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Title: **How Visual Images Help Run Japanese Factories**

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Abstract:

Discusses management and technical staff's extensive use of visual images in the control system of Japanese factories to structure information so that everyone may understand the plan, execute it, identify errors and solve any problems related to performance gaps. Describes the control system, the plan-do-see (PDS) cycle, and the crucial role visual communications play in its effectiveness in identifying problems and correcting them in an efficient manner. Argues that U.S companies may benefit from the use of visual images, not only in their dealings with Japanese companies, but also for improving comprehension and factory floor performance in their own factories.

Keywords: manufacturing; plan-do-see (PDS) cycle; communication; performance; Japan

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How Visual Images
Help Run Japanese Factories

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Introduction

The world now expects Japan to efficiently produce complex, reliable products in high volumes at competitive prices. Among the many reasons for this transformation of Japanese manufacturing is the extensive use of visual images in the control system of their factories. Management and technical staff use images to structure information to help everybody understand the plan, execute it, identify errors, and solve any problems related to performance gaps. Group reviews of technical and business plans critically depend on a *system image* that can be hung on the wall or drawn on a blackboard. We shall briefly describe the control system, called plan-do-see (PDS) cycle, before returning to the crucial role visual communications play in its effectiveness.

The Plan-Do-See (PDS) Cycle

Planning is choosing product strategies and operating policies, factory targets, and steps necessary to achieve the targets. Doing is executing of the plan. Seeing is fast feedback on the results and comparison to the targets, analyzing reasons for any gaps, and taking corrective actions. All three stages of the cycle make intensive use of visual images.

Japanese factories spend a great deal of effort on gap analysis–documenting and diagnosing why the results deviate from the target. The underlying causes of the performance gap are analyzed in detail, and the results are clearly visualized. Once all related departments have a common image of the problem and its cause, department representatives quickly coordinate on the details of how to follow up. As a result, problems are identified and corrected in an efficient manner.

What is "Show-Me" Japanese?

Verbal communication in Japanese is infamous for its ambiguity. Japanese people often comment to foreign visitors that their manner of speaking is very hard to understand, even for other native speakers. So how did the nation with the world's most ambiguous language create the world's most precise system for mass producing physical things?

I use the term "Show-Me" Japanese to refer to the method of communication and control used in all large-scale Japanese production systems. Skillful use of this "show-me" style of language enables Japanese technical and business people to bridge the gap between an ambiguous way of verbal communication and a precise way of creating products. Simply stated, whenever a manager, technical expert or worker wants to communicate any type of technical or business information to someone else, he will "show them" some type of image of that information. The people receiving the information are literally able to "see" exactly what the other person is talking about. As the number of people involved in receiving and reviewing the information increases, the amount of effort expended on structuring the information into easily understandable images correspondingly increases.

In all aspects of factory operations, the Japanese use clear visual images to reveal the structure and detail of the topic or object under discussion. Visual images include well structured tables, drawings, pictures, and graphs. These images clarify essential details such as necessary steps, physical layouts, and timing of events. Images are "well structured" when they naturally correspond to the underlying "real-world" structure of the situation they are representing.

Spoken or written words are then combined with the images to produce documents and presentation materials. These provide the foundation for the everyday work of reviewing plans, analyzing problems, and making the required decisions.

Organizing and presenting "Show Me" Japanese images create a common understanding and starting point for group discussion. As group discussion proceeds, the visual image of the topic under discussion is updated in real time using a drawing board. Written comments layered on top of the images remind people of important background issues or explanations. When people leave the meeting, they all have a "common picture" of what was discussed, as well as a "common picture" of what, if anything, has changed as a result of the discussion.

The use of well structured images to convey business and technical information is interwoven into the everyday routines of Japanese industrial corporations. People at all levels of the company, from the shop floor to the boardroom, take the time required to convert thoughts and information into well structured images that can be shared with other people. Well structured images are used extensively throughout the PDS cycle, from the statement of business goals down to the detailed specification of how to do things. Using the visual language of "Show Me" Japanese, the manufacturing company can quickly pull together and disseminate the vast and intimate knowledge required to create products in the design lab and in the factory, e.g., product architecture and structure, hardware and software details, material characteristics, manufacturing techniques, equipment capabilities, etc.

