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ZEN LEARNING:
A NEW APPROACH TO CREATING MULTISKILLED WORKERS

Dori Digenti

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Center for International Studies
Massachusetts Institute of Technology

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Dori Digenti
Director of Training and Programs,
Massachusetts Institute of Technology Japan Program[1]
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Introduction

The U.S. is facing a crisis concerning the 12.5 million Americans (11% of the workforce) who are involved in manufacturing work. The Office of Technology Assessment estimates that 20-30% of U.S. workers do not have the skills to do their current work efficiently (Avishai, 1994). The crisis is exacerbated by a widening gap between the complexity of the manufacturing task and the skills acquisition of the U.S. manufacturing worker (see Figure 1). The "skills gap" has been recognized as a key impediment to improving America's competitiveness as we face the 21st century.

The skills issue is being addressed effectively in many leading companies. Motorola spends upward of $120 million per year on education for its employees. In 1986-88, 90% of Motorola factory workers had a 5th grade education; now Motorola workers and training programs are a benchmark for the semiconductor and other industries.[2] Texas Instruments, as one of the 10-20% of U.S. companies who provide remedial reading and writing for their employees, addressed the skills gap in the early 1990s, by bringing the reading and math levels of their existing semiconductor manufacturing workers from the 8th to 10th grade level for floor workers, and from the 8th to 12th grade level for technicians. The three-year effort cost $15 million.[3] In the case of Corning's 20,000 employees, 2/3 were deficient in reading and math, and extensive training dollars and 5% of employees' time is now spent on training, including remedial education (Hoerr 1990). Now companies like Motorola, Corning, and TI have established entrance exams for incoming manufacturing employees. However, many small and medium enterprises in the U.S. either cannot afford or are not convinced of the need for entrance requirements for manufacturing workers. The impact of these firms on large manufacturers is significant, as large manufacturers increasingly rely on smaller supplier firms for outsourcing components and subassemblies. In other words, the skills gap must be addressed in every firm to ensure that the skill level workers is commensurate with global competitive standards.

Corporate experience has shown that the root of the skills problem is actually very simple: *we need a strong literate/numerate workforce who has clear and compelling incentives to continuously learn.* Further insights from companies that are addressing the skills crisis are:

1. Reading and writing skills are not independent, i.e., in order to accomplish high-level math, reading skills must be high,

2. Workers have difficulty in the following areas:
- processing complex written instructions
- engaging in accurate interpretation of SPC information
- reaping the full benefits of training dollars being spent on them

3. Studies have shown that a high level of basic literacy/numeracy creates a stronger foundation for the development of higher-order thinking skills, such as problem-solving, paradox resolution, etc.

4. In addition to basic and advanced reading and quantitative skills, workers need the soft skills which allow them to be successful in flexible team-based organizations, such as commitment, motivation, and dedication. (Engelbret, 1993; Healy, 1995; Glimm, 1991, Cappelli and Iannozzi, 1995)

With the increasing sophistication of manufacturing production systems and the worldwide acceptance of total quality manufacturing comes another level of necessary skill acquisition: workers must be multiskilled to work in team-based production organizations. Successful multiskilling efforts require strong basic skills and an organizational commitment to ongoing training and development at every level of the firm. The implications of this second level of skills needs is that many companies are faced with two challenges: improving basic skills while implementing multiskilling efforts.

This paper will introduce an integrated set of Japanese learning strategies, called "Zen learning." These strategies have been used in Japan for centuries, and the basic principles have been modified and translated to the 1990s business environment. The first section of the paper outlines the historical background and defines the Zen learning strategies. Next, in Section II, we will look in detail at two examples of traditional learning that all Japanese engage in to build a strong foundation in basic skills: *shodo* (calligraphy, comparable to penmanship training) and *soroban* (the abacus).[4] These traditional learning methods form an informal support system for formal education in the schools. Following this, in Section III, we will explore how these learning strategies are used in Japanese company training. The final section (IV)

will explore how Zen learning could enhance both the acquisition of basic skills and multiskilling efforts in the U.S. firm.

I. The History and Strategies of Zen Learning

Historical Background of Zen Learning. Japan, through its adoption of Confucian ethics, has valued life-long learning as an obligation of each member of society. In Confucianist thinking, the individual's self-development and spiritual perfection is directly tied to learning. The human mind is seen as infinitely malleable, and success in learning is directly proportional to a good moral character and the willingness to persevere in study of the classics.

In Japan, as early as the Heian Period (894-1185), there are detailed records of court youths studying for exams in order to progress to the next ministerial rank.[5] In the Middle Ages, schooling fell under the purview of the monasteries, and here the training of Buddhist monks became the model for a proto-educational system. In the Buddhist monasteries, long hours are spent in meditation, but in addition, monks learned traditional arts, calligraphy, and martial arts, all taught through personalized instruction and endless hours of practice. This combination of physical and mental training at the monastery formed the foundation for learning in the Tokugawa Period (1615-1867) when secular educational academies evolved.

The Tokugawa Period, a two and a half century isolationist period in Japanese history, marks the beginning of Japan's modern educational system (Dore, 1984). The samurai class--particularly the hereditary retainers of major fiefdoms--came to be systematically trained in the Chinese classics of Confucianist thinking known as *shisho gokyo* (the Four Books and the Five Classics). A young man would typically study from the age of 10 to the age of 20-25. There was a highly codified system of examinations and rankings, for example, 14 grades were recognized at the Hikone school. Recognition and prizes, including food, money, clothes, and books, were regularly given at the time of certificate conferral. Later, graduating qualifications were also codified.

A key piece of the curriculum at the early stages was learning to write Japanese. Constant repetition was emphasized. Repetition was thought to have a positive moral

effect, forcing the young, impetuous mind to focus and slow down. The training of samurai in the Tokugawa Period, through long periods of intense study, repetition, application to task, study under a master, and engaging mind and body, remain the core of the learning strategies used in Japan.

Learning Strategies in Japan: Zen Learning. To understand how Japanese learn one merely has to watch a seven-year-old Japanese child learning Japanese by patiently copying the exact form of the character for "autumn" based on his teacher's example, or a ten-year-old who can compute 60 complex mathematical expressions in under ten minutes by visualizing a soroban in her head (See Figure 2). Or a factory worker in a Mom and Pop manufacturing shop, who can pull a part, align it, and stamp it in less than 10 seconds while mentally organizing the next three steps in the process. The Japanese learn directly, by uniting mind and body, and learn in steps broken down to their simplest subunits.

Zen Learning is accomplished through four integrated learning strategies which both guide and provide incentives for learning:

- "Learning with the body" (*karada de oboeru)*
- Master/apprentice (*sensei/deshi)*
- Certification and ranking (*dankyuu)*
- Layered learning cycles (*shu ha ri*)

Learning with the Body. Overwhelmingly, experts on how the Japanese learn agree that "learning with the body" (*karada de oboeru*) [6] permeates all manner of learning in Japan, from lessons in early childhood, to training in the traditional and martial arts, to training managers and factory workers in major Japanese firms. Coming out of the Zen tradition (see section below for more detail on the Zen background), this system of learning is based on two stages: *minarai*: "look-learning," and *kurikaeshi*, repetition and practice. *Minarai* is said to derive etymologically from the visual depiction of a young bird watching its mother fly (Nishimura, 1991). Thus, *minarai* is the first stage of learning a process, which is passive learning, that is, taking in the steps in the procedure.

Learning with the body is based on the notion of practice through repetition of prescribed forms (*kurikaeshi*). Like the Olympic athlete, the learner engages in

overlearning and physical repetition to break through mental barriers. Learning with the body involves repeating a series of small steps until they are gradually mastered and then uniting the steps in a complex whole. Only through repetition of the correct forms, with both mental and physical concentration, over a number of years can learning become automatic. The repetition of the skill to be acquired is guided by a method or teacher, but is primarily done by the student through self-study. As Yasuhiko Tsukada, a manager in Toshiba's Human Resources Division states:

> "My opinion is that mastering something means that you can do it without thinking. If you haven't mastered something, then you must concentrate on the task; but once you have mastered it, [you can do it] without concentrating or particularly thinking about what you're doing; because of this, you have the leeway to think about the next task coming up. So, unless you truly master it through repetition, it won't become "learned with the body." The flexibility comes because once the task is completely mastered, the worker can begin to play with it and experiment to find efficiencies. This is the basis of *kaizen*. So, the level of ingenuity becomes broader." [7]

By "learning with the body," and expending less conscious energy on the immediate task, the student is enabled to move to a broader synthesis of learning, eventually leading to mastery. Far from producing a rigid response in the student, "intelligent repetition" (see the discussion of layered learning cycles below) produces mastery, a complete facility with the field of study.

Master/Apprentice. Apprenticeship systems are ubiquitous in traditional Japanese culture, and are used to transmit hundreds of craft traditions in Japan.[8] The role of the master, or *sensei* , is critical in Zen learning. In Japan, the master's techniques for training include:

- **use of paradoxes to instruct**
  A master may act irrationally and unpredictably, in order to break through barriers to further learning. In Zen Buddhism, the apprentice, after some years of training in sitting meditation, is given a *koan*, a logical inconsistency which s/he must contemplate over a period of years through solitary practice until it is resolved. By repeatedly concentrating on the *koan* in practice sessions, the apprentice eventually breaks through his/her concepts to a new level of understanding. A famous example of a similar approach is the case of Taiichi Ono, the industrial genius who

invented the Toyota Production System. Ono was said to be an unforgiving teacher, and often rewarded effort with harsh injunctions to do the impossible. The pedagogical purpose of demanding the impossible is actually to inspire the apprentice to throw out mental limitations and preconceived ideas about a problem. There are said to still be "disciples of Ono" at the Toyota Motor Corp. who teach in the old style.[9]

- **providing models for the apprentice to copy**
  The master has been through the same training as the apprentice in the generational transfer of knowledge that characterizes learning in Japan. Therefore, he makes available to the apprentice hundreds of models of the correct form of each step in the process to be learned. The copying of received forms serves several purposes: ensuring the apprentice learns the forms completely by "learning with the body"; providing a discipline to often overly ambitious apprentices; and providing milestones in the apprentice's progress toward mastery. Again, the training is guided by the master, but the practice of the forms and disciplines is done through self-study.

- **taking advantage of fortuitous learning opportunities**
  The master is an expert at creating learning situations for the apprentice, and also taking advantage of potential learning situations which appear accidentally. For example, the apprentice of the tea ceremony, while preparing tea for several guests, accidentally spilled an excessive quantity of thick tea into the tea bowl in a darkened room. The master angrily took the tea bowl and mixed the overly thick mixture forcefully, ruining the fragile bamboo whisk in the process. The master then invited all the guests to drink the ghastly brew, beginning with himself. The lessons from this fortuitous learning opportunity were that guests should accept whatever is offered, there is no second chance, and that the utensils are merely tools to mix tea, not museum artifacts. Note that this entire "lesson" was taught without the master or apprentices uttering a single word.[10]

- **forcing the apprentice to work through a problem with minimum instructions by use of hints and metaphors**
  One of the main dynamics of the master/apprentice relationship is the development of the apprentice through "guessing skills."[11] That is, when the master issues a vague injunction to "Do your best," the apprentice must struggle to develop

the strategies and methods to carry out the master's wishes. Or take the case of the businessman who was told by his Japanese partner, his erstwhile master in his apprenticeship to Japanese business practice, that he must be patient if he wanted to "get in to the castle." The metaphor intrigued him enough to continue the partnership and learn to take advantage of his partner's personal and industrial networks.[12] The master takes the questions of the student and turns them back to the student in an altered form, a form that allows the student to work with the question on her/his own. The master will continue to give hints as the student struggles with learning, but only if s/he has made sincere efforts to develop an understanding on his own.

