

Tokyo Sekisui

Routinely builds 80 percent of a house in three days.

Robert W. Hall

Fourteen years ago, a *Target* article featuring Tokyo Sekisui grabbed attention because they routinely completed 80 percent of the work on a new house in three days.¹ Today, Tokyo Sekisui Heim's standard is still three days, but if modules can be delivered to the building site overnight, 80 percent of the work is done in two days.

During the intervening years, the most noticeable improvements have been in quality from suppliers, in automation (mostly to improve quality), in how each house is designed, and in environmental performance. Today about half of all houses delivered by Tokyo Sekisui are powered by solar panels on the roof, and all eight plants of Sekisui have now delivered 50,000 solar powered houses. In 2001 Sekisui was cited for zero emissions and zero waste at construction sites; no volatiles go into the air, no contaminants flow into water, and all materials dropped at the site are returned for recycling.

Tokyo Sekisui is also busy meeting the human challenges of a new age in Japan. Gone are the days of lifetime employment. Unlike their fathers, today's college graduates in Japan are as likely as Americans to jump ship if the work challenges and the work environment are not to their suiting. Non-college youth are more restive too. The

Tokyo operations must work harder to cultivate a cadre of highly-skilled, experienced people. One has to be lean to compete in this market, and Japanese home buyers are more environmentally demanding than American ones. This combination of forces has pressed Tokyo Heim's corporate parent, Sekisui Chemical Group, to become an icon of corporate responsibility. (See "Facts about Tokyo Sekisui Heim House.")

A quick definition of corporate responsibility is that a company genuinely attempts to improve the lot of all its stakeholders; customers first of course, but also employees, suppliers, communities — and the environment. As for investors, they still demand a profit, so this is a difficult juggling act.

In Brief

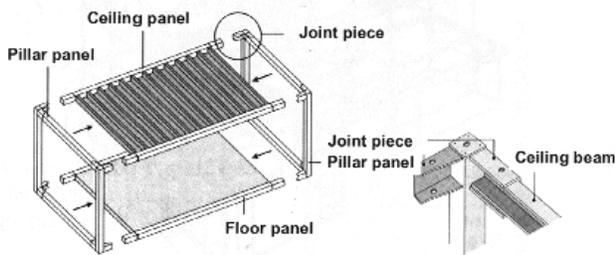
Sekisui is the market leader in factory-built residential housing in Japan. Maturity in lean is necessary to compete in this market. Sekisui's current initiative is to become a model of corporate social responsibility; it is now receiving environmental awards. The key to this is developing a vigorous learning culture. How this works in practice is illustrated by operations at the Tokyo Sekisui factory.

Facts About Tokyo Sekisui Heim House

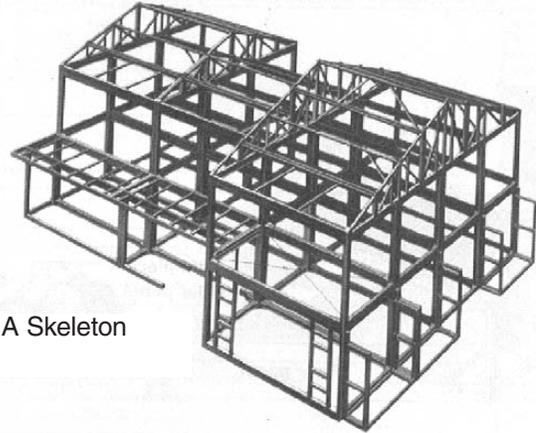
In Japan, Sekisui is the market leader in factory-built residential houses. (One competitor is Toyota, which was in this business for years; dropped out and then re-entered.) The housing operations are a subsidiary of the Sekisui Chemical Group. It has two other large subsidiaries: Urban Infrastructure and Environmental, which fabricates a variety of materials for urban infrastructure, notably PVC water pipe; and High Performance Plastics which, among many other things, is the world leader in interlayer film for automotive safety glass. The subsidiaries are closely tied for operating purposes. The last two subsidiaries are truly global, but about 40 percent of the group's 19,000 employees work in housing operations in Japan. Being part of Sekisui Chemical ties house construction to materials R&D, which in the housing industry is the source of much innovation, creating opportunities to also lead in construction methods. Manufactured houses are more precise than stick-build, but finishing each house on site does employ traditional craft skills.

