, as well as clutch parts for manual transmissions. Although only a $5 to $10 part, the P-valve was critical to safety, its design was patented, it required precise machining, the hundreds of specialized machines devoted to its production were destroyed in the fire, and there was no backup—Aisin had nearly a 99 percent share for this item.

The *Journal* estimated that a shutdown could cost Toyota $40 million a day in lost profits, a particularly galling blow because Toyota had ramped up to accommodate a peak in demand. Toyota offered a reasonably optimistic prediction of recovery, but others were not so sure. An expert quoted by the *Financial Times* predicted the following:

> If Toyota resumes 15 percent of its production within the week, and raises this to 60 percent next week, the cost of lost production would be ¥162 billion in sales and ¥33.1 billion in operating profits.

For victims of Japan's manufacturing triumph over the previous decade and a half, the *Wall Street Journal* article added what must have been a sweet consolation:

> Toyota's trouble also shows the continued vulnerability of Japan's industrial titans to their heralded "just-in-time" inventory systems, even two years after the Kobe earthquake stopped production of key parts and reminded them of flaws in the system. Under just-in-time manufacturing, suppliers deliver parts as often as hourly so the manufacturer does not have to keep expensive inventories. That makes for tiny reserves.

One can imagine more than a little delight around some breakfast tables and over some coffeepots in Detroit and elsewhere that morning, but one hopes they did not start opening the champagne that night. By the next day, the *Journal* ran a story that was headlined "Toyota Sees Output Recovery by Friday, but Many Parts Suppliers Are Hurting":

> TOKYO—Toyota Motor Corp. expects to resume "near normal" production by Friday at 20 Japanese assembly plants idled after a fire destroyed a supplier's factory last weekend. . . .

How could Toyota rebound so quickly? The experts in the previous article had been predicting 15 percent by the end of the week. The *Journal* reported:

> Toyota, Japan's largest manufacturer, said several parts makers have stepped in to make three critical brake and clutch parts that Toyota previously procured solely from Aisin Seiki Co., a supplier that lost a key plant to a fire Saturday.

But what about the unique, specialized, patented precision equipment that had been destroyed? As perplexing as this might have been, at least there seemed to be some doubts about the scope and quality of Toyota's surprisingly swift recovery:

> Mr. [Tatsuo] Ushijima [a senior associate at Mitsubishi Research Institute, a Tokyo think tank] questioned whether the quality of the alternative parts would equal those produced by Aisin Seiki, which

> manufactured exclusively for Toyota. "I don't think the recovery will be as smooth as Toyota has announced," he said.

Observers eager to read accounts of profuse corporate apologies and resignations over the disaster, and more predictions of dire circumstances, found nothing in Thursday's or Friday's *Journal*. It was not until the following Monday that the story was picked up again. Buried in news summaries, between paragraphs about telecommunications in Japan and the Russians selling from commodity reserves to close budget gaps and others blurbs about a French defense contractor's plan to offload shares in a bank, an appreciation of Polish privatization vouchers, and fraud in Albanian financial markets, was the following brief item:

**Toyota Resumes Most Production**

> Toyota Motor Corp. of Japan said it resumed 90 percent of its normal output Friday, almost a week after a Feb. 1 fire at an affiliated parts producer hobbled the auto maker's domestic production of 14,000 vehicles a day. The blaze at Aisin Seiki Co., which supplies most of the brakes and clutches for Toyota cars, forced the auto giant to halt production for two days, set up temporary parts-making lines and seek parts from other companies.

How could the company have rebounded so quickly? A few months later, a hint appeared in the *Journal:*

> By the following Thursday, the 36 suppliers, aided by more than 150 other subcontractors, had nearly 50 separate lines producing small batches of the brake valve.

Through that collective effort, supplies resumed and production gradually restarted:

> Trucks bearing the first 1,000 usable P-valves rolled in late Wednesday. On Thursday, 3,000 more arrived, and on Friday, 5,000. Slowly, Toyota's assembly lines started up again.