- **engaging the apprentice in menial tasks to build discipline and patience** Eshin Nishimura, who began his training as a Zen priest at the age of 2, speaks eloquently of the process of training through menial tasks:

> "When I was in elementary school, my master, who was very serious as I keep saying, would not let me go out to play after school unless I pulled the weeds in the precincts of the temple. Herbicides were not used due to environmental problems, but without it the temple's precincts become very wild with weeds. In Zen temples, we say "ichi-sooji, ni-kankin," meaning cleaning comes first, then comes reading chants. There is no preaching at all. Most of our time is spent cleaning, because of "ichi-sooji, ni-kankin." Therefore, when there is no herbicide, 80% of a Zen temple priest's time is spent on pulling weeds, except for sleeping time. If the grass isn't taken care of, it would be growing thick and wild. Even the smallest weed cannot be ignored, since it keeps the temple from looking like a Zen temple. The precincts had to thoroughly cleaned." (Nishimura, 1992)

These strategies are used by the master to train the apprentice over a period of years. Only through breaking down the apprentice's concepts about the skill to be mastered can mastery actually occur. Once the apprentice has engaged in repetitive tasks to the point where they become automatic does the master slowly reveal more and more complex forms. A key component of the effectiveness of this style of learning and knowledge transmission is the master's *precisely customized and personalized training* for each apprentice.

Ranking/Certification. Every traditional form of training in Japan has ranks or levels of achievement (*dankyuu*) which mark mastery of a technique and status within the group of practitioners. Mastery is determined by number of years of training and attainment, but there is never an endpoint; it is considered to be a life's work. The incentive system[13] of ranking and license-granting in Japan is thorough and well-defined, and operates in concert with "learning with the body" and the master/apprentice system. At every stage of training, there is a built-in testing and notification system that tells the student and the community of learners what levels of accomplishment have been attained. The rankings act as powerful incentive systems to continue learning, and as one rises to higher ranks, the responsibility to teach those at the lower levels becomes ever greater as one nears the level of master.[14] In the company setting, as we shall see in detail below, the ranking and certification systems work to enhance multiskilling, team effort, and employee motivation.

Layered Learning Cycles. In Zen Learning, there is a three-fold process of learning, traditionally known as *shu ha ri*.[15] The literal meaning of this term is *shu*: to protect, *ha*: to break away, and *ri*: freedom. In short, *shu ha ri* is a three-stage cycle of learning leading to mastery. *Shu* is learning the fundamental, basic level of rules and behavior through study and imitation, in other words, the groundwork. *Ha* involves applying what one has learned to many different situations, a kind of "intelligent repetition," drawing on the knowledge acquired in stage one. Judgments and adaptation of the rules to real situations occurs. The result of the *ha* stage is to reach one's own unique understanding of the rules. *Ri* is the fruition stage where the rules are cast aside and creativity and spontaneity replace imitation. But the process is an iterative one; there are cycles of *shu ha ri* in the overall process of *shu ha ri* leading to final mastery, which occurs over the course of a lifetime. In other words, the cycle of *shu ha ri* can be three years, each year constituting one cycle, three three-year cycles comprising ten years, and a three-fold division of 10 year cycles, comprising 30 years, the time ideally required to achieve mastery (see Figure 3). [16]

The ancients describe *shu ha ri* as a learning process which goes from "shallow to deep to shallow," so that there is originally a superficial understanding based upon learning rules by rote; the second stage involves expanding the learning to various applications and situations, in order to deepen; and the final stage is shallow again, as "upon reaching the final stage all bonds are broken and one is completely free. This freedom, however, is none other than to observe the rules."[17] The final stage of

mastery brings one back to the first steps of learning the rules, but now the rules can be understood from a perspective of freedom, in that they are applied not through slavish imitation but through an understanding of their inherent wisdom.

As described in an anthropological study of folkcraft pottery apprenticeship by John Singleton, the first stage of the traditional apprenticeship system is *minarai*, often lasting one year (*shu* stage). During this stage, the apprentice is not allowed to touch the pottery wheel, but is assigned *shitabaraki* (literally "beneath work"). The apprentice must take care of the studio's needs in terms of errands, cleaning, and other menial tasks. Once this period is ended, the apprentice is allowed to start working on the wheel. His first task is to make 10,000 sake cups in the exact size, shape, and thickness of the master's (through *kurikaeshi*). This stage continues for 6 months to one year, but the menial duties of the early training stage continue. Once having completed the sake cups, the apprentice is given progressively more complicated new forms, but each is based on the previous work (*ha* stage). When the master begins to actually commit the apprentice's work to the kiln, this is said to be a major breakthrough. The apprentice continues to increase his repertoire of forms, usually under the tutelage and watchful eye of senior apprentices. Finally, the apprentice breaks away from the master's studio (*ri* stage), but not before completing *orei bookoo,* contributing to the master's salable inventory as an accomplished potter in his own right.

Another excellent example of layered learning cycles as a kind of intelligent repetition, or more appropriately theme and variation, comes from the Suzuki method of music instruction, aptly named "talent education" (Taniuchi, 1986). Practice in the Suzuki method indicates that a musical passage should be played hundreds of time, but each time the student will strive to play it better. Mastery is attained when the student has overlearned the piece and the playing becomes automatic. The simplest pieces, such as the foundation of Suzuki violin training, "Twinkle, Twinkle," are always part of the student's practice regimen, and teachers will take even advanced students back to primary material on a programmed review schedule.

A third approach which shares many features of the Suzuki method, is the Kumon program, which focuses on mathematics and *kokugo*, the Japanese language. Kumon effectively exploits the layered learning cycles through a system of worksheets which present materials in a highly structured manner, building from basic concepts to, in the case of mathematics, advanced calculus. The method is posited on a self-study

approach, with disciplined application of the student to a daily set of 10 worksheets. Tests are given at each level to determine if the student should advance to the next level. If he does not qualify, then the student repeats the level until mastery is attained. In the Kumon method, information is constantly recycled through the worksheets, applying basic concepts to every more complex sets of word problems and calculations. Though the Kumon approach does not emphasize the role of the master, through repetition, self-study, layered learning, and positive incentives, it shares in many of the learning strategies this paper discusses. We will return to a further discussion of Kumon in Part IV.

II: Zen Learning in the 3R's

The methods of Zen learning form an integrated, tested learning strategy which has been shown to be effective in leading to mastery in various disciplines: pottery, music, and mathematics/language in the three examples above. These strategies have carried through to present times, not as cultural relics, but as effective mechanisms for creating a rich learning environment. Both calligraphy and the abacus have ancient roots in Asia, but are still avidly studied in the 1990s because of both the concrete support they provide in the acquisition of basic skills, and the added value of building patience, endurance, cooperation, and discipline, skills which are independent of time and place.

Calligraphy. Most Japanese children study traditional calligraphy as part of the process of acquiring the Japanese language. If fact, calligraphy is taught both in the school and in outside classes. According to the Ministry of Education's 1995 figures, 8.3 million elementary, 4.5 million jr. high, and 4.7 million high school students are studying calligraphy in Japan. In addition to these figures, 10-20% of elementary school students attend classes in calligraphy at a local studio, and thus are engaged in a relationship with a master. In the adult population, there are 5 -10 million involved in the practice of calligraphy, most females being over 40 (children in school), and most males over the age of 55 (retired from company). To give a rough estimate of the calligraphy "industry," which would include tuitions, exhibition costs, and supplies (paper, brushes, texts, accessories), we can say that very roughly it generates $14 billion in revenues per year.[18]

With brush, paper, ink, and water, calligraphy practice involves many hours imitating the forms of the master's brush. The process of learning calligraphy, the foundation being "learning with the body," starts with establishing proper posture, holding the brush, positioning the paper, and using the arm to draw the brush across the page (see Figure 4). Some masters will insist the student draw the character for one (see Figure 5), over and over, sometimes for the entire lesson for one to three months.[19] Through perfecting the curve of the character, the point where the brush contacts and leaves the paper, pressure on the brush, amount of ink, and so on, the foundation is laid for even the most complex series of brushstrokes.

From the foundations of simple characters, including the two Japanese syllabaries (*hiragana* and *katakana*), the student proceeds to learn both more complex characters and the different styles of calligraphy. Beginning with the *kaisho*, or most formal, rectilinear characters, and progresses finally to the *sosho*, the extremely creative, cursive style used in poetry and ink paintings (see Figure 6).

In the study of calligraphy, the role of the master is of paramount importance. The role of the master is to critique and at the same time motivate the student to greater levels of mastery of the various forms. Ranking of student's capability in *shodo* is done through exhibition of the student's work, side by side with the master's example. The master may comment on the student's work to say it is not "natural" enough, a *koan*-like critique which sends the student into practice to find a natural style. As the student becomes more adept, the master will begin to introduce new forms, and more vague injunctions to "join the arm, paper, and brush with your mind as one," or "discover *mushin* ("no mind")."

Ranking in the practice of calligraphy involves the tradition *dankyuu* system divided into three stages of mastery (see Figure 7). There are also complimentary systems, but with different ranking nomenclature, for students under 16, and for adults.

What is the purpose of the fine gradation of these rankings? Cynics in modern Japan will say that the purpose is to make the master wealthy, as each "license" is accompanied by a thank you payment to the master, and the higher the rank, the larger the payment. But calligraphy masters worth their salt will use the system as an

incentive for further study, and up to the point of *shihan*, there is always another level of accomplishment to aspire toward.

The three-fold system of rankings used in calligraphy outline the *shu ha ri* process. When asked how long it takes to master calligraphy, Tanaka Shingai, President of Sho International, describes the first step of mastering the brush and the three forms of characters (*shu* stage) as taking as much as 10 years, but this could take as little as five years if the student is very motivated and practices continually. The second stage (*ha* stage) involves developing a personal style with the three forms, and typically would take 20 years. The third stage, the most difficult, is to couple "genuine originality with a driving spiritual force." This can take an additional 20 years, but many cannot reach this stage in a lifetime. "The inner power of mind is indispensable, but this is not visible. He has to develop himself. In a sense, the more he can improve himself, the better work he can make. ... this may be called the third step, but very very few calligraphers can reach this level."[20] In all, 30 years are required to reach a moderate level of mastery, and over all 50 may be required to distinguish oneself, if that is possible at all.

Training in calligraphy in Japan creates a foundation for a broad absorption of information in the later years. Through calligraphy, the student reinforces his grasp of the Japanese written language, and understands directly the relationship between various characters and their use in a range of contexts. The role of the master as critic and model is essential to the advancement of the student; there is no way to "book learn" the styles and forms used in this field of study. Through repetition of the forms in a variety of styles and media, the student develops an instinctual grasp of the language and more importantly the relationship of writing, speaking, and reading the language. The rankings and certificates work as positive reinforcement mechanisms (it is not possible to "fail" at calligraphy), and create a step by step process to mastery. Finally, the process of passing through the ranks is a lifelong pursuit, and follows the stages of the layered learning cycles.

