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# Visionary Planning at Front-End: A Missing Link for Competitive Manufacturing

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**Abstract**: There is a tendency to think manufacturing practices including JIT related ones are operational in nature. If competitors are competitive and doing good practices, many companies imitate the practices to catch up with them while having strategic behaviors remain the same. In this paper we propose good practices effectively sustained over time are closely linked with effective working of companies' strategic management cycle. Our bottom line argument is the effective implementation of manufacturing practices leading to competitiveness is possible by well-designed, planned and persistent behaviors embedded in the strategic management cycle of the company. Furthermore we show the most difficult and easily mishandled agenda in forming the cycle are to set organizational visions and goals and to form an integrated strategic mind-set of involved functional people. Then we propose a key to the effective formation of the strategic management cycle lies in the process of front-end loading.

**Key words**: Strategic management cycle, visionary planning, integrated functional effort, front-end loading

## 1. Introduction: Alignment of operational processes with strategic focus

High performers in manufacturing practices including JIT are characterized by the close and high linkage of the practices ranging from strategic to operational ones (Sakakibara *et al*, 1993, Morita and Flynn, 1997). The results hint the importance of linking capability of those practices. On the other hand there is an argument that operational practices may not sustain competitiveness over time. Operational effectiveness is necessary, but not sufficient. (Porter, 1996) Then the aligned process between strategic and operational aspects is critically

important to sustain high competitiveness.

The linkage of practices from strategic to operational ones reflects the extent to which strategy is implemented as intended. Good implementation of strategy is thought important to the company's success, but it's still a difficult issue as the Balanced Scorecard approach addresses. (Kaplan and Norton, 2001) The difficulty of the implementation of strategy suggests also the difficulty of securing the effective linkage of practices from strategic to operational ones.

If we apply the management cycle of P-D-C-A to the strategy implementation process as the Balanced Scorecard approach, the cycle is shown as in Figure 1.


Figure 1. Strategic management cycle

In Figure 1, the cycle has three feedback loops. The real line shows the strategic feedback loop and the dotted lines mean shorter-term feedback loops than the strategic one depending on the type of adaptation to specific situations. One important issue we address is what stages of the cycle are problematical to secure the effective linkage. We anticipate a lot of problems are involved in all of them. The Balanced Scorecard approach emphasizes the importance of breaking down strategic focuses into measurements for operational behaviors according to the four perspectives, that is, financial, customer, internal process and learning/growth perspectives to steer the company toward strategic goals. Setting up measurement systems is the main issue there. (Kaplan and Norton, 2001)

Another authors emphasize the front-end stage of setting organizational visions and goals and strategic planning including developing new market opportunities and competitive processes as a key to the company's survival. (Christensen, 1997, Fine, 1998, Christensen and

Raynor, 2003, Christensen *et al*, 2004, Kim and Mauborgne, 2005, Moore, 2005) These authors stress the importance of strategic insights into new value creation in the market for long lasting competitiveness of the company, assuming the totally aligned processes of the company to create new distinctive values.

If considering many actual problems related to processes including product development, manufacturing and selling such as delay and failure of new product development, low production efficiency at ramp-up of new products because of unprepared operation systems on the factory floor, material cost increase due to frequent design changes, excessive and too few inventory by the mismatch of production capacity and sales forecasting, suppliers' delivery delay and unsatisfactory quality because of poor selection and management of suppliers etc, we can hypothesize not only technical incompetence of management dealing with the problems individually, but also inconsistent and unsynchronized coordination of processes due to vague strategic focus as well as inappropriate strategic orientation underlies them. In sum the problems in strategic planning fail to consolidate people and resources.

The front-end stage of setting organizational visions and strategic planning in the strategic management cycle, if the last two stages of organizational deployment of operational practices and measurement and evaluation of organizational performances and control of operations are called the low-end stage, involves more subjective judgment than the low-end stage that requires much objective or technical judgment in tasks because the front-end stage is surrounded by high uncertainty. Then risk attitude comes into play in the decision process. Risk evaluation becomes a critical factor to attain agreement and supports required to invoke committed behaviors to achieve organizational goals from people in the company. If these factors are not satisfactorily coped with, the front-end stage turns unclear. We hypothesize the front-end stage is more difficult than the low-end stage.

Our hypothesis is the company should improve the capability of the front-end stage in order to build up the linked process from strategic to operational practices. In the next section we turn to how the strategic management cycle works based on the High Performance Manufacturing data of Japanese manufacturing companies to show the validity of the hypothesis.

## 2. The strategic management cycle of Japanese manufacturing companies

To measure the strategic management cycle, it's difficult to measure the activity of the stage directly. We can only measure results of the activities. Based on the results we can estimate how well the activity works.

We put the results after each stage of the management cycle in Figure 1. Figure 2 is rewritten by inserting the results. Shaded squares are the results of the stages.