Ever shortening product launch cycles, and ever increasing requirements for quality control require better and faster ways of identifying and correcting problems with both product and process performance. The visualizations that are the core component of "Show-Me" Japanese enables coordination, analysis and root cause problem solving to occur more rapidly, especially across functional areas and organizational boundaries. Many factory employees who do the everyday work have the conceptual ability and drawing skills required to clearly structure and visualize information. This widespread ability to generate and interpret images of an issue or problem as it is occurring in "real-time" on the shop floor enables coordination, analysis, and problem solving to proceed faster and more effectively than if people just "talked" to each other about the problem.

It is not coincidental that drawing boards (i.e., "whiteboards") are so common in Japanese company meeting rooms. Many companies use drawing boards that can print out paper copies of the image on the board. Meeting minutes are often copied or closely derived from the revised image on the drawing board. Written comments are layered in to briefly summarize why there was a change in understanding, or a proposed change to plans or actions. Minutes published after the meeting notify participants and a broader circle of related people that something within the PDS control structure for a particular topic has been revised. Based on a common understanding of how the structure of the situation has changed, managers who receive these minutes can decide on how to proceed.

Visitors' Observations of the Japanese Plant Floor

Over the past 20 years, many visiting manufacturing experts from the West have been struck by their perception of a lag in the application of computer and software technology that the Japanese use to support manufacturing. Visitors tend to characterize this gap in the application of information technology as a weak spot in Japanese industry. For example, visitors often comment on the extensive use of fax machines in the Japanese factory, and wonder why all the fax communications could not be created by computer. Visitors also comment that despite the widespread use of word processors and personal computers in factory offices, hand drawn images and hand written documents are still frequently visible on the desks of technical staff members.

Evidence of documents and images generated "by hand" in the factory should not be misinterpreted as an indictor of a "low level" of information processing technology. Japanese manufacturing companies have developed the world's most effective information processing methods for specifying and communicating

the know-how required to operate a factory. They have developed powerful ways of structuring the content and form of information that is part of everyday planning, design, and problem solving tasks. By developing such powerful methods of specifying and communicating technical know-how, Japanese manufacturing companies have been able to transplant design and manufacturing capability throughout the world—using their unique type of paper documents, fax machines, and supposedly "low levels" of information processing technology.

American and other Westerners who work closely with Japanese factories in Japan, or with Japanese personnel in foreign subsidiaries or joint ventures, are often frustrated by the four commonly experience behaviors listed below:

1. Plan reviews are dominated by negative thinking. The majority of comments made by Japanese management focus on "what could go wrong?"

2. Factory personnel require what seems like an "excessive amount of detail" when they review and analyze the feedback on actual results. They also have a remarkable ability to diagnose the reasons for performance gaps, and to specify the details of how to fix the problems.

3. Managers seem overly concerned with the formatting of technical and business information in any documents they read.

4. Often, Japanese company personnel will not believe the explanations given for the causes of a performance gap when it is reported by a non-Japanese person. The Japanese management often assigns "one of their own" staff members to review the performance problem, and to summarize the key information in a familiar and trustworthy format.

Reviewing Technical Plans

Planning in the Japanese factory system requires the simultaneous consideration of what to do *and* how to do it. A good plan not only includes a well defined target for performance improvement, it must also include detailed consideration of the methods required to achieve the target. When plans are reviewed, the emphasis on seemingly negative comments occurs because reviewers look for and think through the many practical problems that will arise when the plan is executed. A fine tooth comb review that probes the many possible implementation errors does not reflect negative attitudes or lack of management support. It is viewed as a means of verifying that the plan is in fact possible to execute, and that it can be practically translated into the physical realm of materials, machines, and people. A plan that survives the cautionary points raised in the review has a better chance of success. Payoff from the painstaking design, review, and revisions of plans comes in the form of their smooth and prompt execution.

Diagnosing Problems

The Japanese factory system excels in diagnosing problems and fixing them. A major reason for this capability is that factory personnel insist on knowing the critical details related to a problem before they proceed with corrective action. A person who rushes ahead with a plan to fix a problem prior to carefully investigating the reasons for its occurrence is viewed as being irresponsible, and sometimes even as dangerous.

The most trusted way for attacking a complex problem is for the lead investigators to use "Show Me" Japanese to visualize the current understanding of the situation and the proposed solutions to other experienced people. This way, the people with the relevant experience can work together to verify the

diagnosis and critique the solution approach. The use of images facilitates the rapid integration of information regarding the physical things related to the problem (e.g. materials, machines and people) and symbolic representations of these things (e.g., trends over time, patterns of incident occurrence, and conceptual models of failure modes.) "Show Me" Japanese also facilitates the real-time status reporting of complex situations to the management personnel who must prioritize and allocate the resources required to fix problems.