There are other skills that are developed through the practice of calligraphy, in concert with formal training in the Japanese language, including ability in pattern recognition, manual dexterity, and hand-eye coordination. These skills, however, are very difficult to isolate and study in context. Whether there is a direct relationship

between calligraphy practice and factory assembly capability would be very difficult to say for certain, but we will return to this point again in discussion of the soroban.

Soroban. The use of the abacus is well known in many ancient cultures, and Japan's use can be traced to China. Documents show that the abacus was in wide use in China from as early as the 15th century. From this point in history, the use of the abacus spread to Japan and was refined to its current four digit, one five unit format (*Soroban*, 1989).

It is said that at any given time in Japan, 3.5 to 5 million people (3-4% of the population) are involved in some level of instruction in the soroban.[21] There are annually one million persons taking the soroban third, second, or first level test. The soroban industry, which includes tuitions, contests, publishing, soroban equipment, and television/video courses amount to a multi-billion dollar industry in Japan and Confucian Asia. Why should this technique, surely fully supplanted with the invention and spread of the calculator, not to mention the computer, continue to maintain popularity in Japan? (The author, in attempting to purchase a slide rule two years ago, found that the only retail outlet for this device was the MIT Museum, whereas certainly the generation of Americans in their 50s will well remember that the slide rule was a standard tool in high school mathematics class.)

Again, the concept of "learning with the body" offers one explanation. By learning the digital system of numbers, literally hands-on and with the proper posture and attention (see Figure 8), the soroban adept can perform mathematics operations in a cumulative manner, that is, carrying forward a sum or quotient for each step of an operation. Adepts at the soroban actually master computation to the point where s/he is performing *anzan,* which means the soroban is being visualized in the mind, and the computation rate is so rapid that it is faster than s/he can write the answer.

Soroban expertise is certified through testing and the assignment of ranks. These are posted openly in the *soroban* school for all the members to see and compare. The example in Figure 9 shows the ranking by name (left column) for both *shuzan* (middle column - calculation using the abacus) and *anzan* (right column). In this case the rankings range from *juttsudan* (level 10) to *shodan* (beginner level). National statistics are also regularly compiled, and national as well as Pan-Asian contests are held. Of course, these contests are for a very select group who have fully mastered the soroban.

More commonly, *soroban* rank is tied to certain types of employment, for example, Japanese banks require *soroban* expertise from their employees, and those that achieve the rank will be compensated accordingly. A former Shell executive spoke of his accounting clerk, who because of his soroban training, could mentally maintain the credit limits and balances of 200 accounts simultaneously.[22]

When I met with Mr. Hiroshi Itoh, head of Kyoto Seika Gakuin, he enjoined me to "watch what they do at JR (Japan Railways) counters with the soroban." As I approached the JR counter to buy a Bullet Train ticket, I noticed a large, well-worn soroban on his desk. The clerk proceeded to tap in on his touch screen the destination, class, time and date of my ticket, and the computerized system displayed the cost, the cash received, and the change due me. At that point, the clerk picked up the *soroban* and computed the same process over again. Only then did he proffer the change that was due me. Why? The answer is that computerized systems do not count back from the cash received minus the amount of the ticket. According to Itoh, the ability to count back to the whole amount tendered is preserved and confirmed through the use of the soroban. Goh Sing Yau of the University of Malaya concurs, "The key is that you learn complementary numbers, two and eight or three and seven. That makes children more comfortable with numbers."[23]

Through developing a fluency with numbers, training in the *soroban* builds a tremendous basis for skills in the field of mathematics. Geary (1992) has found that Asian students, because of their training in the "building blocks" of mathematics, are more efficient and better problem solvers. In his analysis, students who get more drill, repetition, and practice calculate more efficiently, and have mental resources in reserve for higher-order thinking skills (more discussion of this point will be included in Section IV). Kaye's (1985) work confirmed this in his discussion of computational ability and its relationship to processing capacity. In other words, when basic mathematical operations are automatic, more mental capacity can be allocated to the syntactical, logical, or semantic aspects of the problem.

Increasingly, it is becoming accepted that mathematical reasoning, predicated on a foundation of literacy and accurate communication, underpins the ability of organizations to successfully implement advanced manufacturing techniques. James Glimm (1991), author of a National Research Council report on the mathematical sciences, technology , and economic competitiveness shows that mathematical

capability is critical for statistical process control, successful technology transfer, simulation, modeling, and other key manufacturing and design processes. In particular, the aerospace, computer, semiconductor, petroleum, automobile, and telecommunications industries are dependent on these processes to maintain a competitive edge. The Japanese manufacturing organization has a strong competitive advantage in drawing on a solid base of basic skills among its workers, and then builds on those skills, particularly in the areas of problem-solving and SPC, to improve efficiency and thereby cut costs. For example, according to MacDuffie and Pil (1996), experienced Japanese auto production workers actually spend 41.9 hours of training on SPC and problem-solving, by far the most time spent on any category of training.

Returning briefly to the questions of pattern recognition and manual dexterity, there is very little data available to validate the effect of the repetitive fine motor movements of calligraphy and the soroban on the synaptic connections made in the brain. Healy (1990) in her excellent study of the effect of various inputs on the formation of the child's mind, cites a few primate studies in which intensification of select fine motor activities produced denser "neural nets." Toyota Motor Manufacturing (U.S.) tests for dexterity in terms of numbers of assemblies performed in a given period of time; Toyota Motor Corporation (Japan) does not.[24] Much work remains to be done to determine the effects of this type of training on the brain, which is increasingly considered to retain a high degree of plasticity into adulthood.

Now, let us shift the focus from the use of Zen learning strategies in basic skills acquisition to the use of these same strategies in company training. There is a distinct cultural and traditional foundation to the way Japanese companies train employees, and those strategies are particularly well-suited to a mature, post-industrial society, as we shall see.

III: Zen Learning in the Japanese Company

Japan has one of the world's most flexible, adaptable, and literate/numerate workforces, by many measures. Using the educational system and professor's recommendations as a vetting mechanism, and supported by coherent learning strategies, the Japanese company has practically eliminated the problem of basic skills deficiencies that many U.S. companies are dealing with on a daily basis. In the training

arena, as we shall see in detailed examples below, the Japanese company uses internal training resources and a generational transfer of knowledge to effect a low-cost, high-reliability learning environment. And the cost differences are significant: the percentage of total wage bill spent on average on training in the U.S. and Europe is 1.5%; in Japan it is 0.4% (Lynch, 1994). Add to this the fact that, for example, the Japanese auto company typically commits its workers to *three times* the hours of training (and *seven times* the hours in the first year) of a typical U. S. auto company, and a clear sense of the imperative for extensive training in the Japanese firm is indicated.

The confluence of the Japanese company's need for a highly skilled workforce and the government's policies to develop the highest national skill base possible, have led to a number of systems supporting the lifelong learning environment in Japan. The most striking aspect of Japanese company training is its thoroughness: learning is complete, validated, deep/broad, and continuously evaluated. Bottom line results in Japan show that this type of approach is not merely a cultural fixation, but a pragmatic investment in human capital.

The goal of training in the Japanese company is twofold: to inculcate the employee with the company's values and ways of doing business, and to create a flexible, multiskilled workforce that can deal effectively with rapid change. The methods used by Japanese companies to effectively train employees all have as their foundation the Zen learning strategies described above. In the following section, we will look at the methods companies use to train and incentivize employees, with reference to the foundation learning strategies, focusing in particular on:

- Reliance on On the Job Training (OJT) based on *minarai* and *kurikaeshi*
- Job rotation
- Mentoring to foster a generational transfer of knowledge
- Customized, individualized training for each employee based on manager's recommendation
- Effective use of certification, testing, skill-based pay structures, and skill maps to motivate
- Thorough learning method which includes preparation, application, and review (*yarinuki*)
- Structured 10-year pre-promotion curriculum combining OJT and OffJT

- Informal systems for self-study and study groups
- Learning placed in a framework of overall personal development

Learning with the Body in the Japanese Company. There have been several studies of Japanese company training in light of the success of the large Japanese corporation in the 1980s and 90s, but few have looked at the actual methods employed.[25] Based on a review of what has been done, and from talking to managers from a range of industries, we can say that training in a Japanese company is overwhelmingly based on **on-the-job training** (OJT). In fact, in the neighborhood of 86% of training in the Japanese company is OJT (Tachiki, 1994). This figure is in keeping with the author's discussions with Japanese companies.[26] The efficacy of learning a task *in situ*, of learning a process exactly as it will be carried out on the job, has obvious value to the company. In addition, each company has specific time-proven procedures that by necessity must be transmitted from person to person; classroom learning would actually be an impediment to this transmission of knowledge. Thirdly, there is theoretically a cost savings if the trainee is not taken out of the work process, external training resources are not required, and some portion of the trainees output adds real value to the company's production. The question in this case is why has the Japanese firm relied so heavily on OJT, and why has it been such an effective mechanism of skill building and knowledge transfer?

One of the reasons OJT is so effective in the Japanese company is that it is exactly personalized to the individual being trained. This ties in neatly to the one-to-one relationship between master and apprentice that has transferred in to the company as the manager--trainee and senior--junior relationships. Since OJT is focused on enterprise-specific skills, it is one mechanism to lock in valuable employees to the firm. From the firm's point of view, OJT has a high-return, low-cost advantage that provides a minimum of truly transferable skills. (But note below the counterbalancing contribution of the Japanese government in providing ex-firm certification for skills learned within the company.) From the employee's viewpoint, the firm's investment in employee skills results in a higher potential for promotion, and recently also in a higher merit component of the annual salary increase.

OJT has been used so effectively in Japan because it has been a tool to maintain employee motivation, especially since blue and white collar distinctions have been blurred, some would say eliminated, in the Japanese company (Koike, 1994). That is,

blue collar workers proceed on the same training and promotion track as white collar workers, and are considered equally valuable human resources to the firm. The attitude of the company is that "anyone can be trained in to anything," a point to which we shall return in Section IV.

What has been in the West a recent profusion of "new" learning approaches -- action learning, experiential learning, and situated learning, to give a few examples--has been the foundation of learning in Japan for centuries, again based on the evolution of learning through the traditional, martial, and informal learning methodologies. For example, in Matsushita's invention and refining of the home bread baking machine, the engineers had a very difficult time replicating the texture of hand-made bread until they "apprenticed themselves to the head baker at the Osaka International Hotel to capture the essence of kneading skills through bodily experience."[27] Ikuko Tanaka, project head, proposed the apprenticeship to the head baker. She learned her kneading skills through observation (*minarai*), imitation and practice (*kurikaeshi*). The particularly "sticky" part of this learning process was that the head baker could not articulate the difference between his bread, which was tasty with an even texture, and the engineers' bread, which was decidedly less so. Therefore, other members of the engineering team were sent to practice kneading as well.

In a second example, Chris Couch, an MIT graduate student who spent two years at Toyota, described the slow pace of his training in the Takaoka Factory (Couch, 1994). On the first day, he did *minarai* until lunchtime, and then was allowed to load two parts into a welding machine. The next day, he reviewed what he had learned on day one, and performed the same task until lunch. In the afternoon, he tried the next piece of the process, and was allowed to call for new parts when he ran low. The next morning, review of the day before, and then a new piece was introduced. The thoroughness and incremental nature of the training was part and parcel of the Toyota Production System (TPS).