With P-valves available, Toyota began reopening plants as early as Thursday, and by the following Monday all Toyota plants were back to normal production even though Aisin was able to provide less than 10 percent of the valves, not reaching 60 percent of the supply until more than a month after the disaster.

If you haven't started *The High-Velocity Edge* with Chapter 10, you probably have a few more hints as to how Toyota pulled this off. But before we delve into it, ask yourself how likely it is that your organization could add a new product to its existing line by the end of the day tomorrow. Could a commercial airline launch a new route in a day? Could a hospital add a new service overnight? If you cannot do that now, what would you have to change to be able to do it someday?

For some clues to answering that question, let's entertain alternative explanations for what happened within the Toyota network. One possibility is that either Toyota or Aisin assumed a micromanaging command-and-control posture, telling some 200 other companies exactly what to do in order to produce P-valves exactly as Aisin had done. This explanation may seem plausible, but it doesn't really hold up. The first problem is the basic impossibility of such micromanagement in such a short time. In addition, as accounts of the recovery emerged, they did not accord with such an explanation. According to the *Journal*, "The secret lay in Toyota's close-knit family of parts suppliers. In the corporate equivalent of an Amish barn-raising, suppliers and local companies rushed to the rescue." In an in-depth case study published a year after the fire, Toshihiro Nishiguchi and Alexandre Beaudet found that recovery from the fire was achieved through an "immediate and largely self-organized effort" with companies that "generally [had] no previous experience with P-valves." (Nishiguchi and Beaudet estimated the number of participants at over 200, with 70 directly responsible for production.) Significantly, and contrary to the alternative posited above, that was done with "very little direct control from Toyota."

These accounts suggest another possible explanation: the extraordinary element of trust built into the Toyota supplier network, derived from years of close cooperation. One supplier was quoted as saying: "Toyota's quick recovery is attributable to the power of the group, which handled it without thinking about money or business contracts." Nishiguchi and Beaudet agreed that the recovery had been accomplished without "haggling over issues of technical proprietary rights or financial compensation." Certainly, that loyalty was repaid, for when the dust had settled, Toyota gave its suppliers a bonus amounting to 1 percent of their sales to Toyota from January to March, a total estimated at $100 million.

Trust and rewards to the loyal may explain the effort, but they cannot explain the outcome. Toyota could have turned to many individuals and organizations during the crisis and not gotten the same response. If micromanagement by Toyota or Aisin is not a feasible explanation and trust is not a sufficient explanation, how else can we explain how thousands of people from several hundred organizations could create a new production and logistics system in a matter of days? The key lies in the concept of being self-organized. So let's look more closely at what "self-organization" implies before we turn back to the fire recovery story.

## Self-Organization: Complex Results from Simple Rules

In a variety of domains, designers are increasingly aware that the size, scope, and complexity of the systems on which they work make it increasingly difficult to plan systems that are reliable and robust, able to do what they are supposed to do, able to survive their own flaws, and able to adapt to changing circumstances.

Software designers, whose systems have to be dynamic and responsive, have been struck by systems in nature that seem self-organizing and self-regulating without any command and control or centralized decision making. With this apparent paradox in mind—coordination in the absence of a coordinator—computer-graphics expert Craig Reynolds set out to create a program that imitated bird flocking. He didn't program each "bird" with complex flight patterns, the command-and-control approach, akin to the frame by frame drawing that old-school animators must have done. Managing the detailed trajectories for each individual bird, once a number of them began flocking together, would have been overwhelming. Instead, Reynolds programmed three simple rules into each bird: Avoid obstacles (including other birds), fly in the same direction most of the other birds are going, and try to stay in the middle of the pack. Those simple rules worked well and scaled reliably. They were the backbone for the computer-generated animation of bats swarming in a *Batman* movie and the stampede in *The Lion King*.