Tokyo Heim is one of 147 legally independent subsidiaries of Sekisui Chemical Group and houses the largest of eight Sekisui factories serving different housing territories in Japan. Its plant and center of operations are located in Hasuda, just north of Tokyo to serve Tokyo and the densely-populated Kanto Plain.

Tokyo Heim builds steel-frame "Heim" house modules. Each module corresponds to a room of a house. On average, each house consists of 13 modules covering 1400 square feet of floor space, usually on two floors (about half the size of the average new American house). Around Tokyo land space is tight. Modules come in 90 standard sizes and shapes, but can be combined with no wall between to form a bigger room, and so on.



A Module



A Skeleton



A Typical Finished House

No two houses are exactly alike. Exterior and interior finish combinations vary; so do roof styles. Stairs, fittings, plumbing fixtures, and light-switch locations may be unique. Assembly is build-to-order, lot-size-one, in sequence. The plant has little space to re-sequence to better balance loads, despite 786,000 square feet under roof. Final assembly is on two lines. Light work content modules are on a two meter per minute line. Heavy work-content modules, like kitchens and bathrooms, are on the 0.7 meter per minute line. Fabrication and subassembly feed the lines in sequence. (See Figures 1 through 4.)

Of the 452 employees on the plant site, 307 work production, most on one shift. Others manage the technology, the order flow for houses, suppliers, and shipping. Completed modules go immediately onto a truck going to a marshalling yard. When all modules have accumulated, the trucks convoy them to the building site. The average haul distance is 60 miles; maximum 120 miles. When trucks arrive, Sekisui field workers bolt the modules together and seal them quickly to achieve a water-tight configuration in one day. Weather is often a factor, and no truck can sit in a Tokyo street very long. Coordinating this is a daily routine for Tokyo Heim.

Conformance quality is strict. There is no space for rework at the end of the line. Modules go straight to the truck, and in the field they must fit the first time without error.

This quality level and dimensional consistency took years to develop with suppliers. Today, the plant averages about 2.5 days of material in stock; about half what it had in 1994, but still too much. It consumes space, so they keep working on it. Twenty percent of all supplier deliveries are direct-to-line. Only two-to-four hours of most items can be held at line side. Product and delivery in sequence is scheduled with systems called SHIPS and HAPPS. Only IT people remember what these stand for; the marvel is in the execution, not the software.

To assure dimensional tolerances, welding of module frames is automated in fixtures, like an auto body. Get this right and many other problems disappear. Each module has about 200 dimensional checks in production to flag any problem before it drifts downstream. These checks also give kaizen

The Timeline for a Three-Day House

Finishing 80 percent of the work on a house in three days is the eye-popper for lean enthusiasts, but Sekisui is not unique. Major competitors operate similarly, so this is an operationally tough business. Figure 5 replicates Tokyo Heim's time-line diagram of their overall process. Going down the left side of that figure, note that the time from signing a contract until a house is done averages 40 days. While 80 percent of Sekisui's hands-on work is done in three

Welding Fixture for Modules

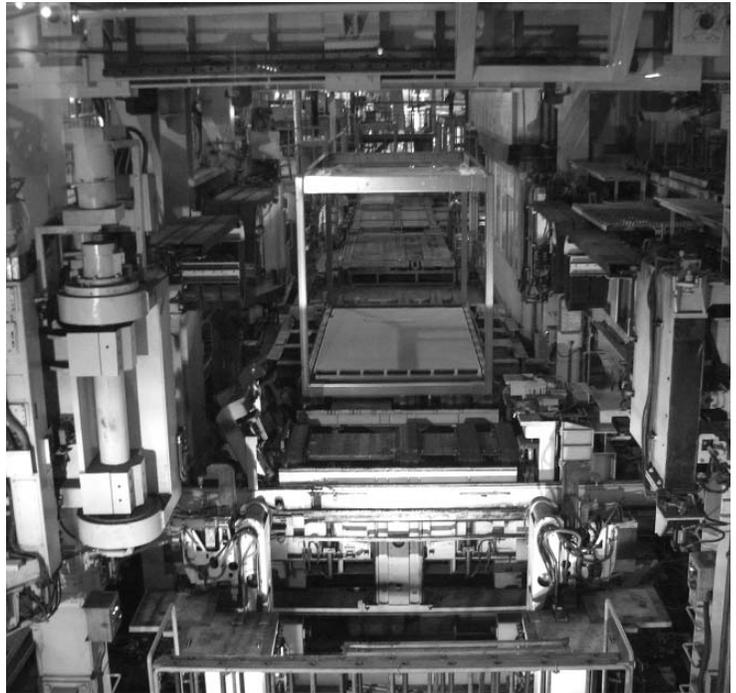


Figure 1. A welded module frame leaving the welding fixture. Panels are pre-attached to both floor and roof prior to welding.