Couch's experience is reflected as well in the transfer of TPS to the Georgetown, Kentucky facility of Toyota Motor Manufacturing. Kathi Hanley, Assistant HRD manager at Georgetown, spent years in the translation process of bringing TPS to the Kentucky site. The overwhelming reliance on OJT that Hanley found in Japan became a key component of the U.S. training regimen, and every course contains a worksite application component. Her biggest challenge? Eliciting

from the Japanese managers the process of OJT so that it could be formalized in Kentucky. One reason for this difficulty is that successful OJT relies on the role of the manager as master, and thus is personalized with respect to pace, content, and presentation style for each individual learner.

A major component of the OJT system and the notion of "learning with the body" is expressed in the thorough, career-long rotation of workers in the large Japanese firm. For example, at Mitsubishi workers are routinely rotated on a 2-3 year cycle in their early career. As part of induction training, almost every large electronics firm places new employees on the factory floor for some length of time. This is not merely to teach them how to make products, but to understand the company's products thoroughly and kinesthetically. As the employee moves from post to post, he develops a repertoire of skills, experience, and networks that over time increase his value to the firm and deepens his understanding of the various divisions of the company. In a U.S. firm, learning another division's procedures and strategies would take place in a three-day meeting or a formal presentation; in Japan that knowledge is acquired through physically participating in the work of that group. The use of job rotation in the firm will be discussed again below in relation to layered learning cycles.

The role of the master and the nature of apprenticeship in the Japanese company. Kazuo Koike of Hosei University emphasizes the critical role of the instructor in OJT as follows:

> "The learner has no choice but to follow and imitate the example of the teacher in order to gain the knowledge and skills of which the contents cannot be defined completely even by the teacher himself .... this form of learning ... constitutes an acceptance of authority connected to respect for tradition."[28]

In a very real sense, joining a Japanese company is equivalent to apprenticing oneself to a master. The approach in the Japanese company to developing future managers has the same characteristics as an apprenticeship: senior-junior relationship, emphasis on skill-building, on-the-job training, and a long period of initial training before one is allowed to practice independently (Williams, 1993). In this case the master is the manager and also experienced workers (equivalent to the senior apprentices in the traditional system), who have been thoroughly trained in the shop floor procedures, company history, credo, processes, and strategies. In some

companies, such as Mitsubishi, the role of the manager as instructor is also the product of a formal "Instruction for Instructors" course. The process of "learning the company," which the manager learned from his manager in a generational transfer of knowledge, is the same long-term, gradual, and largely oral/instinctive transmission of knowledge to the apprentice. In some cases, such as at Nippon Denso, managers are directly compensated for their role in training workers (Dore and Sako, 1989). But in most cases, the managers feel it is their duty to train their workers, and are given what Kathi Hanley of Toyota Motor Manufacturing calls "emotional incentive" to do so.[29]

One of the critical aspects of Japanese company training is the systematic approach to learning, coupled with a very individualized, customized approach to each worker's needs. The manager's main job is to 1) determine the type and amount of training the worker needs and 2) provide incentives to the worker to learn continuously and be committed to the task. The shepherding of employees through a ten-year curriculum at Fujita's "Concrete U." is a case in point. Each employee must do the *hishuu* (required) course, and then may proceed to the *sentaku* (elective) course. However, the length and type of elective course selected will be decided between the manager and worker. Finally, there is the *tokubetsu* (special) course, which only certain workers will be approved to attend.

The manager's role, in addition to teacher and adviser, is to apply "spiritual pressure" to the employee to encourage him/her to learn each process thoroughly. The relationship developed with the manager is one of the key incentive factors in the demanding path of continuous learning in the Japanese company. The "carrot" in this case is the positive incentive of acquiring new knowledge and, eventually being monetarily rewarded for it. The "stick," however, is not the iron fist of job termination, as this would only happen under the most extreme circumstances, but rather the shame of letting down one's manager and team members (and by implication, one's family and the nation altogether) by failing to apply oneself wholeheartedly to the task. This is another aspect of the efficacy of putting a human face on the enterprise in the form of the bond with the employee: it is strong incentive for the employee to take learning very seriously.

The greats of Japanese industrial history: Taiichi Ono, Konosuke Matsushita, and others, utilized the tricks of the trade of the master tradition, such as obscure analogies, vague injunctions, and creating learning opportunities from fortuitous

circumstances. Kei Matsushita founded his leadership school, the Seikei-juku, on the principles of the type of Zen instruction that masters would impose on apprentice monks. Drawing from the Zen tradition of *angya*, "learning while travelling on foot," he created a system of job rotation. Again, a focus on menial tasks, such as *sooji* (cleaning), as a methodology to both learn with the body and build the proper motivation toward work, is emphasized. Williams (1993) in his fascinating study of Matsushita's leadership school, experienced the *sooji* training, which began at 5:30 am with cleaning of the grounds, and proceeded to calisthenics and the morning assembly. Through *sooji* training, Matsushita encouraged employees to develop awareness through repetitive activities, and to develop mastery of menial tasks as a stepping stone to higher levels of mastery.

Few in Japan now would claim that Japanese companies have such masters of industry as those above, and many would claim that the guessing skills needed by the employee to ferret out learning and "steal the master's secrets" exist now in the Japanese firm. However, the institutionalization of the manager as teacher in the company, and his critical responsibility to bring along the next generation, are features drawn from the wealth of the old sensei and business geniuses.

Ranking/certification and learning motivation. One of the major competitive advantages of the Japanese industrial system is the skillful balance of cooperation and competition, maximizing the gains of each. In the interest of learning and development of employees, companies freely allow exchange of information and networking opportunities for their employees by utilizing professional societies, government organizations, and industry associations (Henry, 1993). The Japanese government provides a great deal of support to companies to encourage them in human resource development. Beginning with The Vocational Training Law of 1958, the active role of government and the foundations of the present-day system of skill testing and certification were established. For example, the Ministry of Labor oversees 146 professional certification exams, 31 private practice exams, 23 government grade position exams, and 563 performance exams. In total, 1203 courses offered to prepare for exams are subsidized by the Ministry. Large companies are reimbursed 25% of the cost of sending employees to these prep courses, and small and medium enterprises are reimbursed 33%. In addition to these prep courses, organizations such as the Japan Management Association, with 250,000 enrollees, and JEDECS (Japan Education

Development Center for Skilled Workers) with 100,000, offer self-study and correspondence courses which prepare workers for certification exams.

Government subsidies do work to encourage both companies and workers to continuously learn and improve the workers' skill base. In addition, in many Japanese companies, pay is based on skill level, the so-called ability pay, rather than job description as in the U.S. That is, skill level is compensated for even if the worker is not currently using the skills that he has acquired. In this way, the company directly encourages the acquisition of a wide range of skills over time. In order to encourage such skill acquisition, and to create true high-performance, flexible teams, companies such as Toshiba and Toyota use **skills maps**. This is none other than a translation in to the company of the ranking systems from the traditional learning approaches, including the public posting of ranks, that we saw in Section II above (see Figure 9). The skill map, often posted in the break rooms right next to the assembly line for each section, is used as a tool for job rotation planning, and as an incentive for learning. Since learning is a group activity, the ego-damaging consequences of an incomplete skill map encourages the worker to get a wide range of skills, and gives management an immediate visual check on team performance.

The Toshiba skill chart shown in Figure 10, the "Tanookoo Ikusei Mappu" ("map for fostering or nurturing multiskilled workers"), shows four gradations of skill level for each task (across the top) for each worker (name is written down the side), as follows:

Pie	**Skill Level**
1/4 shaded	has performed job less than 1 month
1/2 shaded	has performed job 1 to 6 months
3/4 shaded	has acquired skill
completely shaded	expert

Note that no time frame is given for the second half of the pie, as the acquisition of expert level is not time-dependent, but rather dependent on the worker's skill, opportunity, and perseverance.

Toyota's skill charts, our second example, come in two forms, the pie chart, similar to the Toshiba example above, and the skill web, shown in Figure 11. Here, a set of 15 skills are ranked on a scale of 1 to 5, 5 indicating "I have enough technical ability and knowledge, and have the ability to make improvements" to 1 "I have no knowledge at all." The point of the skill web is to fill out the shaded area over the course of a 17 year time frame to bring skill levels up to the highest grade possible.

We will return to a discussion of the skill maps later, but they are perhaps the most powerful illustration of learning incentives in the Japanese company, incorporating personal mastery, group performance, skill-based pay, both individual and group "face," and company pride as motivating factors for learning.

In addition to ranking workers according to acquired skill levels, training in the Japanese company involves formal testing procedures. Often these tests take the form of presentations given to senior management or to the work group. That is, a worker who is sent for training is expected to come back and report on what he has learned, so that the rest of the group may benefit from his learning. This also provides strong incentive for the worker to pay attention, take notes, and be sure that he understands and integrates the information received. Overall, the approach to training in the Japanese company is based on the notion of follow-through (*yarinuki*), where each learning is approached by prior preparation (*yooshuu*) and subsequent testing/review (*fukushuu*). Again, this process involves the incentive of what Yasuki Endo of Fujita Corporation terms spiritual pressure.

Layered learning cycles and self-development in the Japanese company. There is a fundamental difference between how the Japanese company and its employees view learning as compared to the U.S. case: in Japan, learning is part of an overall, thorough approach to *jiko keihatsu*, personal development, which has no defined end point, and is the key role of the employee in his career with the company. Personal development in the firm is documented in a self-development plan. The plan is a record of the goals, accomplishments, job rotations, and aspirations of the employee, including comments from the employee and his managers, and is updated each year in consultation with his manager. At its most skillful, as Gundling (1994) reports concerning Fujitsu, the Japanese firm has aligned its strategic goals with the personal development of the individual through accomplishment at work. The development of the individual in the organization follows the outlines of the *shu ha ri* process, and outlines decade-long

cycles of learning to develop first breadth, then depth, then a return to breadth at the level of senior management.

In a sense, the entire approach of the Japanese firm to human resource development can be looked at through the model of the layered learning cycles (*shu ha ri*), leading from beginner to master. The layered learning cycles constitute the career-long process of the learning. That is, the initial 10-year cycle that leads to the first promotion to management is the shu cycle of the career-long learning process, but that 10 years in itself is composed of a *shu ha ri* cycle, each stage being approximately three years in length. Finally, the first three years in the company constitutes its own learning cycle, each stage lasting one year. This process is shown in Figure 3 in graphical form.

As Y. Tsukada of Toshiba Human Resources states, in answer to the question: Does the *shu ha ri* framework inspire Toshiba's training program:

> "Yes, it definitely does. We start with the basics for the first three years, and then move on to their application in years 4-6. Executive programs form the third level, including case studies and problem solving. *Shu ha ri* forms a philosophical basis for our training.[30]"

Looking at Toshiba's training curriculum in detail, the first learning cycle begins with the new employee training, which lasts for one month, and leads directly into the Basic course, from year 2 to 4 of employment, which involves learning one's role in the company and how to problem solve by understanding technologies and products. The Basic Course is the shu stage of training. Next, the Advanced Course, which runs from the fourth to sixth years, deals with "development of competitive new systems and technologies at an early stage by improving his own speciality [sic] and learning other technologies."[31] This corresponds to the *ha* stage of development, where the rules are expanded, personalized, and internalized. Finally, the Special Course, which is available after year 6 at the company, involves the following:

- applying the most advanced technologies and know-how to foster development ability
- providing the driving force for producing new products and for solving difficult problems
- developing new ideas and finding practical applications for them

- Refining leadership ability
- Achieving desired results with members of the group as well as thorough individual activities

This is the *ri* stage, the culmination of the first cycle of learning, which leads to promotion to management. It compares well with Fujita's approach, and is informed by the same background of creating mastery in the Japanese company employee.