Although the swarming of bats in the Bat Cave is nothing like the swarming of problems at a Toyota plant, the underlying principle that complex successful behavior can arise from a few simple rules is the same. Throughout this book, we keep coming back to the four capabilities that helped Alcoa and the U.S. nuclear navy stay accident-free, that helped Toyota get ahead of overwhelming competitors, and that helped Avenue A and Pratt & Whitney turn tangled or plodding internal processes into lean, mean, profit-generating operations. Here are the four capabilities expressed as rules:

1. *Design:* Specify work systems in terms of what output is being pursued, who will perform what steps in what sequence along a pathway to generate that outcome, how exchanges of materials and information (including the informational triggers to start work) will be made across the connections between steps, and what methods will be used at each step. Design systems with tests built in to immediately identify any gaps between what was predicted and what happens.
2. *Improve:* Swarm problems the moment they are seen so that they can be contained, investigated, and resolved

quickly. Involve those affected by the problem in resolving it, using the discipline of the scientific method to ensure that solving problems also builds additional useful knowledge on ways to increase the chance for success in the future.

3. *Share knowledge:* Share throughout the organization whatever is learned locally. Share the discovery process as well as the particular solution, so new insights can be put to wider use and have broader benefits.
4. *Develop problem-solving capabilities:* Develop these core capabilities in those for whom you are responsible as a leader.

If we look closely at the Aisin fire recovery, we'll see that the self-organizing effort succeeded because these four straightforward capability rules were followed with great discipline even before the fire was brought under control.

First, of course, was the recognition that there was a problem that had to be addressed. Within an hour of the fire starting, before it was under control, Aisin had created a "war room" stocked with several hundred cell phones, an additional 230 land lines, and sleeping bags to accommodate a round-the-clock operation. (By 8 a.m. that morning, Toyota was racing 400 of its own engineers to Aisin.) Immediately, Aisin began establishing new processes with which to supply its customers. This task was divided into four subprocesses: setting up alternative production sites, establishing logistics networks to handle material flow to and from those sites, working with customers (Toyota was the plant's largest but not its only major automotive customer), and working with unions and neighbors, among others.

Aisin and its customers started inventorying the types of P-valves for which production capacity had to be reestablished; there were over 100. This inventory was itself no trivial task, as Aisin's part-numbering system did not match Toyota's. Aisin and its customers determined the priority with which supplies had to be provided. If a customer used P-valves on more than one car model, it had to determine which model had higher priority.

In other words, the first task was to specify what output had to be achieved by the system overall—how many of which parts to which customers by when? All other decisions would support that one. Objectives could now be set for the firms that had offered to help. Aisin began faxing drawings of particular parts by early Sunday morning, within a day of the fire. This delegation of responsibility continued through the network. For example, the Toyota supplier Somic Ishikawa Inc. was farming out its own production to its suppliers to free capacity for the assignment it accepted from Aisin. Taiho took a mixed approach, offloading some of its normal work and some of its P-valve work to 11 of its suppliers. Kayaba, another supplier, parceled out responsibility to three of its suppliers on the basis of equipment availability and appropriateness (the largest had approximately 100 employees and the smallest only 6), helping them ramp up but doing no P-valve production in its own plant. Toyota itself took some responsibility for P-valve production, creating "temporary production sites" in a department normally responsible for experimental processes and equipment maintenance.

Regardless of where production responsibility landed, each of the autonomous elements within the self-organizing network followed the same rule: Given the abilities and constraints of the available people and equipment, establish production flows that generate defect-free P-valves. From site to site, the steps would differ, but the output would be reliably the same. Whereas Aisin had depended on automated high-speed transfer lines dedicated to P-valve production, Denso had to reconfigure its machining centers for P-valve production. Brother had not made auto parts before the Aisin fire; it had to "cobble together a P-valve production line by adapting computerized milling equipment that usually makes sewing machine and typewriter parts."