Ironically, when a serious problem occurs in the factory, and there is great pressure for getting the situation corrected, the technical staff or workers investigating the problem could outwardly appear to be "relaxing!" A visitor might see the lead investigators standing at the site of the problem, observing the situation, and carefully sketching images of what he observes. Other factory people would retrieve relevant performance data and technical documentation, and the investigators would typically take the time required to read and discuss this material. While reviewing these documents, a visitor would see the lead investigators sitting at a conference table, or drawing pictures on a board, conferring with one another. In sharp contrast to shop floor problem solving in most U.S. factories, nobody would be rushing around and yelling at other people to "do something fast!"

Psychologists recognize the power of cognitive artifacts--external tangible representations of concepts that can be shared by multiple people in a workspace. Good cognitive artifacts capture only the critical features of the situation that need to be analyzed, are appropriate for the particular users and tasks involved, and enable the users to more rapidly identify relevant regularities and structures. As a result, these images assist people in making judgments and in solving problems.

Formatting and presenting information can be viewed as making a "cognitive tool" for the purpose of accelerating a person's ability to solve problems in the factory. Cognitive tools are equally important as the automated tools on the production line. Like the process of building high performance "physical tools" such as automated machines for assembly and testing, cognitive tools, too, must be created, tested, and revised to enhance their usefulness. To a visitor, the sight of a Japanese factory person making numerous revisions to the format and graphics of a document may appear to be mere "busy work." Actually, this type of activity plays a crucial role in improving the "information processing" efficiency of the Japanese factory.

Structuring Plans and Problems into Easy-to-Understand Pictures

To a visitor, the Japanese appear to be reluctant to believe technical information that is transmitted only in the form of oral or written words. Verbal description is insufficient to grasp the underlying structure of a complex technical situation. When people in the foreign subsidiary send information back to supporting engineering groups in Japan, the information received must be translated twice-the first time from English paragraphs of text to Japanese text, and the second time into a structured visual representation of the situation. Also, without evidence of well-designed cognitive tools to support the discussion, there is no evidence that the person who generated the original information considered the situation to the depth required.

Non-Japanese working with Japanese counterparts often complain that it takes too long to get a response when the foreign subsidiary sends requests to the Japanese home office for technical information. An important factor causing this slow response is directly related to visual communication. At the Japanese end, it is difficult (and sometimes impossible) to construct good representations of the situation solely from words of written text, especially when the focal items in the discussion are physical things and technical systems.

As a result, the second step of translating the information into a structured visual representation takes a long time, and often requires the Japanese side to make numerous requests to the originator for additional input. Meanwhile, back at the foreign subsidiary, the technical people anxiously waiting for a response are unaware of the need for the second stage of translation, and complain about the delays in receiving the required response. If both sides used visual representations, information exchange could proceed faster. The first step of the translation—from text paragraphs of English words to Japanese text—could be eliminated, and both sides could work directly from the well structured tables or visual images (including words that explain details related to the images).

Closing Comments on Visual Images in Japanese Factories

Figures 1 and 2 illustrate the contrast in communication styles between a factory struggling just to achieve average performance, and a high performance factory of world-class capability. Both types of factories exist in both the United States and Japan. My own personal observations are that the scenario depicted in Figure 1 is more typical of factories in the U.S., and the scenario depicted in Figure 2 is more typical of factories in Japan.

In Figure 1, the performance improvement goal is clearly stated, but there is no common image of the underlying structure of the problem. Details of how to achieve the goal are not considered in parallel with the setting of the specific performance target. People attending the meeting are informally pressured to accept the mission of achieving the improvement target before they can identify methods or development approaches that will reliably lead to the promised results. The informal code of behavior is for meeting participants to minimize open discussion on potential problems with "execution details." The meeting is short, since the attendants are all concerned about using their time "efficiently." Yet, the follow on activities that occur during the subsequent weeks or months do not proceed in an efficient nor effective manner.

In Figure 2, physical examples and well-designed cognitive artifacts are used to construct an image of the problem, as well as to verify the existence of a practical way of proceeding from the target through the details of execution. Everyone involved is able to share the same common image of the problem and its underlying structure. People are expected to delay their approval of the project until they can clearly "see" the underlying problem structure and the enabling mechanisms of the proposed solution. Potential problems likely to occur as a result of "real-world" limitations of materials, machines, methods, and people are explicitly considered in order to verify that they do not invalidate or seriously jeopardize the plan.