It would be easy to say at this point that the Japanese company has excellent in-house educational systems that thoroughly train their employees in the company and simultaneously create the next generation of teachers. But the large Japanese firm also has a very well articulated, but **discretionary and largely informal,** system of self-study. This system dovetails perfectly with OJT/OffJT approaches and the incentives which support them. It is a key component of learning systems in the company and the use of "intelligent repetition" in the layered learning cycles.

As Dore (1989) reports, there are over 600,000 self-study books on quality control alone published by the Nikka group. Since the average company employee commutes three hours per day by train, there is a key opportunity for self-development during this commutation time. At NEC alone, there are 150 self-study courses offered as part of the "self-development support program."[32] Managers frequently suggest to employees that they prepare for upcoming training through self-study. In addition, national certifications offered in a whole range of fields, as described above, are often prepared for through self-study. Another variation on this approach is the "study group" (*benkyokai*), which will, for example, assign each member one chapter of a book to read, take notes on, and summarize for the other members of the group. Done on the employees' own time, this is a very effective and efficient mechanism for learning. Junior employees will often be given articles in English to summarize in Japanese. These summaries are circulated to senior managers with the author's name on them. Thus, the junior gets an opportunity to show his capabilities to the management, and the managers are able to benefit from the junior's effort.

Another layer of the learning cycles process is the use of job rotation in the firm, as part of OJT. Rotation is a key mechanism for creating the *tanookoo*, multiskilled worker, through learning with the body in a number of complimentary assignments. Typically, the manager, with the advice of the human resources and

training department, will decide the rotation pattern of the employee in the first three years of employment. After this, the employee will be rotated through a series of jobs in order to broaden as much as possible his repertoire of skills. The added benefits of this rotation strategy include the building of personal networks across plants, the transfer of technology through example and learning from co-workers, and the increasing flexibility of the worker over time due to his enhanced skill base. Those promoted to management will then often take on four to five year rotations, often in remote assignments. The rotation pattern is a career-long strategy. The overall strategic benefit to the company of creating the multiskilled worker through job rotation is the direct relationship between problem solving ability at the lowest worker level and planning and long-term strategic capabilities at the upper management levels (Rohlen, 1992).

The Japanese company has adapted an impressive arsenal of learning strategies based on the principles of Zen learning. Through reliance on (OJT) based on *minarai* and *kurikaeshi;* job rotation; mentoring to foster a generational transfer of knowledge; customized, individualized training for each employee based on manager's recommendation; effective use of certification, testing, skill-based pay structures, and skill maps to motivate; preparation, application, and review (*yarinuki*); structured 10-year pre-promotion curricula; informal systems for self-study and study groups; and learning placed in a framework of overall personal development, Japanese companies have created a virtuous cycle of learning that is self-sustaining and proven successful. In the fourth section of this paper, then, the task remaining is to see how these strategies can be applied to the tremendous challenge U.S. companies face in the "double catch-up" game of eliminating skill deficits and implementing successful continuous learning to create multiskilled workers.

IV: Effectiveness of Zen Learning and Implementation

Is Zen learning effective? The information and examples presented above point to a paradox: how is it that "learning with the body," repetition, and slavish imitation of received models lead to multiskilled, flexible workers who are devoted to continuous learning and skill improvement? Conventional wisdom in the West tells us that imitation and repetition dull the mind and result in compliant, rigid, and narrow-minded adults incapable of acquiring new skills.

To solve the paradox, it is important to highlight two aspects of Zen learning which differentiate it from rote learning. The first is the integration of methodology, motivation, and support systems that leads to the successful development of multiskilled workers. In other words, training in basic skills alone will not give the desired outcome; it must be combined with career incentives and management and institutional support to yield the flexible, multiskilled worker.

The second factor brings us again to the series of studies over the past 15 years which indicate that repetition, particularly in mathematics, can lead to higher-order capabilities in problem solving, due to the creation of alternative, dense "neural nets" which form the basis of creative problem-solving capabilities (Lewis, 1992). Most manufacturers will acknowledge that in current practice the skill most needed for success is the ability to problem-solve. In fact, the total quality management movement is predicated on the skill of the worker in identifying and resolving problems in the manufacturing process. Whether the problems take the form of defects, production bottlenecks, or non-routine problems, it has been shown that successful quality programs work only when the workers themselves develop a deep passion for problem solving.

What are the components of a problem-solving skill base? They are exactly the higher-order thinking skills (HOTS) alluded to in the discussion of the soroban and calligraphy. As we saw above, when the mind is trained through observation and repetition, an automatic sense of process and pattern recognition evolves due to the "freeing up" of mental effort. Beyond accurate and rapid calculation ability and the ability to recall thousands of complex ideograms, the HOTS developed in traditional learning in Japan build the ability to:

- classify ideas (is this a recurring problem, special problem, process- or product design-related?),
- structure partial and whole relationships (what are the missing data in resolving the problem? do I have all the facts?),
- sequence and order (what is the series of steps that will lead to resolution of the problem with the least amount of effort and the most assurance?),
- analyze cause and effect (Are there several layers of cause leading to the negative effect?),

- predict (If I begin with step A, this will probably lead to the subsequent steps in resolving the problem), and
- use transference analogies and metaphors (what tools can I use to effectively explain the problem with process or product?).

The more intelligently each worker approaches the manufacturing task, the more likely zero-defect production and continuous process improvement will take place. The real genius of this skill improvement system from the worker's point of view is the virtuous cycle of job satisfaction, mental stimulation, and team building that results with each turn of the *shu-ha-ri* cycle. This is the primary benefit of the Zen learning strategies: the joining of personal development and company success.

Are there any models for Zen Learning in the U.S.? The self-managed team environments that U.S. manufacturers have been attempting to create in the 1990s require multiskilled workers. Even if closer working relationships do eventually evolve between schools and industry -- in the form of corporate-sponsored high schools, school-to-work programs, and a revitalization of the vocational school -- the responsibility for creating multiskilled workers falls on industry in the short term and for the foreseeable future. There are models for Zen learning strategies in the U.S. Some examples follow.

The way that we create doctors in the U.S. shares many characteristics of the Zen learning approach. From the third year of formal medical school, students are involved in OJT in the form of internships, leading to residency. They work with real procedures, starting with the simplest and leading to more complex medical problem solving and procedures. They "learn with the body" by practicing on cadavers. Interns and residents also learn through observation and repetition, following the maxim "see one, do one, teach one."[33]

The would-be doctor trains under a series of masters (practicing doctors) through a series of rotations in the various aspects of medicine. They also train with and receive advice from their seniors, mirroring the role of the senior apprentice in the traditional systems. They proceed through ranks, from intern to resident to senior resident to attending physician, and are tested and licensed. Where medical training departs from the Zen learning strategies is in the layered learning cycles, which, as we have seen in Japan, develop from broad to deep to broad learning. The U.S. medical

system tends to promote deep, specialized knowledge, such that the development of the physician through a specialty works against mutiskilling. Obviously, the specialist system in medicine has benefits for the health of patients. At the same time, the rise of the family practice specialty suggests a recognition that the fragmentation of medical knowledge can be detrimental, particularly in the area of preventative medicine.

Another example of the Zen learning approach being effectively utilized in the U.S. in the late 1980s is the case of the Semiconductor division of Texas Instruments. TI recognized the skills gap that had occurred since the mid-70s with their fab workers. As David "Rock" Beal, Training Manager at Wafer Fab 1 in Houston, reports, "upgrading the skills of workers was critical, as jobs could not be simplified any further. What we found was that math skills were dependent on reading level, as the material the workers needed to analyze was complex." [34] What TI put in place was a comprehensive initiative to test, upgrade through training, and retest workers, at the same time instituting "entrance exams" for incoming hires. And TI utilized the Kumon technique to supplement their training in math. As mentioned above, the Kumon method utilizes a series of worksheets to gradually drill math facts through self-study and built-in student incentives. The method includes periodic cycling of learned material and gradual introduction of new learning, all in a consistent approach which requires daily practice. Beal reports that "Those who did the Kumon had no problem with math testing in computation and measurements."

The result of this upskilling effort, as Beal reports, was improved cycle time and SPC programs, and a reduction in scrapped material. As successful as the Kumon program was, however, many of the participants found it difficult to follow through on the complete Kumon program. What seems to have been missing was company-based incentive systems to encourage employees to complete the Kumon program. What this means for the firm is that the "students" they train will respond to programs that involve career-based incentives. The best learning methods will not be successful if there is not positive motivation for each individual involved in the extra effort to expand his/her skill base. Corning's multiskilling efforts require that workers learn a family of skills in two years or lose their jobs, but this type of "stick" motivation has not been found to be effective in the long-term.

The prescription for upskilling the U.S. manufacturing worker is therefore a combination of good methodology and incentive systems. In terms of **methodology**,

there may in fact be value in engaging manufacturing workers directly in traditional Zen learning approaches: calligraphy, *sooji, soroban*, to name a few that have been mentioned in this paper.[35] Though the Japanese typically begin these training methods in childhood, there is potential for a positive influence on adult learners in the areas of computational ability, teamwork, visual acuity, manual dexterity, and pattern recognition. It is an area that deserves further research. In the short term, however, the major emphasis in adapting the best from the Zen learning approaches must take the form of the layered learning cycles. Through intelligent repetition, training and performance improvement efforts can surmount the paltry 10% retention rate that the typical adult learner is said to have from traditional lecture-based training.

For example, if we expected a shop floor worker in the typical U.S. manufacturing firm to learn a new quality control audit (QCA) method, s/he would typically be sent to a training class (with no testing to check for knowledge acquisition), and then would work with perhaps a more experienced partner to actually do a quality control audit. At that point, the employee would be expected to know the method and to be able to implement it on an ongoing basis.

In the Zen learning approach, the employee would follow these steps:

1. Engage in self-study on quality control audit methods, through books recommended by his manager (perhaps through a study group) (master)
2. Observe a quality control audit from start to finish (*minarai*)
3. Attend a class on quality control audits led by a senior quality specialist in the company (offJT)
4. Take a test following the class on QCA, repeating the class or engaging in more self-study if needed, again under his manager's advice. Alternatively, pursue external certification with company support. The new qualification would impact the employee's value to the organization and be compensated for either directly or indirectly. (certification/ranking)
5. Attempt a QCA using the acquired knowledge, with seniors standing by to assist, and possibly with a group of equally inexperienced workers (OJT)
6. Attend a debriefing session where seniors will critique the results of the QCA (*yarinuki)*
7. In subsequent years, study in more depth QCA theory, and eventually teach the method to new workers (layered learning cycles)

This approach ensures that the worker knows and can replicate the method; has accurate, current knowledge; and can pass that knowledge on to others. This type of layered, thorough learning strategy has obvious benefits, but also costs in terms of time and employee commitment. U.S. companies do not enjoy the luxury of the large Japanese firm in recruiting the *tabula rasa* college grad and pursuing a low-risk, high investment learning strategy over time to build exactly the type of worker the company needs. But we know for certain that the so-called volatility in the U.S. labor market (overall average job tenure rests at 4-6 years (Maguire, 1993)) , some percentage of it induced by post-industrial downsizing, typically occurs in the first 5 years of employment.[36] That is, if an employee stays with a job 5 years, and particularly if that employee is over 30, he will tend to stay with that employer long-term.