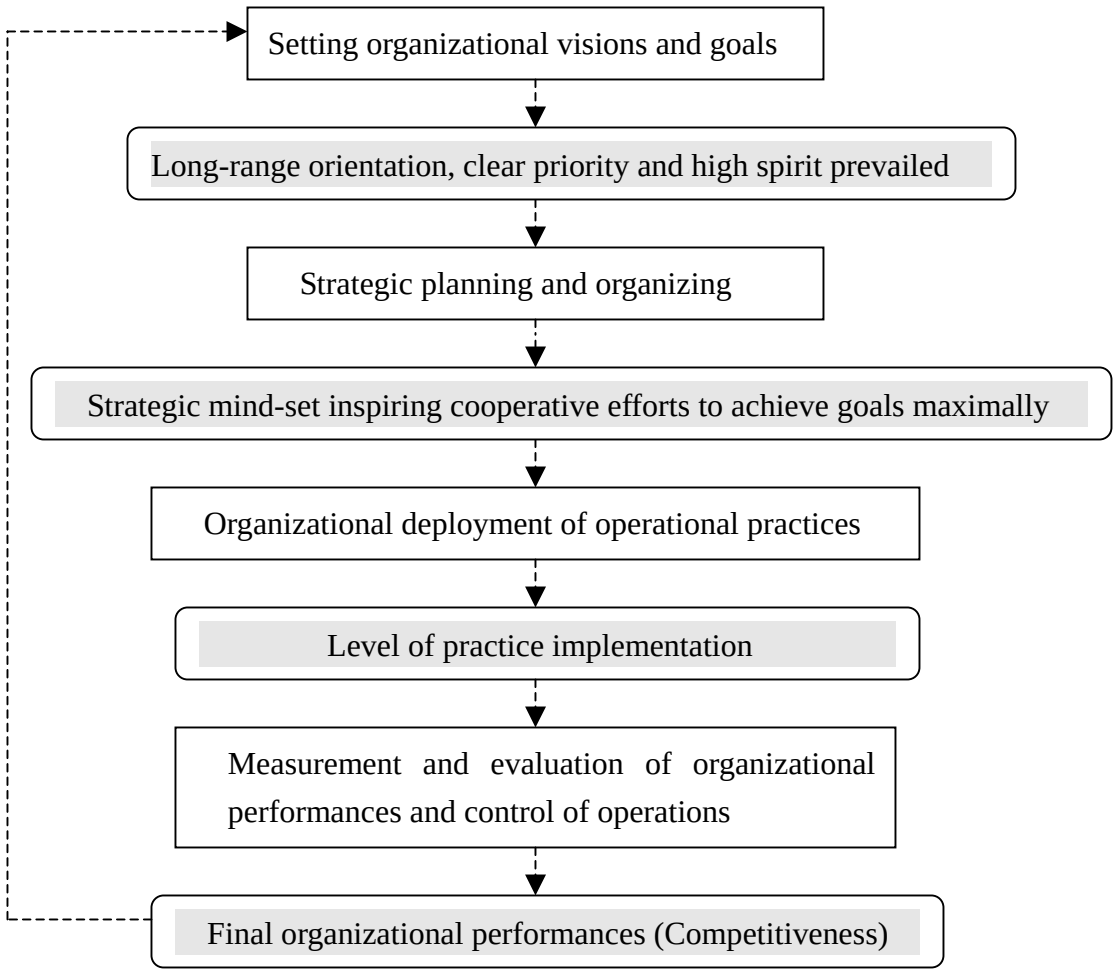



Figure 2. Strategic management cycle for measurement

The first stage is implemented based on previous organizational performances. After the stage, an organizational situation reflecting the degree of commitment to visions and goals of people in the company comes out. If the stage works well, we expect long-range orientation backed up by clear visions and goals in the future, clearness of organizational priority and high spirit or morale invoked by the shared visions and goals prevail in the organization. If previous organizational performances are good, they can be confidently associated with more challenging next visions and goals when the company performs the stage well. But it may be possible the negative feedback works.

The result of the first stage, that is, the degree of commitment to visions and goals of people in the company, become a condition for the next stage, strategic planning and organizing. If the second stage functions well, we expect people in every functional area are ready to

cooperate with each other to achieve organizational performances maximally rather than individual functional performance. But even if people share organizational visions and goals well, they may prefer their own ways to cooperative ways. Good strategic thrust accompanies with well-aligned functional competencies. Then the quality of strategic planning and organizing is measured by the degree of strategic cooperative functional alignment.

The third stage of organizational deployment of operational practices starts with the strategic mind-set with integrated functional efforts. The third stage determines the level of operational practices depending on the quality of the strategic mind-set. We expect in general higher the strategic mind-set inspiring cooperative efforts to achieve goals maximally, higher the practice level. Cooperative efforts, typically cross-functional integration efforts have been pointed out as one of the most important factors to achieve high practices and performances in past researches and literature. The mind-set can be considered as one important element composing "the capability to achieve integration across the functions in a timely and effective way." (Wheelwright and Clark, 1992)

The fourth stage of measurement and evaluation of organizational performances and control of operations, leads to final performances of the company. The stage steers operational activities toward final performances by checking, modifying and coordinating operational practices and activities subject to contingencies and changes of environmental situations. If the level of operational practices is high and the steering is good, we expect high performances come out.

The result of final performances invokes the next formation of organizational visions and goals as described before. If the company behaves a goal seeking entity and is a purposeful system, previous good performances drive another more challenging visions and goals. But the company is not a machine in the sense that its goals are not deterministic. (Ackoff, 1972) At this stage the company likely behaves in its own unique way.

The four results are expected to be high if the company's strategic management cycle functions well. Now we turn to measurement of the functioning of the cycle based on Japanese manufacturing companies' data.

## 3. Measuring the functioning of the strategic management cycle of Japanese manufacturing companies

The measures of the four results of the cycle stages are summarized in Table 1. The data we used come from the database built in the High Performance Manufacturing project.[i] The result of the first stage measures the degree of long-range orientation of the company and prevailed clear priority with high morale. In other words it measures the degree of determinedness of the company for future growth.

The result of the second stage of the cycle implies the degree of functional integration and alignment of manufacturing strategy with business strategy. It shows how the company is integrated organizationally to seek for the attainment of organizational goals.