Module Assembly

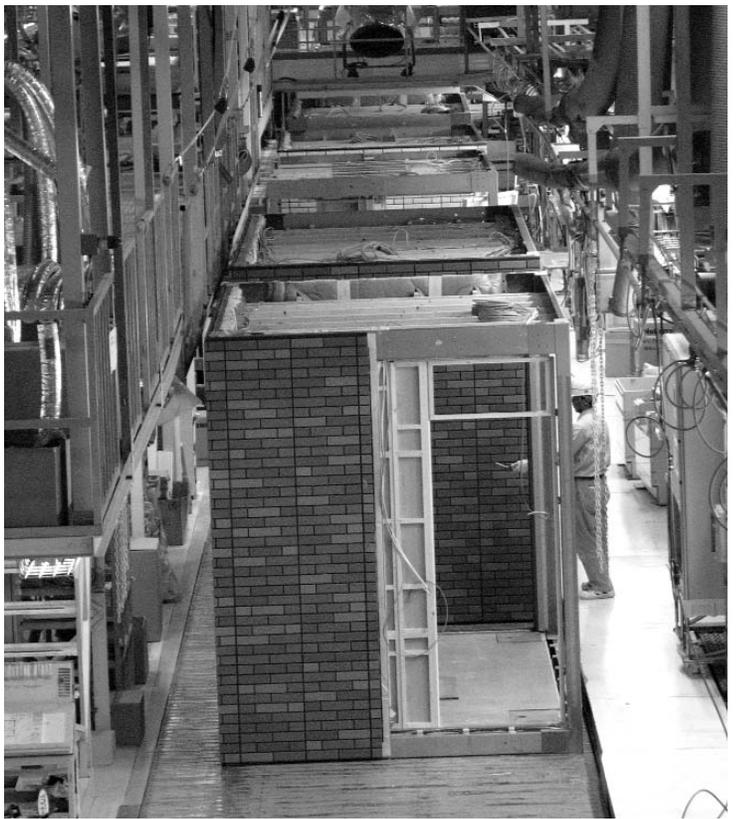


Figure 2. Light workload room modules starting down the fast line. Note the coiled wiring atop the modules. Module wiring, plumbing, and window installation are completed on the assembly line.

Feeding the Line



Figure 3. About two hours of line side inventory is at the right. With such big items, material movement is highly visible in this plant. At left, about a half day's production of bathroom modules are waiting to be trucked to their building sites. Most bathrooms are small by American standards.

Module Leaving the Plant



Figure 4. A completed, wrapped room module on the truck, ready to haul to the building site. Modules are designed not to be oversized loads on most Japanese streets and highways; special escorts are unnecessary.

days, labor by suppliers prepping material for module assembly is not included; supplier lead time is ten days.