Conclusion

In light of this job market reality, it makes more sense for U.S. companies to delay advanced training both as an incentive for good workers to stay on board and as a way to address the tenure pattern of the U.S. worker. Of course, this approach presumes that the strategy of continual downsizing would be made unnecessary by the training and retention of highly productive employees. U.S. firms tend to either underinvest in training because they don't want to invest in workers who may not be around for the long-term, which is a losing strategy, or to at least resent "training everyone else's future employees." [37] Rather than fear investment in training, what if U.S. industry used learning opportunities as a deliberate strategy to retain good workers through providing both emotional and financial incentives to develop a deep and broad base of skills? Leading U.S. manufacturers, cited at the beginning of this paper, are already embarked on this course, but the incentives must be part of a learning strategy that ensures the workers both learn and retain knowledge in a virtuous cycle of learning and teaching.

A National Center for Educational Quality of the Workforce report states that soft skills are the key factors in creating competitive manufacturing workers, specifically personality, motivation, and prosocial behavior (Cappelli and Iannozzi, 1995). Much of the capabilities in these areas are generated from family, childhood, and schooling environments, not to mention the predisposition of the individual. There is

no question that the Japanese firm endorses and seeks this same set of soft skills in its employees, which partially explains the elaborate selection processes for new employees, but the intersection of hard and soft skills is thought of quite differently. Specifically, motivation and character issues are developed and fed **by the process of acquiring the hard skills**. For example, in multiskilling the Japanese factory worker, the process *itself* of acquiring those skills enhances the soft skills which make high-performance teams successful. We know that many Japanese blue-collar workers are paid on a skill-based system, but in referring to the overall notion of *jiko keihatsu*, what specifically is the skill that is being compensated for? Is it ability to perform a complex procedure, or is it also commitment and ongoing learning skills that are being cultivated and compensated?

There is no panacea for the tremendous challenges of creating a highly productive manufacturing workforce throughout the U.S. Asian countries, particularly Japan, Korea, Taiwan, and Singapore, have made tremendous strides in this direction, but they are small, largely homogeneous countries with very strong government-bureaucratic-corporate linkages, in addition to long traditions of focus on education and learning. By considering the strategies used in Zen learning and implementing methods which address both basic skills acquisition and multiskilling, an environment of continuous learning and improvements in productivity can result, with benefits for the employee, the firm, and the nation.

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Endnotes

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[2]Jim Frazier, Manager of Educational Research, Motorola, personal communication, November 23, 1994.

[3]Mr. David Beal, Training Manager, TI Houston Fab 1, interview, October 18, 1994.

[4] I have not included any discussion of the Japanese institutional schooling, as the methodologies used center on factual memorization rather than the skill acquisition, incentives, and practice-based traditional learning methods like soroban and shodo. The distinction between memorization and practice through repetition or drill is an important one. The use of "intelligent repetition," in concert with successful learning incentives, to master a skill leads to the freeing of "mental real estate," as we will show, whereas rote memorization as we understand it at the present tends to lead to dullness and rigidity.

[5] In the Ming and Ching dynasties in China, it was common for a young man to study the Chinese classics from age 5 to 35, at which point he would qualify for the civil service examination. If he passed the exam, he would be admitted to the ministerial ranks.

[6] I first heard the phrase "karada de oboeru" when I began to study the tea ceremony as a student in Japan in 1984 from my sensei Mariko Minagawa of the Urasenke School. Minagawa sensei would emphasize the "learning with the body" aspect of tea ceremony training, and would also ask that students "learn by watching" (*minarai*) and "learn through 'empty practice' "(*karademae* - practice of the motions of making tea without holding any utensils). All of these methods are well-known in the oral transmission of tea ceremony. A recent confirmation of these practices, their Zen origin, and their application to Japanese industry can be found in Nonaka and Takeuchi, 1995, pp. 9-10.

[7] Interview, February 28, 1996.

[8] A small sample would include: tea ceremony, soroban, pottery, incense ceremony, flower arranging, calligraphy, Suzuki, Zen, archery, karate, judo, ink painting, court dance, shakuhachi flute, Noh drama, etc.

[9] Irene Kuge, Toyota Motor Corporation, interview on March 1, 1996.

[10] The apprentice was the author.

[11] This term was coined by Mr. Kenji Kawashima of TI Japan, interview on February 28, 1996.

[12]Gercik, Patricia, *The Case of Hal,* unpublished case study.

[13]One caveat is significant: Japanese society is structured in such a way that some incentives for learning in Japan are unique to that society--the status of gaining entrance to a national university, the system of long-term employment in a large prestigious Japanese firm, the dynastic system of family structure, the tradition of Confucian meritocracy, and the overarching pressure of loss of face--all serve to keep learning a central focus and students learning mountains of irrelevant facts by rote (Rohlen, 1988). However, there are incentive systems in Japan that are not so strongly tied to the unique aspects of their society, and can serve as models for motivating learners to faster, more accurate, and more fully integrated learning. These will be explored in detail in the third section of this paper.

[14] Japan has typically been know as a nation of learners, a nation exceptional in its ability to absorb, systematize, adapt, and disseminate technological knowledge (Samuels, 1995). The aspect of Japan as a nation of teachers, as a function of both the master/apprentice tradition and the dissemination imperative, is less well explored. It is common knowledge that teachers have a high social status in Japan in terms of the formal education system, but the teaching that takes place, for example, in leading manufacturing organizations, is based on a less formal and therefore more hidden fashion.

[15] GIVE KANJI.

[16] "Tea masters of former times, rather than learning through letters, sought to grasp chanoyu (tea ceremony) with the body .. [they] would persist in this practice for 30 years." Hanamoto Soshun as quoted in Hirota, 1995, p. 314.

[17] Hirota, Dennis, ed. *Wind in the Pines,* Fremont, CA: Asian Humanities Press, 1995, p. 332.

[18]Personal communication from Tanaka Shingai, President of Sho International, Kyoto, Japan, April 21, 1996

[19] Personal communication from Eiichi Okamoto, a calligraphy master in Kyoto, Japan, July 11, 1995.

[20] Tanaka Shingai, personal communication, April 21, 1996.

[21] According to an article in the *Kyoto Shinbun*, April 8, 1994.

[22]Jinnosuke Miyai, President of the Japan Productivity Council and former Shell vice president, interview March 1, 1996

[23] Brauchli, Marcus W., "Singapore Solution: If Johnnie Can't Add, Give Him an Soroban," *The Wall Street Journal*, Nov. 22, 1994, p. 1

[24] Interview with Kathi Hanley, Toyota Motor Manufacturing, May 12, 1996

[25] See studies by Gundling (1994), Rohlen's (1974) classic study of training in a Japanese bank, and Miller's experience (Schlesinger, 1992).

[26] Companies described the ratio of OJT to OffJT as follows:

Company	OJT	OffJT

NEC	90%	10%
Fujita	98%	2%
Toyota	90%	10%
Toshiba	80%	20%
TI Japan	60%	40%

[27]Nonaka and Takeuchi, 1995, p. 85

[28] Koike, 1990, p. 45

[29]Kathi Hanley, Toyota Motor Manufacturing, interview on May 12, 1996.

[30] Interview with Y. Tsukuda, Human Resources Manager, Toshiba Corp, March 2, 1996.

[31] "Toshiba Today, Human Resource Development," Toshiba Human Resources Division publication.

[32] "Outline of Human Resources Development," Presentation from the Human Resources Development Division, NEC Corporation

[33] "48 Hours" segment on medical training, broadcast July 25, 1996.

[34] Interview with David Beal, Texas Instruments, October 21, 1994.

[35] In fact, Susan Skjei, Manager of Organizational Change at Storagetek, has experimented with introducing PC board assemblers to Japanese flower arranging and found positive results in terms of defect reduction and attention to detail.

[36] Kazuo Koike, interview on March 1, 1996.

[37] Statement heard at Motorola University Japan, March 1996.

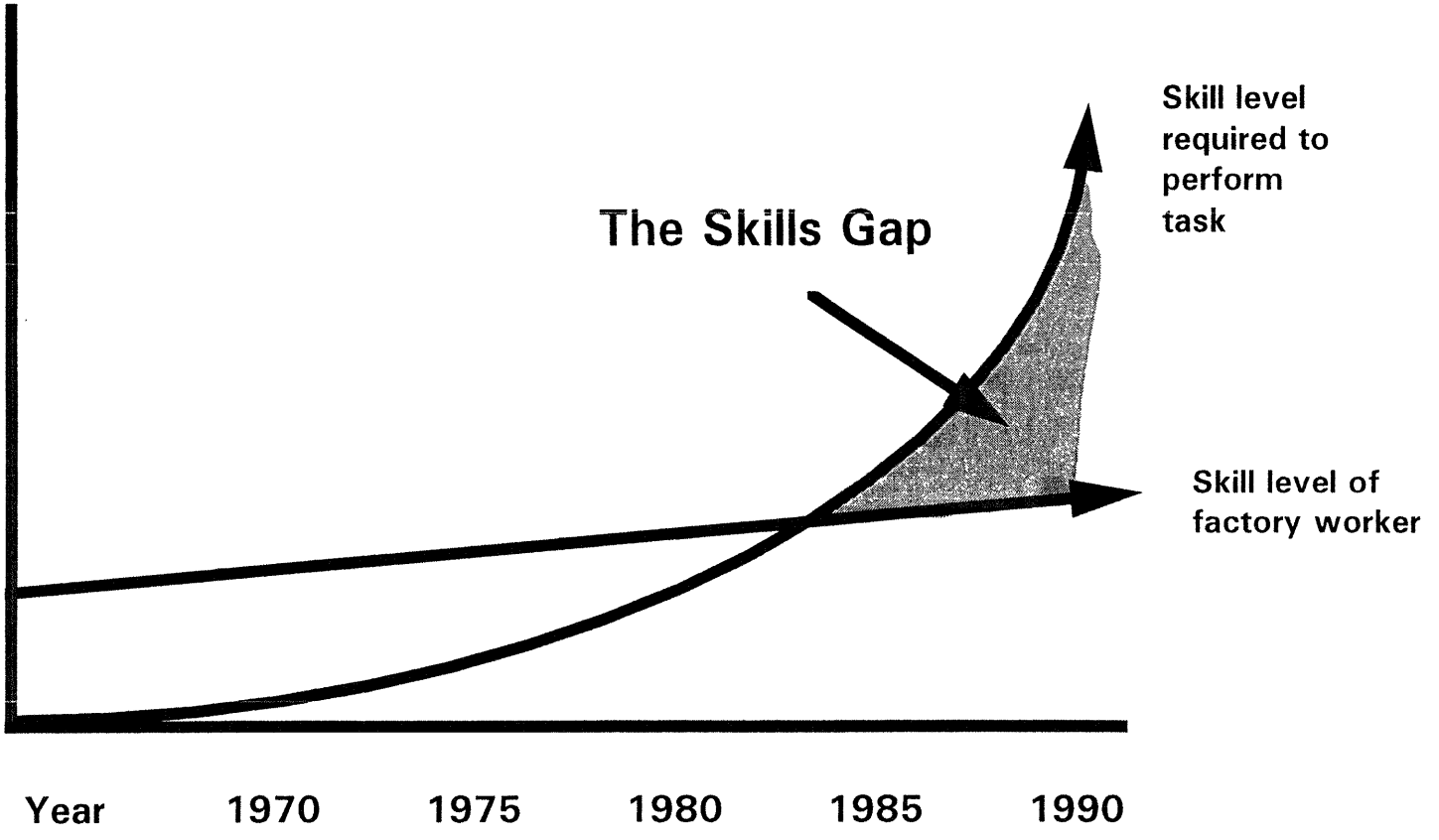

Figure 1. The Skills Gap

No.	
1	27,073,213,270 ÷ 495,130 =
2	985.519372 8 ÷ 2,360.148 =
3	4,551,999.7762 ÷ 509.731 =
4	0.1161907 2849 ÷ 0.7403829 =
5	361,357,036.04 ÷ 8,372 =
6	25.27634394 ÷ 0.06753 =
7	75,730,746,730 ÷ 9,164 = 【余り】
8	65,306,635,018 ÷ 71,986 =
9	0.0331576289 1 ÷ 0.5682041 =
10	133,635.28309 ÷ 0.92107 =
11	2,589,567.464 ÷ 35.2418 =
12	386.6304791 5 ÷ 6.3285 =
13	8,327,077,446 ÷ 2,546 =
14	0.2390718652 ÷ 0.084793 =
15	874,722.2088 ÷ 1,276,594 =