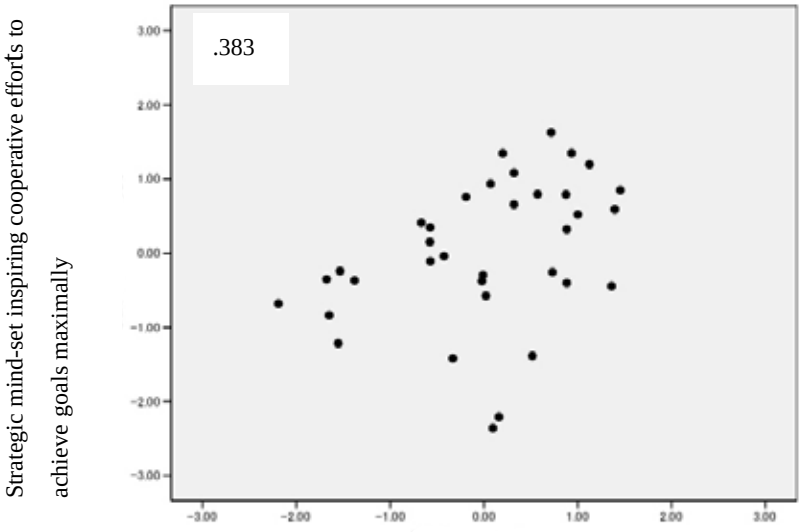
Table 1. Measurement of the four results

| Result of the stage | Constituent measures | Factor loading & Cronbach's α |
|---|---|---|
| 1. Long-range orientation, clear priority and high spirit prevailed | (1) Clearness of project priority<br>(2) Team spirit<br>(3) Long-range orientation | .849<br>.890<br>.612<br>α = .682 |
| 2. Strategic mind-set inspiring cooperative efforts to achieve goals maximally | (1) Manufacturing-Business strategy linkage<br>(2) Integration between functions<br>(3) Inter-functional design efforts<br>(4) New product introduction cooperation<br>(5) Manufacturing involvement in new product development | .768<br>.848<br>.795<br>.676<br>.663<br>α = .761 |
| 3. Level of practice implementation | (1) Supply chain management initiatives<br>(2) Just-in-time linking with external companies<br>(3) Distinct manufacturing<br>(4) Organizational quality improvement initiatives<br>(5) Quality improvement on the floor<br>(6) Efficiency & smoothness on the floor operation<br>(7) Activated and cooperative floor | .875<br>.822<br>.728<br>.813<br>.834<br>.958<br>.892<br>α = .761 |
| 4. Final organizational performances (Competitiveness) | (1) Efficiency competitiveness<br>(2) Product competitiveness<br>(3) Flexibility competitiveness | .947<br>.858<br>.771<br>α = .818 |

Note) each constituent measure's composition is summarized in Appendix A.

The result of the third stage in the cycle measures the degree of operational practices' implementation. It includes from supply chain related ones to operation-related ones on the floor. The result of the fourth stage means competitiveness as a whole.

We put four relationships as scatter diagrams in the order of the cycle's stage. Figure 3 shows the relationship between the two results, that is, the long-range orientation, clear priority and high spirit prevailed and the strategic mind-set inspiring cooperative efforts to achieve goals maximally. The shape of plotted dots indicates how the long-range orientation, clear priority and high spirit prevailed relates to the strategic mind-set inspiring cooperative efforts to achieve goals maximally. In other words, it exhibits the performance distribution of the second stage of the cycle, the strategic planning and organizing. If the scatter is widespread, the strategic planning and organizing is difficult in the sense that the company may not transform the long-range orientation, clear priority and high spirit prevailed into the strategic mind-set in proportion to the level of long-range orientation, clear priority and high spirit prevailed. The numerical value in Figure 3, .383, is the correlation coefficient between the two results.




Note) all values of the results are normalized in each industry.

Figure 3. How the company achieves the strategic planning and organizing based on the long-range orientation, clear priority and high spirit prevailed

Figure 4 shows the relationship between the strategic mind-set inspiring cooperative efforts to achieve goals maximally and the level of operational practice implementation. Judging from the width of scatter of plots, the company can implement operational practices well if it

develops good strategic mind-set. In other words the strategic mind-set is a critical factor to achieve good operational practices.

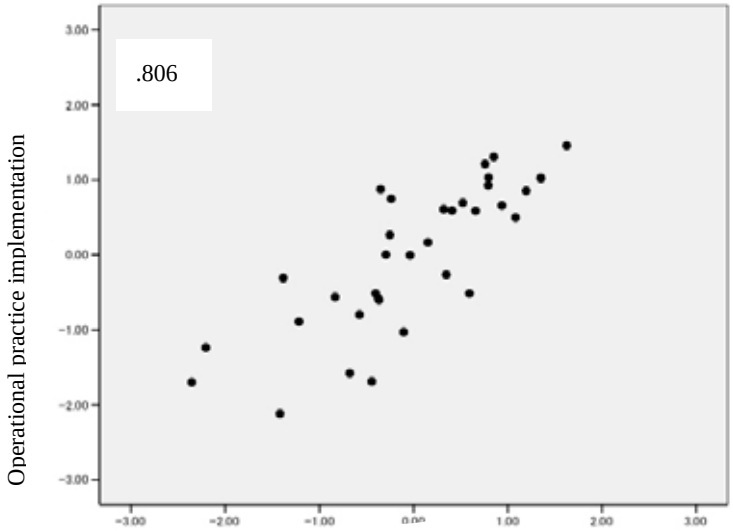



Figure 4. How the company achieves the organizational deployment deployment of operational practices based on the strategic mind-set inspiring cooperative efforts to achieve goals maximally

Figure 5 exhibits the relationship between the two results, that is, the operational practice implementation and the final organizational performances or competitiveness. Behind the relationship, the stage of measurement and evaluation of organizational performances and control of operations works. In the steering of the practice implementation toward the organizational performances the level of operational practices is critical. The performances tend to be high in proportion to the level. The steering is automatic or technical in the sense.