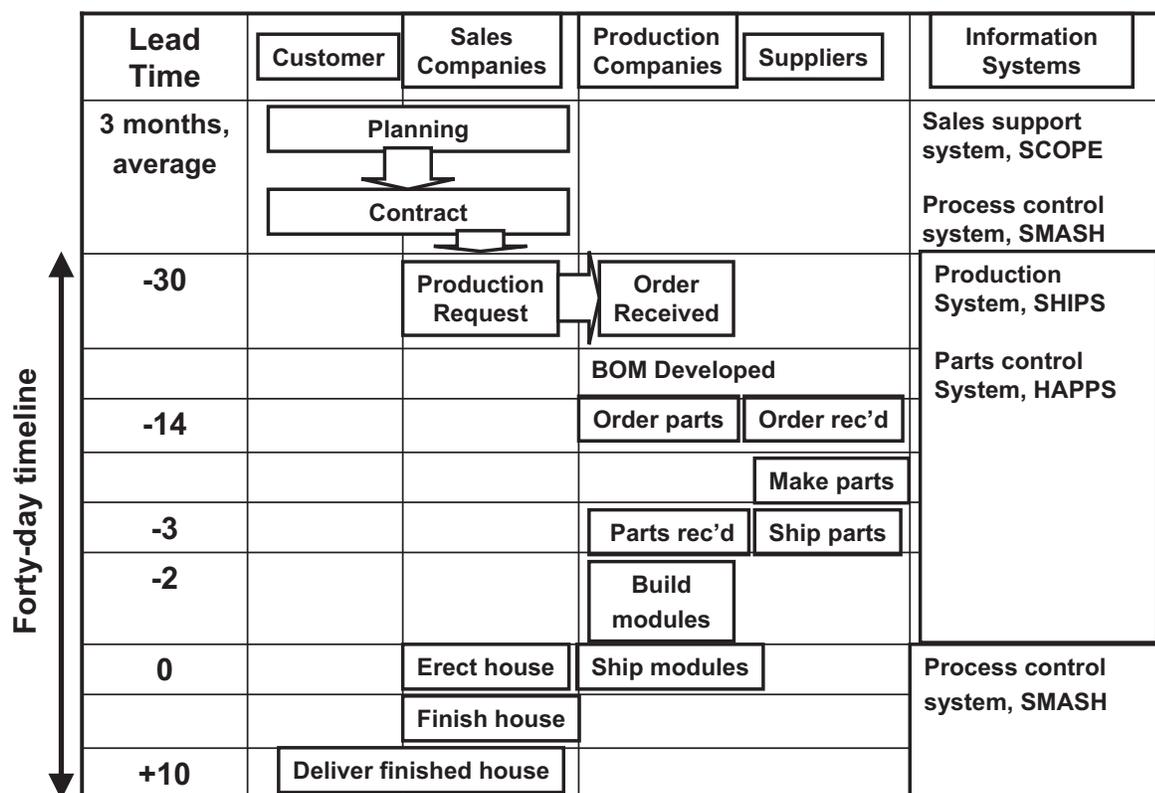
Selling and designing a house also takes time and work. Sales personnel interest a customer in a concept design; then design consultants called housing advisors work with each customer to make up the order in the Sekisui CAD format. This averages 30 hours of skilled, experienced time per house. It usually stretches for months before a contract is signed. Signing signifies that the CAD drawings detail what the customer wants, and a commitment that Tokyo Heim will deliver it ready-to-move-in 40 days later.

The CAD drawing conventions are unique, but standard throughout Sekisui housing operations. All employees must learn to interpret them, which takes three-six months. They cue all work to be done. Few additional work instructions are necessary when all employees "speak" the same CAD drawing language. Extensive preparation of other work instructions then becomes waste. This common core of communication is a big factor building a house quickly without error.

A lot of activity during the 40-day leadtime is not shown in Figure 5. An existing building usually occupies the site for a new house. In that first 30 days, it must be torn down; its materials saved for recycling if possible, and the site prepared for assembly of the room modules. All permits must be in order, and usually one or more government inspectors must certify that everything agrees with local code. Like inspectors almost everywhere, they may attach little importance to somebody else's time line.

Once the modules are delivered and assembled on site, the house must be finished, which includes everything from connecting utilities to landscaping. And before the keys can be delivered to the owner, inspectors have to certify compliance to code — more wait time.

However, a 40 day leadtime beats stick-build time, a selling point for Sekisui Heim. Around Tokyo, land remains much more expensive than the house itself.



All planning and scheduling for a Sekisui House count +/- from the day that modules are joined to erect a house on site, called Day Zero.

Figure 5.

Owners don't want their property unoccupied very long.

Houses Designed for Everything

Sekisui has constructed houses of all kinds of materials, but now almost all of them are either wood frame or steel frame, with steel becoming more popular. Tokyo Heim builds only steel frame. Design has evolved with careful attention to details such as fasteners and frame cross sections for high strength, but light weight.

Translating customers' desires into CAD using Sekisui modules is an interactive exercise. Few customers can interpret the CAD, so illustrating a design's appearance, inside and out, is done with 3D models and imagery. Using check lists, the customer must then imagine how they will use the house to specify electric plug locations, for instance. Delivering a house that

matches what a customer had in mind is a detail-oriented tacit skill cultivated by experience. Change orders after signing a contract are no longer a perennial process for kaizen.