We've seen that high-velocity organizations are set apart by their capabilities to design systems, improve systems, and share what one has learned so that each person or organization can perform as if in possession of everyone else's experience. If there was ever a time when this capability for sharing was needed, it was in the first few hours after the fire. Outside of Aisin, the cumulative experience of P-valve production was nearly zero. However, since Aisin had not made those parts in machining centers as the substitutes were doing, it was not the best source of advice. Aisin therefore organized problem-solving sessions in which one plant could transfer what it had learned to others. Denso not only shared the insights it had gained by solving bottlenecks, but "also modified Aisin's design drawings and process instructions to make them more appropriate for machining centers." Although the speed and urgency were unusual, the basic approach of collaborative problem solving, cross-site learning, and leveraging local learning into system-wide gains was very familiar.

For decades, Toyota and its suppliers have honed their skills in designing exceptionally reliable processes, improving them quickly, and, as they make improvements, sharing what they have discovered along the way. Remember that Capability 4 is the development, by a leader at any level, of just these skills in the people for whom that leader is responsible. So when Toyota affiliates were faced with the challenge of reconstructing—or constructing for the first time—production lines to make a vital precision part, it was not an abrupt departure from what they normally did. Command-and-control micromanagement was not necessary because employees at all levels had been trained every working day to be quick problem solvers. What might have been crippling for some organizations was, for Toyota and its suppliers, a challenge of the sort they already knew they could handle.

I interviewed a member of the Aisin fire recovery effort. He explained that the hours were long and the pressure was high, but what was most noticeable was that, despite all this, people seemed to be having fun. They had practiced their skills at discovering great systems at exceptional speed and this was a chance to test themselves, like a sports team playing for the championship.

Now we'll look at a few more examples of high-speed crisis recovery to show the variety of situations to which this sort of agility can be applied and to emphasize the point that the capabilities needed for "normal" high-velocity management—creating and delivering an organization's products and processes—are the same as those needed to handle larger disruptions. In fact, we'll see that the difference between "normal" operations and "crisis" response is not a distinction in type, only in scale and scope.

Before we do that, let's consider a contrast between Toyota and one of its direct competitors on something much simpler, the day-to-day work of digesting small, local shop-floor process improvements and the steady redistribution of work to keep the line in balance. When we consider how different the attitude toward such a challenge is at the two companies, we'll be better able to appreciate the idea of crisis recovery as normal work.

On my first visit to Toyota, a group of us toured an assembly plant and were learning from those responsible for logistics how they managed the inbound and internal flows of parts and materials. To put some perspective on this, the plant used a vast number of parts on a just-in-time basis; some suppliers were delivering up to eight times per day. So tight was this operation that they were currently dealing with the "problem" of some suppliers' trucks arriving a minute or more *early*, causing congestion and delay in the unloading area. Their goal was to have trucks arrive within 30 seconds of the target time so as to avoid creating bottlenecks.

Despite how tightly wound this system was, we were told that there were daily reassignments of "line-side stores," the points in assembly where parts were distributed, because of the need to rebalance and shift work. These reassignments, normal for this plant, happened up to sixty times per day. The consequence was not only that some workers had to pick up the tasks previously assigned to others, but that parts and materials had to flow without delay or interruption to their new locations.

When one member of our group, a senior manufacturing manager at a Toyota competitor, heard this, he couldn't believe it until he saw documentation indicating what had been moved where over several days. Then, he explained his disbelief. Had one of his plants tried something similar, even with the cushion of inventory it normally held, the plant would be paralyzed for hours.

With that contrast in mind, let's look at the types of disruptions a high-velocity organization can handle on a regular basis.

## Crisis Recovery as Regular Work

It might seem that events like the Aisin fire are rare, but a complex system, particularly one as sprawling as Toyota's, is constantly buffeted by disruptions and disturbances. The question is how to handle them. If the organization's activities are sufficiently limited, it might rely on redundancy—backup equipment, spare capacity, and extra suppliers. But that type of safety can exact a competitive price: the cost of extra resources, the space they take up, the inventorying and maintenance they require. There can also be an impact on quality. To the extent that redundancy protects an organization from problems, it also protects the organization from opportunities to solve those problems and from all the practice, learning, and improvement that come from that.