Figure 2: Sample of problems to be solved using anzan (mental calculation). 60 problems are to be solved correctly in 10 minutes. Source: Mr. Hiroshi Itoh.

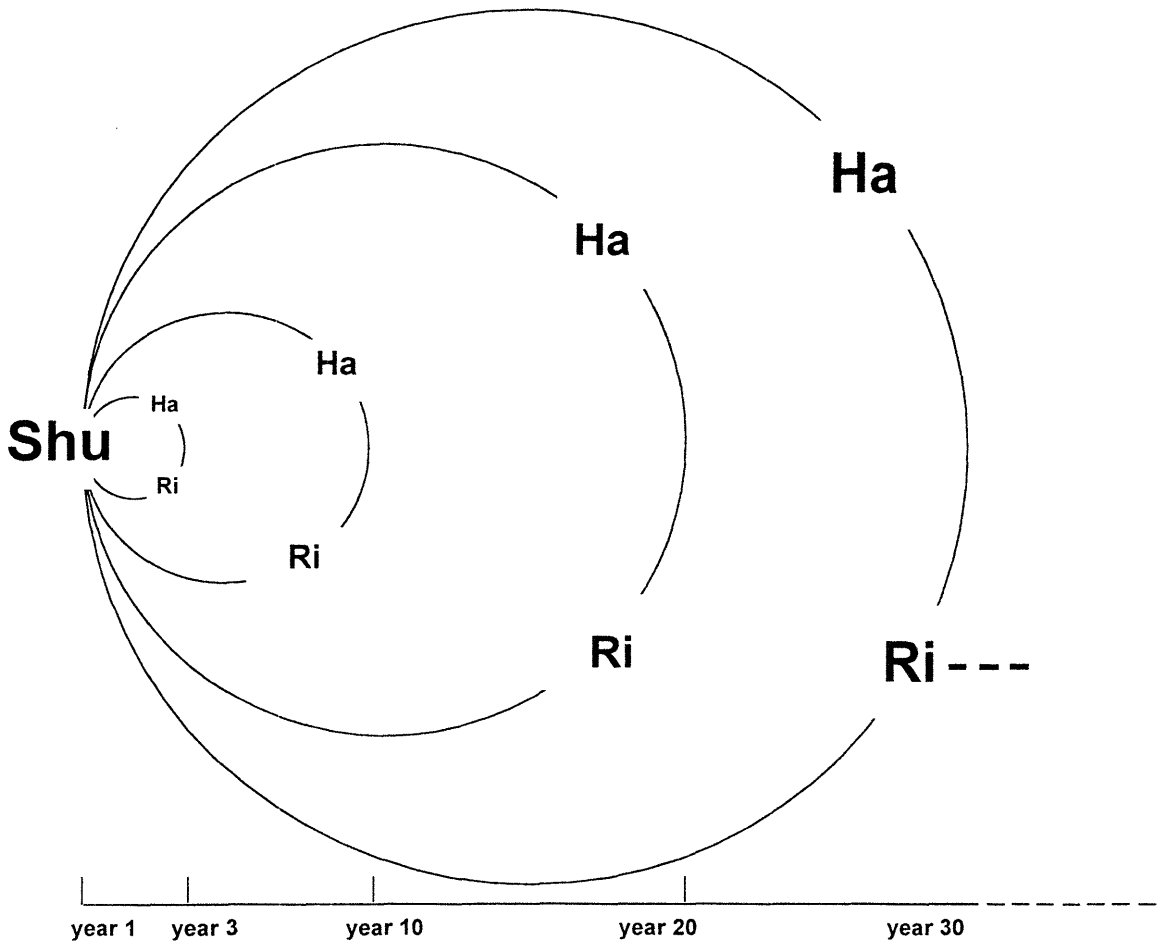

Figure 3: The shu ha ri layered learning cycles leading to mastery in 30 years.

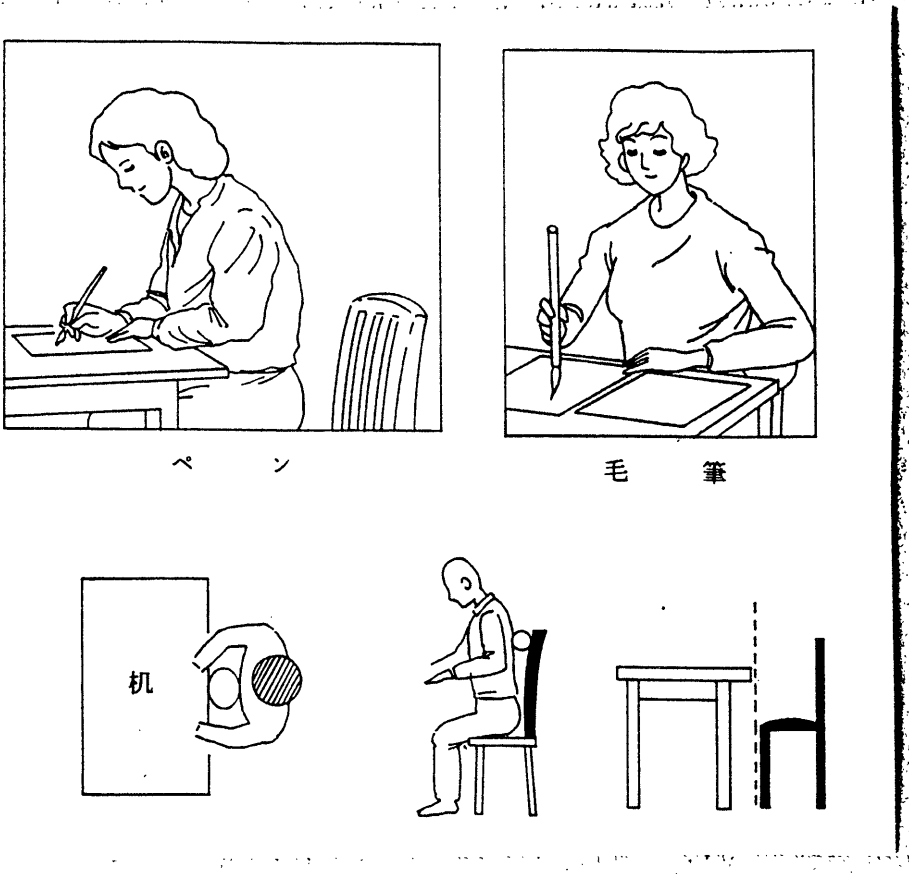

Figure 4: The correct posture for practicing calligraphy. Source: Penji no Kakikata.

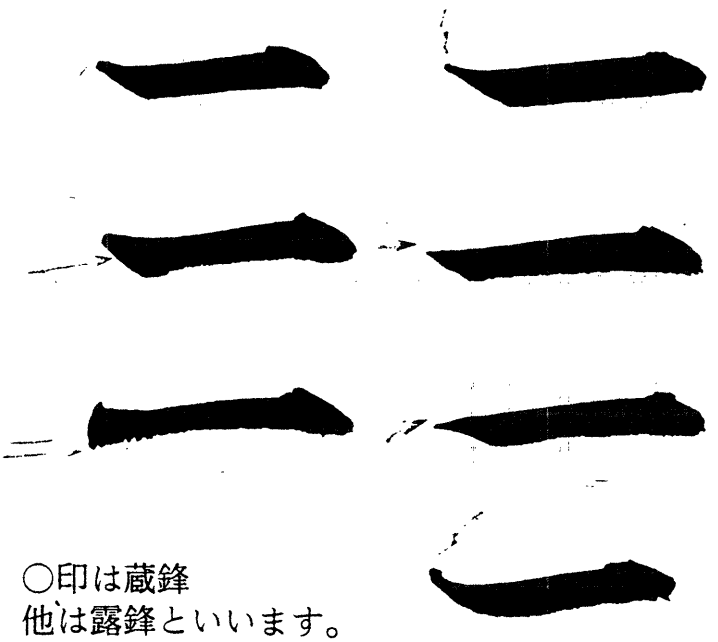

Figure 5: Character "ichi" (one). The author is indicating that the second stroke in the left column is the more correct version. Source: Penji no Kakikata.

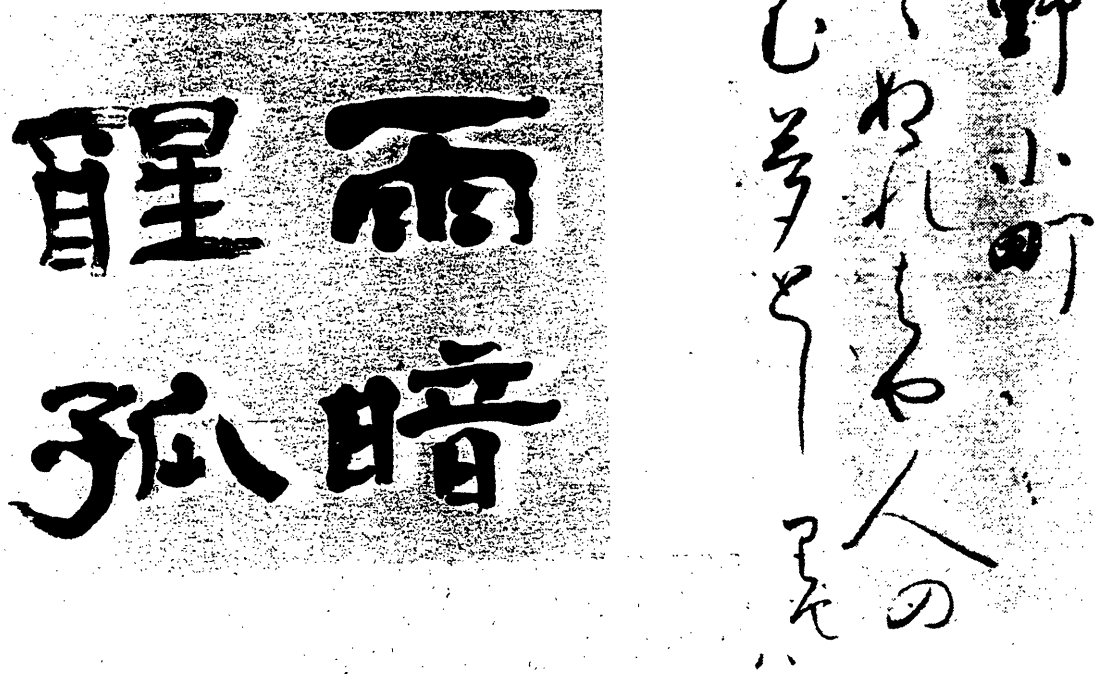

Figure 6: The kaisho (formal, left) and sosho (informal, right) styles of calligraphy. Sources: Sho:Calligraphes de Kyoto (left); Chanoyu Quarterly, No. 41, 1985.