Figure 6 shows high irregularity involves in the setting of organizational visions and goals given the organizational performances. The relationship between the two results is not significant statistically.

Throughout the cycle, the company can easily mismanage at the first stage and then at the second stage of strategic planning and organizing. Even if initial conditions of the stages, results of the previous stages, are good, the company may not take advantage of them. At the other two stages, if their initial conditions are good, the chance to manage well becomes high. In other words, the first two stages are difficult to manage. In order to sustain the strategic management cycle effectively, the company should improve the results of the four stages. The

first two stages are full in traps for the effort of improvement.

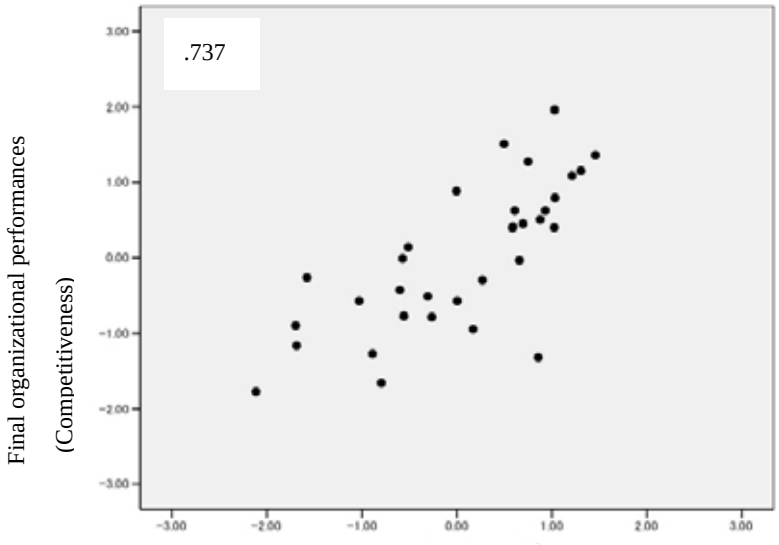



Figure 5. How the company achieves the measurement and evaluation of organizational performances and control of operations based on the level of operational practice implementation

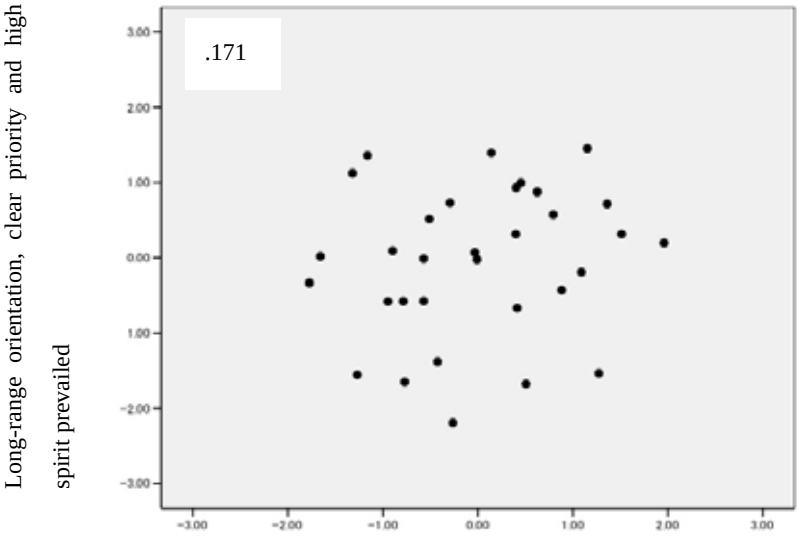



Figure 6. How the company achieves the setting of organizational visions and goals based on the final organizational performances

If the company sustains the strategic management cycle more effectively, we hypothesize each result of the four stages is also high. Table 2 compares the three groups of top average, middle average and lowest average groups in terms of the average level of the four stages' results. Higher the average level more effectively the strategic management cycle is working in general. But the difference becomes narrow at the result of the first stage. It suggests the first stage requires special caution in sustaining the strategic management cycle. The other three stages are positively correlated with each other. But if the company fails to sustain the result of the first stage well, it may get into the trouble to sustain the cycle at the previous level.

If the company is a going-concern, the company should make an effort to improve and sustain the strategic management cycle at competitive level over time. In the effort, the first stage, the setting of visions and goals, becomes a key in the sense it's highly possible for an opportunity of change, upward or downward, to come in regardless of the previous momentum to every company.

Table 2. Comparison of the strategic management cycle's functioning

| Result of the stage | Top average group 11 companies | Middle average group 11 companies | Lowest average group 11 companies |
|---|---|---|---|
| Long-range orientation, clear priority and high spirit prevailed | .643 | -.145 | -.569 |
| Strategic mind-set inspiring cooperative efforts to achieve goals maximally | .918 | -.157 | -.888 |
| Operational practice implementation | .943 | .280 | -1.047 |
| Final organizational performances | .942 | .003 | -.917 |

Note) the group classification is done based on the ranking of the mean of the four results that creates most equal groups in terms of the number of sample companies. The difference of the three groups is significant at 1% significance level beside the difference in the long-range orientation, clear priority and high spirit prevailed where the difference between the top and middle average groups is significant and one between the middle and lowest groups ** is not significant at 5%.

## 4. A key to high performance manufacturing: Visionary planning

In the previous section we found the first two stages, the setting of organizational visions and goals and the strategic planning and organizing, are more influenced by behavioral factors that are less subject to the results of their previous stages than the second two stages that are

generally ruled by their previous stages' results. The behavioral factors emerge more strongly when the situation involves more uncertainty, more complexity and the degree of freedom of subjective judgment increases. Formation of new visions and business concepts and design of new business process are typical examples of the situation.