If system stability is to be maintained without compromising cost, quality, and product variety, it cannot be because the system has been dumbed down in its simplicity and bulked up in its redundancy. It must be because the system is good at seeing and solving problems, not only on a small scale, like a high-functioning immune system, but also on a larger scale, able to repair itself even when seriously wounded. For such an organization, responding to crises is not idiosyncratic work. It is something that is done all the time. It is this responsiveness that is their source of reliability.

Let's look at some other examples of dealing with abnormal situations in a normal way.

### Example: Port Lockout

After the Aisin fire, the loss of a single supplier had to be countered by a self-organizing network. If that seemed challenging, what if the entire supplier network went off the grid? That is exactly the situation that confronted Toyota when 29 ports on America's West Coast were shut down from September 29 to October 8, 2002, due to labor-management conflict. Diverting ships to Canada would not necessarily do the trick because Canadian longshoremen were affiliated with and sympathetic to the American longshoremen. Mexico also had limitations: Once the ships were there, the infrastructure of roads and railways was insufficient. Even diverting to East Coast and Gulf ports would be problematic: Some of the cargo ships were too big to pass through the Panama Canal.

Let's look at how Toyota self-organized to solve this problem.

The strike was not entirely a surprise. But the truth is that the union and management had been negotiating and most people thought the two sides would stop playing chicken soon enough to avoid a collision. That was not to be, however, and now Toyota's ability to produce and deliver vehicles was going to be impaired.

A decade earlier, when more Toyota cars were imported from Japan fully completed, the problem might have been less severe. North American dealers would have had some leeway, thanks to the inventory on their lots. But in 2002, Toyota was manufacturing nearly 1 million autos per year in North America. A disruption in shipments from Japan would affect North American body shops, engine production, and final assembly as well as many suppliers that used foreign-sourced materials.

There was little time to act. Toyota had already been increasing the frequency and decreasing the lot size of shipments between its suppliers and itself within North America. It had been pushing the same effort with supplies coming from Japan. True, there had to be some accommodation to the scale economies of packing things in containers and the vagaries of ocean travel times, but many of those issues had been addressed by bundling small batches of different types of parts on shipments. So there was little inventory for certain items. If supply networks could not be reestablished quickly, plants might have to shut down. With so many companies dependent on the West Coast ports, there was going to be a mad dash to lock up alternative routes. Toyota was looking at a winner-take-all contest.

The shutdown came on Sunday. Within hours, experts in supplier relations, production planning, control, and logistics on both sides of the Pacific were assembled into a working team.

The first priority was building a "bridge" from Japan to the United States to replace the stranded fleet. Without a means of moving material, all else was moot. Space was lined up on cargo-carrying 747s (ultimately, more than 100 flights were used, nine or ten per day). That was to be the pipeline. Mean-while, other groups were establishing what had to flow through that pipeline by calculating what materials were expected at what plants by when (establishing the target "output" for this temporary shipping system). One team was tallying what was onboard ships waiting to dock along the West Coast. This was critical information. First, it gave them a measure of the volume and weight of what had to be transported. Second, they could start setting production priorities for supplier plants in Japan. Materials manufactured but not yet loaded could be diverted, but materials already at sea had to be replaced.

Still more needed to be done. Not enough 747s were available on short notice to move all the supplies that were needed to keep Toyota's plants running. A massive Antonov transport plane, so big that it had its own internal block and tackle to move shipping containers, was available but was not cleared to land in the United States. Separate routing had to be created to transport cargo from its landing field in Canada. One ship operator stranded off the West Coast got fed up and dumped 200 cargo containers in a port in southern Mexico. That was both a hassle and an opportunity. The situation necessitated creating an unloading-and-transport mechanism, not only to accommodate the infrastructure in an out-of-the-way place, but also to move the material through the Mexico–United States border crossing without undue delay or cost. But at least those parts were now part of the lifeline if they could be delivered quickly enough.