Ranks in Calligraphy

(from lowest (juttsukyu) to highest (shi-han)

First Stage (from level 10 to level 1):

juttsukyu

kyukyu

hakkyu

shichikyu

rokkyu

gokyu

shikyu

sankyu

nikyu

ikkyu

Second Stage (from level 1 to 6):

ichidan

nidan

sandan

yodan

godan

rokudan

Third Stage:

jun-shihan

shihan

Figure 7. The ranking levels in the study of calligraphy.

〔正しい姿勢のとりかた〕

① なるべくいすに深く腰をかけ，机とからだのあいだを近づけ，上体をやや前に傾ける。

② 基本的には，そろばんは机の手前から 3 cm ぐらい前におき，からだの中心にそろばんの中央部がくるようにする。

③ 左手でそろばんの左端を軽くおさえ，ひじを張らないようにする。

④ 左右のひじは下げすぎないようにして，手首やひじを，机の端やそろばんにつけない。

⑤ 足は組まず，背骨をまっすぐにし，からだを左右に傾けないようにする。

⑥ そろばんのたまをはじくおや指とひとさし指は，そろばん面に対して直角になるようにし，使わないほかの指は軽く握る。

Figure 8: Posture details in the practice of calligraphy. Source: Soroban

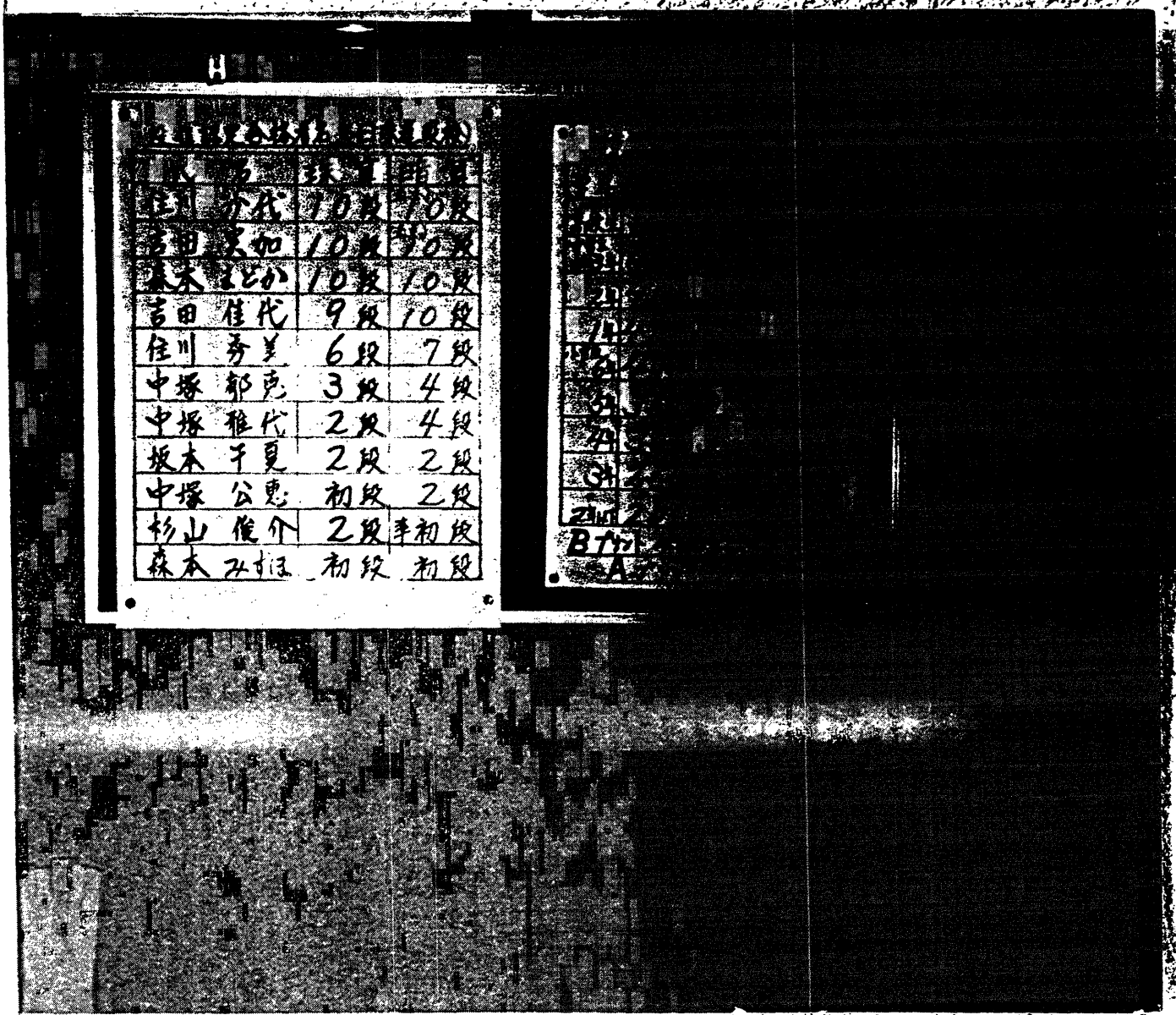

Figure 9: Chart of rankings in a soroban classroom posted on wall. Source: author's photo

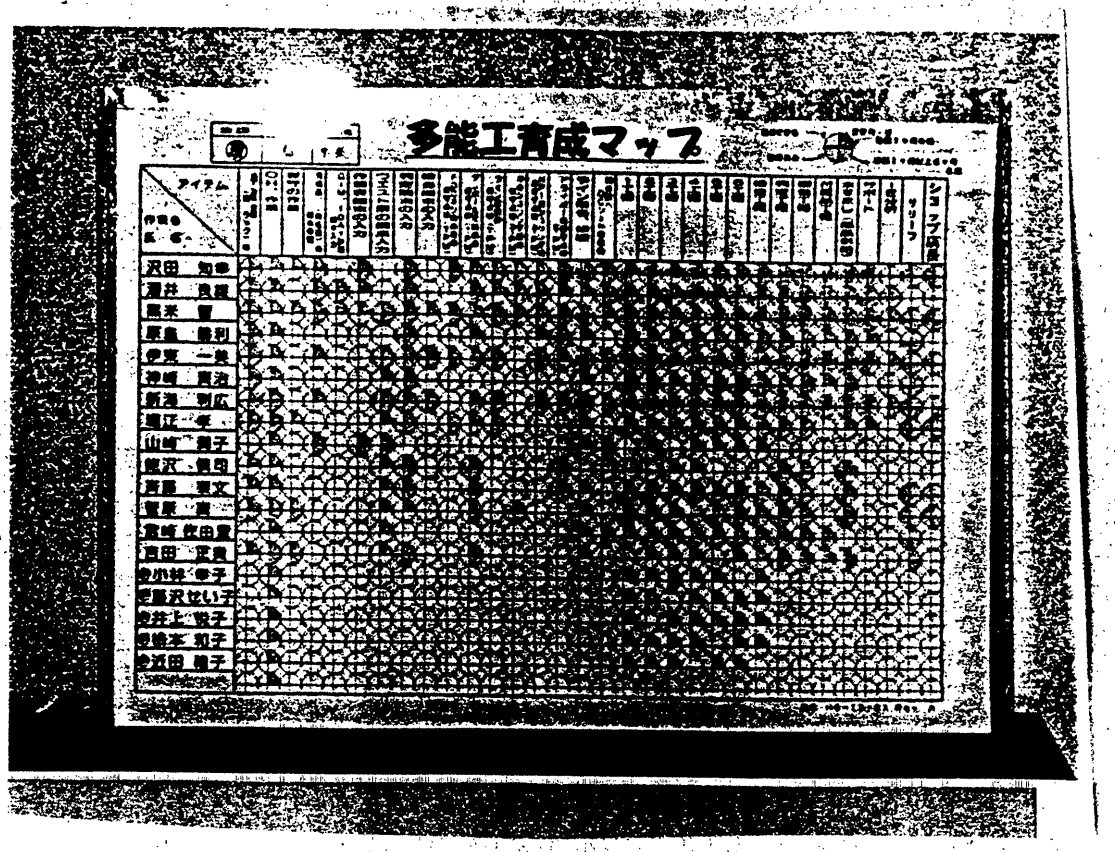

Figure 10: The Toshiba skills chart, with ability level ranked by worker name and posted publicly. Source: Kojo Kanri, Vol. 41, No. 8.

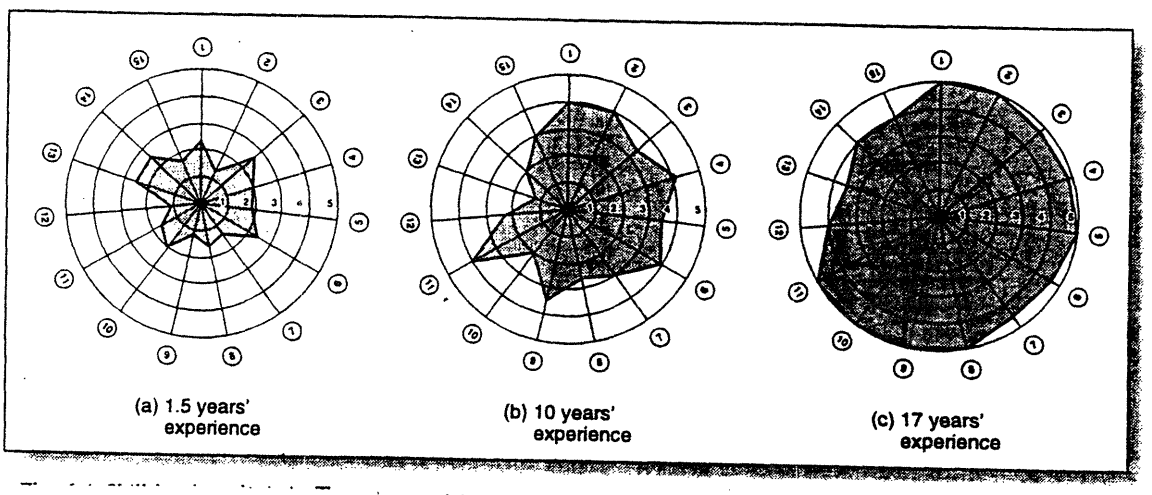

Figure 11: The Toyota skill web. Source: Lorriman and Kenjo, Japan's Winning Margins, 1994.