Then we call the aggregated stage of the first two stages as visionary planning stage. The result of the visionary planning stage is assumed to be the mean of the two stages' results. The result implies how the company is clear in the strategic orientation and high morale and cooperative culture supporting the orientation prevails in the organization. Organizational processes including many human factors work to determine the result.

Table 3 compares the results of the organizational deployment of operational practices and the measurement and evaluation of organizational performances (competitiveness) and control of operations between three groups classified based on the average level of the visionary planning stage described above. The results shown in Table 3 indicate the importance of the visionary planning stage. Though the visionary planning stage is not an easy task and amenable to organizational processes or dynamics involving human subjective judgment, if the company performs well at the stage, it performs well also in operational implementation leading to high organizational performances.

Table 3. Comparison of practice implementation and organizational performances

| The other two results | Top average group 11 companies | Middle average group 11companies | Lowest average group 11 companies |
|---|---|---|---|
| Practice implementation | .881 | -.087 | -.722 |
| Final organizational performances | .700 | -.092 | -.578 |

Note) the difference is significant at 5% significance level between the top average and middle average groups. But the difference between the middle average and lowest average groups is significant at significance level of 5% in the practice implementation and not significant in the final organizational performances at the same level. The group classification is done based on the ranking of the standard deviation of the mean of the visionary planning stage that creates most equal groups in terms of the number of sample companies.

After the bubble economy in Japan, many manufacturing companies focus on reducing costs to survive and put severe pressure on factory operation or increase outsourcing. On the other hand they have emphasized to develop new businesses or products to break market constraints. One significant problem is the efforts tend to go separately. In other words, the

visionary planning has not been linked to the operational practice. There, all the factory has to do is to make it more efficient without knowing where it goes in future. Introduction of JIT operations by the assistance of Toyota's people has been implemented to strengthen existing product lines on the floor without knowing what new products come next to the factory.

Managers of a plant we interviewed said, "We want to join in planning new products to prepare more competitive new processes". They introduced new cell systems to adapt to flexible production, but they looked not excited even after they did it. They seemed to worry whether the corporate might shut the factory or change product lines suddenly even they built new systems for existing lines. One plant manager of a different factory of a large electronics manufacturing company answered, "Yes" to our question to the effect that you might not be interested in manufacturing PC only to reduce cost to survive in the severe competition in the market. [ii] The factory just started to introduce JIT systems to achieve more cost savings with the aid of external JIT experts who worked for Toyota. It's difficult to induce their commitment over time. Part of the increase of outsourcing among Japanese manufacturing companies may be due to the consideration of possible reduced morale among internal employees who are pressed only to cut costs.

Sharing the feel of contributing to the value creation of the company is important to induce employees. (Barnard, 1938) The sharing is possible by identifying the achievement of operational activities with organizational performances. In other words, the feel of achievement among people engaged in operational activities should be linked to the feel of organizational achievement to induce their commitment to the company. The attitudinal commitment interacts with the behavioral commitment to reinforce each other. (Mowday *et al*, 1982) The feel of achievement promotes the positive interaction of the commitments. The clearness of achievement and high achievement increases the commitment that in turn makes it possible for people to work better next so that the improvement or sustainability of organizational performances can be secured.

The well functioning of the strategic management cycle contributes to the linkage of employees' achievement with organizational achievement. Especially the visionary planning is important to the linkage. It relates the employees' achievement with the organizational achievement. Also it develops the source of next achievement. The effective strategic management cycle driven by the good visionary planning creates the company of the stage 4. (Wheelwright and Hayes, 1985)

## 5. Concluding remarks: Front-end loading for visionary planning

Manufacturing competitiveness comes from realizing high values for clients. It clearly comes from operational activities in the sense that final value creation goes through them. Just

ideas of the values are meaningless. Then to activate operational activities is critically important to the manufacturing company. The trend, however, has shifted toward development activities rather than operational activities. It means toward the first stage of manufacturing, especially in matured products. (Wheelwright and Hayes, 1985) The trend weakens the capability of manufacturing in essence. Even if the company comes up with good new product concepts or product technologies, there may not be competitive manufacturing capability then.

The point is the company should strengthen the capability of manufacturing always to realize competitive values. It's possible only by aligning strategy with manufacturing process anytime. It means the company should operate under the effective strategic management cycle. The company should cope with the life cycle of innovation. (Moore, 2005)

The effort to build up JIT systems supposed to be effective for existing products, for example, is also effective for every new product that may come in future. JIT is itself an ideal concept. It's usable for every product with some adjustment regardless of its difficulty of implementation. (Ohno, 1978) Such an effort should be posited in the visionary planning, not piecemeal one just for a specific product line.

The visionary planning gives birth to future visions and goals of the company, designs concepts of competitive products and processes to attain the visions and goals, and aligns and organizes resources to achieve them. It's done at front-end of the company's processes. The fuzziness of the front-end becomes a source of problems for following implementations activities including new product development. (Khurana and Rosenthal, 1997) The concept of functional mapping suggests we need a formal step to clear the fuzziness at the front-end. (Wheelwright and Clark, 1992)

The visionary planning stage used to be informal and unsystematic. Top management should be equipped with the holistic view of the company's processes. (Khurana and Rosenthal, 1998) But more important is systemizing the visionary planning so that every important expertise of the company can be integrated to have effective and promising insights into the future course of actions of the company that can be shared among people of the company. It's beyond the capability of any individual. The informality and ill-structured process of the front-end visionary planning is a big source of organizationally ambiguous and weak focused visions, goals and strategy. It deteriorates the functioning of strategic management cycle.