Toyota's Glenn Uminger, who was in the thick of this crisis, explained to me how this was handled in a plug-and-play fashion:

> The person that we sent there had a proven history. He was from the Georgetown [Kentucky] plant and he was a guy who can just get things done. He can make decisions on his own. Send him into this hole—into the unknown.
>
> He had had experience with U.S. ports, so he could handle the technical difficulties of getting the ships unloaded, and the inventory accounted for, tracked, loaded onto trucks, and sent on its way. That was "normal" process to him. But then we had to insert another step into the flow—clearing customs—so we had to plug in the other piece, having a group of customs experts support him on how to file the right paperwork to transit the border. These people didn't typically work together, but with a common approach to jump-starting a process and solving a problem, they meshed perfectly. We never missed production except for a few of the trucks in Indiana, where it didn't make economic sense to airlift heavy engines and transmissions.

Uminger reflected on managing abnormality as a normal occupation:

> It is never routine, but it is repeatable. We follow the same formula.
>
> [In the moment,] you are looking to people because they have faced things and are prepared for this right now, so the leaders are very important. They are the ones with the experience, so we try to

> team up people who have been through some small problems over the years at different levels, for instance, very experienced people plus experienced people on their staff plus less-experienced people to give them experience who can learn how to manage the situation and run with it.

He then discussed the alternative of running operations with more slack:

> We get this [criticism] all the time. The whole discussion of how just-in-time doesn't work. People comment, "This is stupid. Why not just carry inventory?" From our perspective, it's better to have a tightly linked supply chain and manage disruption when it occurs rather than carry fat all year round. If you do that, you lose your ability to see problems and solve problems. Instead, we practice on real problems all the time, so when a big problem hits, it's just a matter of degree.

### Example: Finding a New Permanent Supplier

While a port's closure is a dramatic example, complex systems are constantly dealing with crises as events occur, conditions shift, and plans go awry. Being able to respond in a dynamic fashion is what converts crises into an exercise in building and ramping up new systems in a methodical fashion (albeit at great speed) rather than a potential derailing of the enterprise. Here is another example.

Kirk Manley, a manager in Toyota's Production Control Division who specializes in project planning management, is another of those Toyota people whose normal work is dealing with abnormal situations. One arose when a supplier to three of Toyota's North American factories requested that it be freed of its obligations. It fell to Manley to manage the transfer of production from that supplier to an alternative, all the while ensuring that there would be no interruption in supply to the customer plants. Time and execution were critical. With the supplier eager to end its obligation but with little inventory in the system, any glitch could be serious.

Manley was in no position to solve the problem on his own, and even the permanent staff with which he worked was too small and lacked the particular skills to make this bad situation good. So Manley had to build a virtual organization to handle the challenge.

He started by outlining the large objectives he had to meet and the key process steps that had to occur. First, someone had to identify alternative suppliers that had both the technical skills and the physical capacity to pick up responsibility for new production in midmodel, well after they had made the budgeting decisions and space, equipment, and labor allocations to support their current commitments. Second, a gap analysis had to be done: What were potential new suppliers capable of doing and what resources would have to be transferred from the existing supplier? There was also the technical challenge of dismantling, transferring, and reinstalling specialized production equipment. Then there were logistics considerations: Raw materials would have to be diverted from their current paths to new destinations and finished product originating from these new production facilities would have to get to Toyota's plants.

Within weeks, the new suppliers were ready to go. Not only had the crisis-management team generated a design, it had also done a number of validation tests—its version of the hold, not tape, not bolt, not weld approach Bob Dallis had practiced. Mock-ups had been created at the new production sites to ensure that ergonomics, material transport, plumbing, wiring, lighting, and other factors could be fine-tuned before the equipment arrived. Representatives from the new plants had worked on the equipment at the current supplier's plant before that equipment was disconnected, establishing standard work processes for both production and preventive maintenance, with people from production engineering learning from the experiences of their counterparts at the current supplier and reviewing that supplier's maintenance logs. When it was their turn to solve problems, they would not be starting from scratch but would benefit from the experience with the equipment that had already accumulated.