The meeting scenario in Figure 2 is not "short and sweet." It could take several hours, and seem to drag on as difficult issues are identified, discussed, and incorporated into the common visual image of the situation. The attendants stick with the discussion, or schedule a follow on meetings, until they are convinced that implementation efforts that will take place over the subsequent weeks or months will proceed in an efficient and effective manner.

The capability and know-how to produce powerful cognitive tools to aid thinking and decision making is readily available in the U.S. *Scientific American* and other technical journals, children's science materials, museums, text books, sales, and advertising brochures provide ample examples. While there are many well-educated people in the U.S. who have mastered the capability for creating representations, very few of these people are doing the everyday work in product design and manufacturing organizations. In typical business and technical work settings, this type of visual communication is usually reserved for "special" projects and "special" presentations. Often the visuals are prepared by a specialized graphics department or project consultant, rather then by the people who are directly responsible for the situation.

In typical office or factory work setting in the U.S., native born speakers of English assume that if they speak clearly and write clearly, other people (including non-native speakers) should be able to comprehend the underlying meaning and image behind the words. Hence, the scenario depicted in Figure 1 occurs frequently in the U.S.

In Japan, factories have developed a powerful means of structuring and presenting information to support the clarity and precision of communication required to create and mass produce complex products. Fluid movement between physical and representational realms enables the Japanese factory to efficiently execute the steps of the PDS control cycle to the depth required to create complex and reliable leading edge products.

Professor Karatsu (1986b) provides some of the historical context that led to the development of this graphically oriented "Show Me" Japanese:

> "Seminars on QC were first given in Japan by experts from the United States in 1947.
> The principles taught at that time, however, were those of so-called statistical QC, and
> they were very difficult to understand. Even when such concepts were introduced in a
> factory, it was hard to put them into practice. Over the years, Japanese devised methods
> that were simple enough and understandable enough to be usable on any job site. "