But it's still difficult to find a promising systematic framework for the front-end visionary planning. In order for a blue ocean strategy not to be accidental, the company should set up a formal process for the front-end visionary planning. It's not a once for all effort in the sense that the company should improve the process continuously including organizing expertise and knowledge throughout the organization. Operational processes should be designed and controlled linked with the visionary planning if the company wants to provide real differentiated

values to the market.

Appendix A. Measurement's composition

| **Measure** | **Constituent practice** | Loading factor and Cronbach's α |
|---|---|---|
| Integration between functions | Achievement of functional integration | .890 |
| | Integration between functions | .874 |
| | Leadership for functional integration | .861 |
| | | α = .844 |
| Supply chain management initiatives | Stability of demand | .806 |
| | Trust-based relationship with suppliers | .919 |
| | Supply chain planning | .818 |
| | | α = .774 |
| Just-in-time linking with external companies | Just-in-time delivery by suppliers | .909 |
| | Just-in-time link with customers | .797 |
| | Reduction of supplier lead time | .829 |
| | | α = .773 |
| Distinct manufacturing | Proprietary equipment | .938 |
| | Unique practice | .820 |
| | Manufacturing as a competitive resources | .767 |
| | | α = .796 |
| Organizational quality improvement initiatives | Customer satisfaction | .885 |
| | Top management leadership for quality improvement | .804 |
| | Cleanliness and organization | .800 |
| | TQM link with customers | .742 |
| | | α = .816 |
| Quality improvement on the floor | Customer involvement | .864 |
| | Feedback | .789 |
| | Organization-wide approach | .848 |
| | Prevention | .705 |
| | Process control | .836 |
| | Supplier partnership | .833 |
| | Supplier quality involvement | .842 |
| | Customer focus | .775 |

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|---|---|---|
| | | α = .914 |
| Efficiency & smoothness on the floor operation | Daily schedule adherence<br>Equipment layout<br>Set-up time reduction<br>Synchronization of operations<br>Preventive maintenance<br>Maintenance support<br>Team-based maintenance<br>Effective process implementation | .864<br>.886<br>.925<br>.892<br>.913<br>.875<br>.864<br>.945<br>α = .960 |
| Activated and cooperative floor | Commitment<br>Cooperation<br>Coordination of decision making<br>Multi-functional employees<br>Recruiting and selection<br>Shop-floor contact<br>Small group problem solving<br>Supervisory interaction facilitation<br>Task-related training for employees | .891<br>.818<br>.869<br>.839<br>.853<br>.918<br>.865<br>.840<br>.892<br>α = .955 |
| **Measure and Practice** | **Constituent questionnaire** | |
| Efficiency competitiveness | Unit cost of manufacturing cost<br>On time delivery<br>Inventory turnover<br>Cycle time fro raw materials to delivery<br>(Subjective evaluation by plant manager based on the Likert scale from 1 (Lowest) to 5 (Highest) if compared with other companies in industry on global basis) | .638<br>.688<br>.826<br>.833<br>α = .739 |
| Product competitiveness | Conformance to product specification<br>Speed of new product introduction into the plant<br>Product capability and performance<br>Customer support and service<br>(Subjective evaluation by plant manager based on the Likert scale from 1 (Lowest) to 5 (Highest) if | .784<br>.899<br>.764<br>.881<br>α = .748 |

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|---|---|---|
| | compared with other companies in industry on global basis) | |
| Flexibility competitiveness | Fast delivery<br>Flexibility to change product mix<br>Flexibility to change volume<br>(Subjective evaluation by plant manager based on the Likert scale from 1 (Lowest) to 5 (Highest) if compared with other companies in industry on global basis) | .741<br>.843<br>.873<br>α = .748 |
| Achievement of functional integration | The functions in our plant are well integrated.<br>Problems between functions are solved easily in this plant.<br>Functional coordination works well in our plant. | .804<br>.838<br>.826<br>α = .760 |
| Integration between functions | The functions in our plant work well together.<br>The functions in our plant cooperate to solve conflicts between them when they arise.<br>The marketing and finance areas know a great deal about manufacturing.<br>Our plant's functions coordinate their activities.<br>Our plant's functions work interactively with each other. | .776<br>.685<br>.603<br>.672<br>.823<br>α = .729 |
| Leadership for functional integration | Our top management emphasizes the importance of good inter-functional relationships.<br>Our managers do a good job of solving inter-functional conflicts.<br>We are encouraged to communicate well with difference functions in this plant.<br>Our managers communicate effectively with managers in other functions. | .682<br>.704<br>.792<br>.831<br>α = .760 |
| Stability of demand | Sales and manufacturing personnel communicate well with each other in this organization.<br>Manufacturing demands are stable in our firm.<br>Our total demand, across all products, is relatively stable. | .621<br>.893<br>.846<br>α = .693 |