With a plan in place and its key elements tested, the current supplier ramped up production, building a buffer inventory that could be stored at the new facility to cover the transition. Moving that inventory to the new site also provided a chance to debug material handling, shipping, and other logistics problems before responsibility switched from one site to the next.

With everything in place, the production at the original site was stopped and the choreography of who was to do what commenced. Of course, things happened that had not been anticipated, but those problems were swarmed and solved with equal acumen. For the plants dependent on these suppliers, the transition appeared to be completely seamless. Not because the system was simple enough to rearrange easily. Nor because the system was complex but had wisely built up enough protective layers of redundancy. Rather, the system was well-practiced and well-honed at being self-correcting and self-improving and at treating *anything* that happened as an opportunity for additional self-correction and self-improvement.

## Example: Finding a Temporary Supplier

Kirk Manley's colleague, Matt Buckenmeyer, has led similar efforts, dealing with abnormal out-of-control situations in a normal, in-control way. For example, a supplier of wheel rims suffered a fire; it had sufficient capacity to restore production, but it would take several days before the fire-damaged equipment was repaired. In the meantime, five of seven machining lines were unusable. A few days might not seem like a lot, but it is when the system has been chiseled lean.

Wheel rims might seem like a relatively simple part of an automobile, but in fact they are the product of sophisticated forging, machining, and powder-coating processes. What's more, because customers get to personalize their rides, rims and wheels have to be matched to particular vehicles. Because they are big, bulky, and expensive, they cannot be stored in anticipation of demand. With one supplier down even temporarily, it was not sufficient merely to have other suppliers lined up to pick up the slack. To maintain sequence and timing, logistics had to be ramped up so that the suppliers could produce and deliver exactly what was needed when it was needed, loaded and presented in just the right sequence.

This takes us back to the concept of self-organizing systems and how Toyota's high-velocity way of doing things allows it to benefit so much from self-organizing systems when something goes wrong.

Outside the Toyota system, it might be common for each pair of supplier plants and customer plants to have its own approaches to placing orders and responding to them. Some customer plants might broadcast a production schedule days or weeks in advance, others have electronic ordering systems; some might convey orders to headquarters, others to individual supplier plants, and still others to specific lines, bypassing any centralized system. Imagine trying to solve a supply problem by unplugging one supplier and temporarily plugging in the next. It would take a huge effort just to establish how orders would be sent and received. It would be like getting PC peripherals to work with Macs and vice versa, but much worse.

That's not how it is within a Toyota supplier network. In accordance with the "rule" of specifying connections, or handoffs, Toyota and its suppliers develop "interfaces"—standardized ways in which orders are exchanged. When a plant needs something, it must ask for it directly from the designated supplier for that item and the designated supplier will deliver only when asked. It is Ohno's rule from his Kamigo engine plant days applied over great distances. But if one supplier cannot do the job, the plant can easily ask another without having to learn a whole new ordering procedure. The forms of the requests and responses have already been agreed on; all that has to be worked out is how much of what is being requested by when. It's like living in a world in which every computer peripheral connects effortlessly through USB ports, but much better.

For another automaker, the loss of a wheel-rim supplier for a few days could have been an enormous hassle, if not a crisis. Alternative suppliers would have to be found and, in each case, the complex mechanics of getting the right rims delivered to the right places at the right times would have to be mastered—all that trouble for just a few days until the old supplier came back on line. For Toyota, it was as easy to order rims from one supplier as from another; capacity might be a problem, but logistics would not be.

### Example: Crisis as Improvement Opportunity

You might think the Buckenmeyer family pet was a Dalmatian, the way Matt kept having to respond to fires, both figuratively and literally. An oil-pan supplier had been building up an inventory buffer to create a bit of breathing room. Planned installation of new equipment and modification of existing equipment would require some downtime, as would the investigation of some process issues, such as excessive scrap. In January 2007, the supplier had a fire. Thanks to the buffer inventory, oil-pan deliveries were not interrupted, and the supplier was up and running within two days. But now, rebuilding the buffer meant delaying the expansion, modification, and improvement efforts.