Reality is that house usage changes over its lifetime, so nothing is ever exactly as desired at a given time. A Sekisui house is guaranteed for 30 years. Its design lifetime is 60 years because of materials other than the steel frame, which will last much longer. Consequently, Sekisui Heim is starting to see more business in remodeling and refurbishing. When a non-Sekisui house is torn down, perhaps 30 percent of material can be reused or recycled. When a Sekisui house is taken down, that ratio goes up to 70 percent. For that reason, a different kind of business is beginning to emerge. A Sekisui house owner can expect to maintain a house for decades in nearly-new condition if it is regularly

revised or upgraded. Interchangeable bolt-on modules make such things possible — a complicated version of tinker-toy re-building. Already a large fraction of Sekisui Heim profitability is from re-modeling. It's too early to tell if this will be a wave of the future, but Sekisui certainly hopes that it is.

However, customer safety is a must-do design requirement for Sekisui engineers. The steel-frame Heim house is guaranteed resistant to major structural damage in winds up to 140 mph — about Katrina force. However, Japanese live in the most earthquake-prone spot on earth, so owners fear earthquakes more. A Heim house is designed to withstand earthquakes much stronger than the one that struck Kobe and Osaka in 1995. Tokyo Heim competes with other factory-built housing companies to create the most

robust designs to withstand natural disasters. (See the box on design for earthquakes.)

Corporate Social Responsibility

Sekisui Chemical, Tokyo Heim's parent, has long pursued what Americans might call quality and lean initiatives. Process kaizen based on these is embedded in the work culture — the way we do things.

These have become the base for Sekisui's new initiative, Corporate Social Responsibility, or CSR. That is, as shown in Figure 6(a), they intend to meet the expectations of all stakeholders to the maximum extent possible. Every company has to balance this, of course; but Sekisui goes well beyond just keeping a balanced scorecard.² Their systems and process improvement ini-

Complex Mission and Goals

Create Social Value While Responding to Stakeholder's Expectations



Figure 6(a). This is a summary of the mission statement appearing on page 3 of “Sekisui Corporate Social Responsibility Report 2007.”²

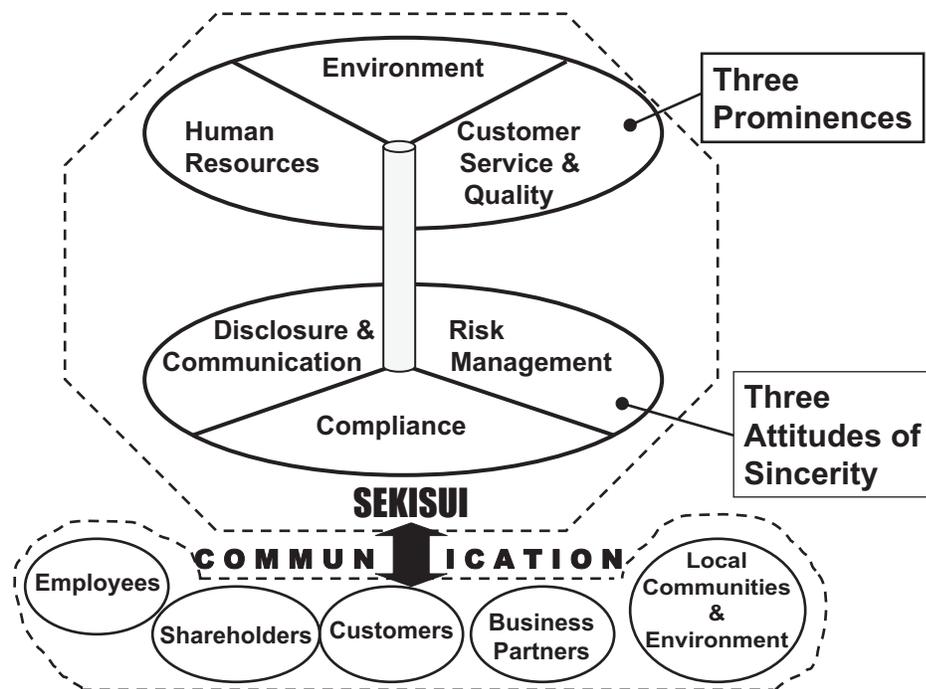


Figure 6(b). is a simplification of Sekisui Chemical's depiction. Multi-stakeholder balance is difficult to explain in any language, much less to actually achieve. Definition of the headings in Figure 6(b) may help understand how Sekisui is attempting to make this operational:

Prominence in the Environment: Make the ecology and economic activities compatible.