| | | |
|---|---|---|
| Trust-based relationship with suppliers | We are comfortable sharing problems with our suppliers.<br>We believe that cooperating with our suppliers is beneficial.<br>We emphasize openness of communications in collaborating with our suppliers. | .726<br>.803<br>.683<br>α = .577 |
| Supply chain planning | We actively plan supply chain activities.<br>We consider our customers' forecasts in our supply chain planning.<br>We strive to manage each of our supply chains as a whole.<br>We monitor the performance of members of our supply chains, in order to adjust supply chains plans.<br>We gather indicators of supply chain performance. | .787<br>.727<br>.814<br>.582<br>.815<br>α = .802 |
| Just-in-time delivery by suppliers | Our suppliers deliver to us on a just-in-time basis.<br>We receive daily shipments from most suppliers.<br>We can depend upon on-time delivery from our suppliers. | .854<br>.723<br>.848<br>α = .733 |
| Just-in-time link with customers | Our customers receive just-in-time deliveries from us.<br>We always deliver on time to our customers.<br>We can adapt our production schedule to sudden production stoppages by our customers.<br>Our customers are linked with us via JIT systems. | .831<br>.715<br>.654<br>.866<br>α = .768 |
| Reduction of supplier lead time | We seek short lead times in the design of our supply chains.<br>We purchase in small lot sizes, to reduce supplier lead-time.<br>Our company strives to shorten supplier lead-time, in order to avoid inventory and stock-outs. | .757<br>.639<br>.754<br>α = .673 |
| Proprietary equipment | We actively develop proprietary equipment.<br>Our equipment is about the same as the rest of the industry.<br>We have equipment that is protected by our firm's patents.<br>Proprietary equipment helps us gain a competitive | .839<br>.610<br>.652 |

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|---|---|---|
| | advantage.<br>We rely on vendors for most of our manufacturing equipment. | .813<br>.718<br>α = .774 |
| Unique practice | We are known for developing innovative new practices.<br>Our practices are unique and cannot be easily copied by others.<br>We gain a competitive advantage from our unique practices. | .781<br>.789<br>.855<br>α = .732 |
| Manufacturing as a competitive resources | In our company, manufacturing is considered to be a source of competitive advantage.<br>Manufacturing is actively involved in make-versus-buy decisions for new products.<br>Decisions about materials, systems and services sourced from outside our company are screened for consistency with our manufacturing strategy.<br>Our manufacturing competence is a substantial source of value added.<br>Our make-versus-buy decisions are made to sustain or strengthen our manufacturing competence. | .661<br>.660<br>.808<br>.704<br>.588<br>α = .697 |
| Customer satisfaction | Our customers are pleased with the products and services we provide for them.<br>Our customers seem happy with our responsiveness to their problems.<br>Customer standards are always met by our plant.<br>Our customers have been well satisfied with the quality of our products, over the past three years.<br>In general, our plant's level of quality performance over the past three years has been low, relative to industry norms. | .823<br>.805<br>.829<br>.844<br>.685<br>α = .852 |
| Top management leadership for quality improvement | All major department heads within the plant accept their responsibility for quality.<br>Plant manager provides personal leadership for quality | .792 |

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|---|---|---|
| | products and quality improvement. | .902 |
| | Our plant management creates and communicates a vision focused on quality improvement. | .778 |
| | Our plant management is personally involved in quality improvement projects. | .858 |
| | | α = .844 |
| Cleanliness and organization | Our plant emphasizes putting all tools and fixtures in their place. | .677 |
| | We take pride in keeping our plant neat and clean. | .842 |
| | Our plant is kept clean at all times. | .858 |
| | Employees often have trouble finding the tools they need. | .675 |
| | Our plant is disorganized and dirty. | .837 |
| | | α = .829 |
| TQM link with customers | Our processes are certified, or qualified, by our customers. | .808 |
| | Our customers involve us in their quality improvement efforts. | .723 |
| | Our customers can rely on us for quality products and processes. | .834 |
| | Quality is our number one priority in dealing with our customers. | .688 |
| | | α = .757 |
| Customer involvement | We frequently are in close contact with our customers. | .676 |
| | Our customers give us feedback on our quality and delivery performance. | .691 |
| | We strive to be highly responsive to our customers' needs. | .764 |
| | We regularly survey our customers' needs. | .755 |
| | | α = .679 |
| Feedback | Charts showing defect rates are posted on the shop floor. | .733 |
| | Charts showing schedule compliance are posted on the shop floor. | .700 |
| | Charts plotting the frequency of machine breakdowns are posted on the shop floor. | .674 |
| | Information on quality performances is readily available to employees. | .816 |
| | Information on productivity is readily available to | |

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|---|---|---|
| | employees. | .759<br>α = .778 |
| Prevention | We believe that prevention is preferable to inspection for quality improvement.<br>In our view, quality should be designed into a product, rather than defects inspected our after the fact.<br>We believe that prevention is more effective and economic than repairing undesirable problems.<br>We think that a good inspection system is more effective and important than a lot of up-front design work. | .679<br>.724<br>.730<br>.583<br>α = .609 |
| Process control | Processes in our plant are designed to be “foolproof”.<br>A large percent of the processes on the shop floor are currently statistical quality control.<br>We make extensive use of statistical techniques to reduce variance in processes.<br>We use charts to determine whether our manufacturing processes are in control.<br>We monitor our processes using statistical process control. | .743<br>.849<br>.809<br>.700<br>.874<br>α = .855 |
| Supplier partnership | We maintain cooperative relationships with our suppliers.<br>We provide a fair return to our customers.<br>We help our suppliers to improve their quality.<br>We maintain close communications with suppliers about quality considerations and design changes. | .816<br>.811<br>.806<br>.824<br>α = .829 |
| Supplier quality involvement | We strive to establish long-term relationships with suppliers.<br>Our suppliers are actively involved in our new product development process.<br>We use mostly suppliers that we have certified.<br>We maintain close communication with suppliers about quality considerations and design changes.<br>We actively engage suppliers in our quality improvement efforts. | .655<br>.712<br>.633<br>.812<br>.772 |