For Toyota, the immediate problem was coordinating accurate deliveries out of the buffer inventory, while the longer-term problem was that this supplier was less agile than needed. To deal with the immediate problem, Toyota's purchasing department, responsible for relationships with suppliers, managed coordination with the engine plants that depended on the part to ensure that there were no stockouts while the plant got back on line.

At the same time, Matt Buckenmeyer was sent in to deal with the longer-term situation. The production problem had been precipitated by the fire, the recovery from which had wiped out the supplier's backup inventory. Without that buffer, the supplier faced a dilemma. It couldn't afford to put off the equipment upgrades and modifications long enough to rebuild a large enough buffer to carry it through. But if it did shut down for upgrades without having built up a buffer, it wouldn't be able to make delivery of parts. Neither option was acceptable. But for Toyota, and for Buckenmeyer, the real question was: Why couldn't this supplier manage upgrades and the like without building up an inventory and shutting down? Why couldn't it do normal production and normal improvements simultaneously? What was so fragile about the system that both couldn't happen at the same time?

With some investigation, Buckenmeyer and his team realized the sources of vulnerability. Although the supplier was linked to its Toyota customers with a just-in-time pull system and therefore had a clear view of its immediate production demands, it did not have an equally simple, reliable system for coordinating its internal flows of material and information. Within the plant, it wasn't absolutely clear what had to be made because external customer demand wasn't reliably setting the pace of final production, in turn setting the pace of upstream processes. So one reason the supplier felt it necessary to build a store of finished goods before the equipment upgrade was that it was never entirely sure that it had made what it needed to make. (As we saw in Chapter 6, this was the very predicament that motivated Taiichi Ohno to develop a just-in-time pull system. We also saw how such a system helped Aisin Seiki be far more responsive to its customers, making custom mattresses in response to actual orders and shipping them right off to customers rather than making them in response to anticipated orders and piling them up in a stockroom.)

Not only hadn't the supplier developed the capability to follow the rules for designing a system, but there was also a second problem. Because the supplier was unable to track what was needed and what was available with ease and accuracy, it was difficult to detect abnormal situations. This compounded the need for extra inventory "just in case" a problem came to light—a problem that might have existed for a while before being discovered.

The solution to both problems, of course, was to help the supplier's management develop their capabilities to design and operate reliable systems and to solve problems as they occurred, so the production system would be more reliable, more agile, and less vulnerable.

## Crisis? What Crisis?

Many people think of work as having a demarcation between the normal demands, in which people stick to a groove, and the crisis situations, in which the rules have to be thrown out the window to make do. Let's consider an alternative view. Not that there are two categories of work—regular and crisis—but that there are two categories of organizations—those for which everything feels like a crisis and those for which everything feels regular.

In some organizations, the processes are so poorly designed that, even on a routine day, they regularly generate problems. Because the problems are so hard to see (the processes not having been designed to make problems visible), they can be exceptionally disruptive by the time they are recognized as problems. Even then, they are not contained and resolved effectively; they are bandaged and worked around and are sure to pop up again. Lessons learned by one person are rarely of use to someone else. The result is constant firefighting just to get the job done each day.

Then there are the organizations with well-honed, broadly shared routines for accomplishing work, improving work, and continually learning how to accomplish and improve even more. Processes are detailed in a methodical fashion while they are being designed; when they are in operation, there is constant attention to perturbations. When perturbations are experienced, they are swarmed and investigated; problems are resolved through high-speed, low-cost cycles of discovery. When discoveries are made, there is an organization-wide protocol for sharing them. Every situation requires people to design and operate, improve, share knowledge, and develop these skills in others; the only difference between glitches and crises is one of scale and immediacy, not approach. That is the situation Toyota tries to create for itself and for its suppliers. That is the situation its competitors have been unable to create, much to their detriment.

Now, let's look at some health care organizations that have tried to do the same for themselves as well.