Prominence in Customer Service and Quality: Gain and maintain the full trust of our customers.

Prominence in Human Resources: Encourage our employees to positively set their own goals.

Attitude of Risk Management: Take thorough steps to prevent trouble occurring and reduce the generation of after-the-event risks.

Attitude of Compliance: Enhance each employee's awareness (of the situation, of all stakeholder needs, etc.)

Attitude of Disclosure and Communication: Reflect stakeholder's opinions in corporate activities.

tiatives have been directed to this end since 2004. For example, Tokyo Heim's Quality System and Environmental Management System have begun to blur into each other.

Quality is coming to mean anticipating and precluding future problems for all stakeholders, and one stakeholder is the environment. Note the definition of "an Attitude of Risk Management" in Figure 6(b). Socially responsible operational specifics have to escape the mush of fine sentiment. Juggling the conflicts is no small task. For example, some customers are very environmentally conscious while others regard environmental extras as frills. (While not advisable for long run value, the customer is still the decider.) And satisfying investor demand for profit growth requires cost reductions of several percent per year. To navigate these balances, one

must be innovative and imaginative, and as Sekisui has found, very skilled communicating with all stakeholders.

Employees are expected to make judgments about this balance. The "Attitude of Compliance" as defined in Figure 6(b) is not blind compliance with rules, but something beyond that, knowing how to exercise the Sekisui system to achieve what is needed in any given situation.

Thus Sekisui Heim's improvement initiatives focus on that elusive attribute of successful organization called communication. All stakeholders need to "understand;" therefore communication excellence has to be built into operational systems. Mere promotion — soothing the public into believing that the company is concerned about them — is not good enough.

DFE Means Design for Earthquakes

Seismic monitors record an average 300 earthquakes per day in Japan. Amid the other rumbles of urban life, only a tiny fraction of these are noticed by humans, but all Japanese regularly experience quakes above Richter 5.0 when furniture walks or tumbles over. Occasionally, powerful earthquakes disrupt life, and sometimes end it. The last disastrous Japanese earthquake was in Kobe in 1995, which hit 7.3 on the Richter scale. It claimed 6500 lives, with economic damage estimated at \$200 billion, more than the claims so far from Hurricane Katrina in the United States. In Japan, the Big One before that was the Great Kanto Earthquake of 1923, which claimed 140,000 lives. Earthquakes are never far from the minds of Japanese homeowners.

The Richter scale is a logarithmic scale for seismic detection. For every one-point increase on the Richter scale, earthquake wave displacement amplitude increases by ten times and the earthquake energy causing this increases by about 32 times. Richter readings don't directly indicate how much shaking is going on, so they are of little help improving designs.

Design for earthquake resistance considers peak ground acceleration, peak ground velocity, and the duration of tremors. Sekisui and most other Japanese designers consider peak ground acceleration to be the most critical factor. They prefer to measure it by GAL readings (1 GAL = 1 cm / sec²). 1 GAL is imperceptible, but above 100 GAL, storage cabinets begin to shake, and at 400 GAL over 30 percent of wooden houses will be totaled — a disaster. During the Kobe earthquake the gas company recorded a GAL of 833. A reading of 980 GAL is equivalent to the acceleration of gravity, or one g.

Welded steel modules bolted together flex to prevent fracture, but keep the structure intact. Sealants and other materials are developed to prevent cracked walls, broken pipes, and other damage. Test stands to check design ideas replicate the vibration signatures of historic earthquakes plus hypothetical worst case possibilities. In the Kobe quake, Sekisui Heim houses suffered minor damage, while the tile roofs (typhoon resistant) of wooden houses fell in, crushing the occupants. Interest in the Heim house picked up.

The design objective is for a house to maintain its core structural integrity if the GAL rating doubles that of the Kobe earthquake. That's about the intensity at which a house would literally sink into the ground melting beneath it.