As the U.S. workforce becomes more diverse and multi-lingual, the cycle may reverse. The Japanese "Show Me" approach of visualizing the problem structure might prove to be an invaluable aid for increasing comprehension and factory floor performance.
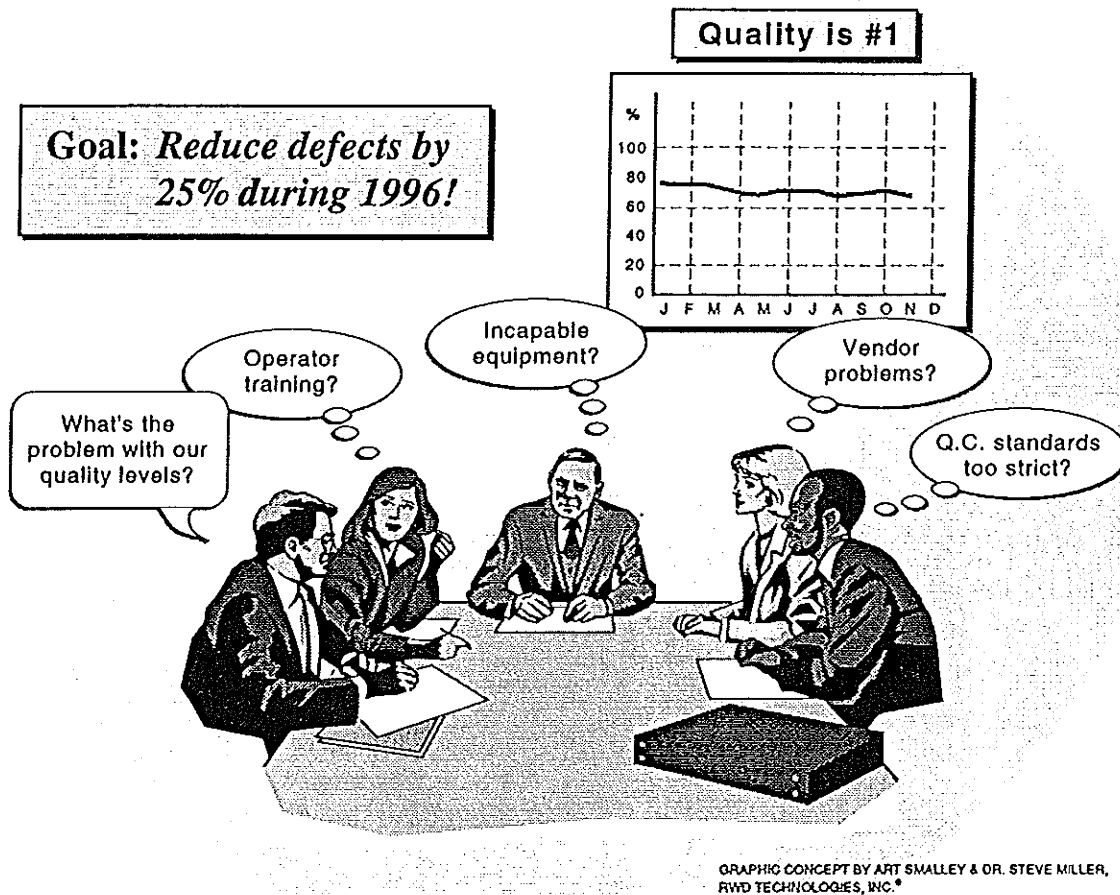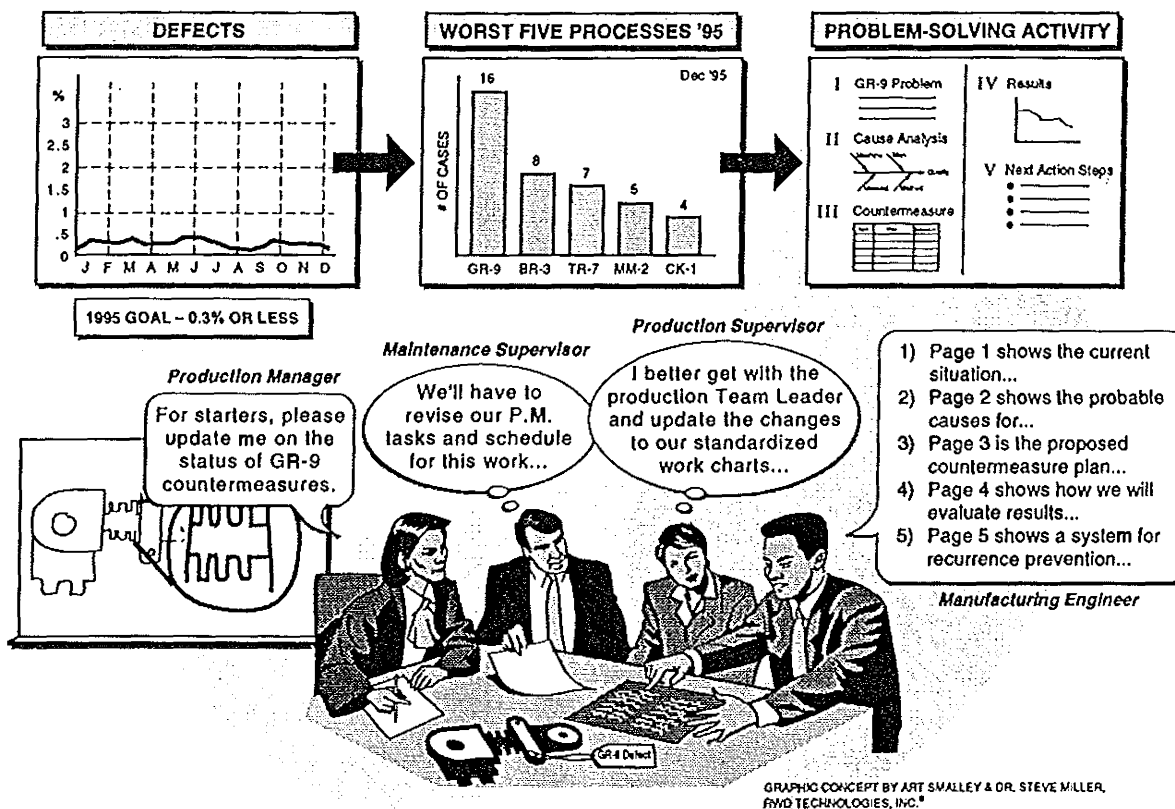
Figure 1. United States Factory Scenario

Figure 2. Japanese Factory Scenario

References

Karatsu, Hajime, *Invitation to QC: Its Challenges and Rewards, Part One.* PHP Institute, Tokyo, Japan, 1986, a.

Karatsu, Hajime, *Invitation to QC: Its Challenges and Rewards, Part Two.* PHP Institute, Tokyo, Japan, 1986, b.

Norman, Donald, *Things That Make Us Smart.* New York: Addison-Wesley, 1993.
Addison-Wesley, New York

Miller, Steve, *Japanese Thinking About Manufacturing: Ambiguous Language and Precise Images.* RWD Technologies, Inc., Columbia, Md., 1996

Miller, Steve, *Ambiguous Language, Precise Images.* Manufacturing Engineering, April 1996. 75-78