The Communications Culture

To communicate without waste, every employee in Tokyo Sekisui has to be fluent in the "languages" of the company. The two leading languages are the CAD drawing system and the kaizen system.

The CAD system takes a few months to learn. The kaizen system is never completely learned. Every new employee — all sales personnel, all installers, all material handlers, all staff — begins immediately to learn the basic industrial engineering and quality tools used by Sekisui Heim, starting with beginning level projects. Everybody in every position is expected to engage in Sekisui kaizen and progress in ability to do it as part of their work responsibilities. Improvements range from trivial to big multi-functional projects.

Kaizen leaders on advanced projects must have at least ten years' experience, and perhaps closer to 15, both with kaizen and with the company. Leaders should understand all the workings of the company, the improvement methods, and

demonstrate skill in coaching others — both technical and behavioral.

After decades, kaizen improvement remains a big deal inside Sekisui. Every six months, every employee must report on their kaizen experiences and accomplishment to a large group of fellow employees. Once a year, each operating unit of Sekisui Chemical (Tokyo Heim is one) selects their best kaizen project of the year to send to all-Sekisui competition. Winning this is recognized throughout the company as a high achievement, and even each unit's contenders are held up as role models.

Developing People

Developing a cadre of employees to perform at the Sekisui level has become more challenging, for today's requirements require closer teamwork, while the attitudes of new employees have become more individualistic, like Westerners. Lifetime employment in Japan was always a custom, not a binding contract. Only large, growing companies could maintain

it. This social convention assured employment in return for doing whatever the company needed at the time; something like being in military service.

Economic opportunity coupled with the changing attitudes of new hires eroded that custom. For the past few years Japanese companies have lost 35 percent of all new college hires in the first year. In this environment, Sekisui Heim must retain and develop a skilled cadre of people able to perform at a level that its leadership projects will be necessary. So far, their approach seems to be working. In 2007, Sekisui Heim lost only 3.7 percent of new college graduates in the first year. If they stay the first few years, they are likely to be "lifers." If Sekisui is not what they want to do with their life, it's best that new hires go their way sooner rather than later. Thus Sekisui Heim must pay more attention to "getting the right people on the bus," but the upside is that the people who stay have an intrinsic interest in the work.

Sekisui has job postings. New employees are encouraged to rotate through several jobs to find a niche in which they feel challenged and happy.

The old system of promoting age cohorts as a group is gone. Promotions are now much more by merit — although merit greatly depends on demonstrated performance in a team setting. In the past two years, senior managers have had to learn how to evaluate their charges carefully and fairly. The older Sekisui managers obviously were still getting used to this idea.

As a result, senior managers' mentoring of their charges is no longer a now-and-then activity. Part of their standard work is coaching the "soft stuff:" the value system in practice; the work culture; how to think; how to listen; how to behave in meetings; how to persuade others ... Mentoring takes place on the job, during work every day, in addition to periodic personal conversations. All managers from the president down to team leaders should take advantage of good teaching opportunities at times

when they are relevant to the activities of the day. (And there is no better way to deepen one's own learning than coaching others.)

This is considered so important to the future of Sekisui that for the past two years, managers have had classes and discussion meetings on effective mentoring. The premise is that they must develop all people in the organization to work together solving problems with minimal friction. If they can eliminate communication waste, every other challenge to beset Sekisui will become easier to surmount.

A Vigorous Learning Organization

Sekisui fits the pattern of a vigorous learning organization outlined in a prior *Target* article.³ It has a common language that enables people to communicate and learn quickly — the CAD drawing system and the kaizen system. It has a systematic means to draw the right people into the company and to develop them behaviorally for effective problem solving together. And it has a mission statement with a social objective that points the direction for further learning and improvement. In such an organization, lean and quality are base-level givens.

Robert W. Hall is editor-in-chief of Target and a founding member of AME.

Footnotes:

1. Robert W. Hall and Yoshinori Yamada; "Sekisui's Three-Day House," *Target*, July-August, 1993.
2. Sekisui Chemical's 82-page 2007 Corporate Responsibility Report is considered a model for such reports and can be downloaded from: http://www.sekisuichemical.com/csr/report/pdf/csr_report_2007_e.pdf.
3. Robert W. Hall, "The Vigorous Learning Enterprise," *Target*, Issue 1, 2008.