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| | | α = .763 |
| Customer focus | We believe that customers are a better judge of their needs than product designers.<br>We believe that organizations should be proactive in anticipating their customers' needs.<br>We believe that customers are the best judge of their needs and wants.<br>Customer satisfaction is important to the long-term performance of our organization. | .750<br>.761<br>.795<br>.803<br>α = .775 |
| Daily schedule adherence | We usually meet the production schedule each day.<br>Our daily schedule is reasonable to complete on time.<br>We usually complete our daily schedule as planned.<br>We cannot adhere to our schedule on a daily basis. (Reversed form)<br>It seems like we are always behind schedule. (Reversed form) | 848<br>.600<br>.817<br>.763<br>.792<br>α = .808 |
| Equipment layout | We have laid out the shop floor so that processes and machines are in close proximity to each other.<br>The layout of our shop floor facilities low inventories and fast throughput.<br>Our processes are located close together, so that material handling and part storage are minimized.<br>We have located our machines to support JIT production flow. | .762<br>.843<br>.836<br>.788<br>α = .815 |
| Set-up time reduction | We are aggressively working to lower setup times in our plant.<br>We have converted most of our setup time to external time, while the machine is running.<br>We have low setup times of equipment in our plant.<br>Our crews practice setups, in order to reduce the time required.<br>Our workers are trained to reduce setup time. | .705<br>.599<br>.745<br>.788<br>.784 |

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| | Our setup times seem hopelessly long. | .708<br>α = .806 |
| Synchronization of operations | Capacities are balanced in our supply network.<br>Our manufacturing capacity is balanced throughout the entire manufacturing process.<br>We can easily determine bottleneck operations in our supply chain.<br>We have large in-process inventories between different operations. (Reversed form)<br>Our suppliers do not use large inventories to supply us. | .763<br>.774<br>.675<br>.616<br>.568<br>α = .709 |
| Preventive maintenance | We upgrade inferior equipment, in order to prevent equipment problems.<br>In order to improve equipment performance, we sometimes redesign equipment.<br>We estimate the lifespan of our equipment, so that repair or replacement can be planned.<br>We use equipment diagnostic techniques to predict equipment lifespan. | .798<br>.727<br>.803<br>.788<br>α = .781 |
| Maintenance support | Our production scheduling systems incorporate planned maintenance.<br>Spare parts for maintenance are managed centrally.<br>Equipment performance is tracked by our information systems, | .747<br>.813<br>.775<br>α = .674 |
| Team-based maintenance | We find that equipment performance is improved by the work of cross-functional teams.<br>In the past, many equipment problems have been solved through small group sessions.<br>Groups are formed to solve current equipment problems. | .804<br>.788<br>.848<br>α = .744 |
| Effective process implementation | Once a new process is working, we leave it alone.<br>We pay close attention to the organizational and skill | .821 |

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| | changes needed for new processes.<br>We search for continued learning and improvement, after the installation of new equipment.<br>Our processes are effectively developed and implemented. | .771<br>.828<br>.784<br>α = .807 |
| Commitment | I talk up this organization to my friends as a great organization to work for.<br>I find that my values and this organization's values are very similar.<br>I am proud to tell others that I am part of this organization.<br>This organization really inspires the best in me in the way of job performance.<br>I am extremely glad that I chose this organization to work for, over others I was considering st the time I joined.<br>For me, this is the best of all organizations for which to work. | .808<br>.672<br>.852<br>.769<br>.822<br>.858<br>α = .885 |
| Cooperation | We work as a partner with our suppliers, rather than having an adversarial relationship.<br>We encourage employees to work together to achieve common goals, rather than encourage competition among individuals.<br>We work as a partner with our customers.<br>We believe that cooperative relationships extend to both employees and external partners.<br>We believe that an organization should work as a partner with its surrounding community. | .744<br>.713<br>.695<br>.713<br>.731<br>α = .761 |
| Coordination of decision making | Generally speaking, everyone in the plant works well together.<br>Departments in the plant communicate frequently with each other.<br>Departments within the plant seem to be in constant conflict.<br>Management works together well on all important | .764<br>.865<br>.710 |

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| | decisions. | .787<br>α = .784 |
| Multi-functional employees | Our employees receive training to perform multiple tasks.<br>Employees at this plant learn how to perform a variety of tasks.<br>The longer an employee has been at this plant, the more tasks they learn to perform.<br>Employees are cross-trained at this plant, so that they can fill in for others, if necessary.<br>At this plant, each employee only learns how to do one job. | 785<br>.740<br>.681<br>.841<br>.774<br>α = .823 |
| Recruiting and selection | We use attitude/desire to work in a team as a criterion in employee selection.<br>We use problem solving aptitude as a criterion in selecting employees.<br>We use work values and attitudes as a criterion in employee selection.<br>In hiring, we select employees who can provide ideas to improve the manufacturing process.<br>When we are hiring, we try to select employees who are able to work well in small groups.<br>We have developed an effective interview instrument for hiring employees. | .789<br>.757<br>.775<br>.750<br>.603<br>.593<br>α = .804 |
| Shop-floor contact | Managers in this plant believe in using a lot of face-to-face contact with shop floor employees.<br>Engineers are located near the shop floor, to provide quick assistance when production stops.<br>Managers are readily available on the shop floor when they are needed. | .816<br>.734<br>.829<br>α = .668 |
| Small group problem solving | Our plant forms teams to solve problems.<br>In the past three years, many problems have been | .805 |

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| | solved through small group sessions.<br>Problem solving teams have helped improve manufacturing processes at this plant.<br>We don't use problem solving teams much in this plant. | .653<br>.784<br>.818<br>α = .764 |
| Supervisory interaction facilitation | Our supervisors encourage the people who work for them to work as a team.<br>Our supervisors encourage the people who work for them to exchange opinions and ideas.<br>Our supervisors frequently hold group meetings where the people who work for them can really discuss things together.<br>Our supervisors rarely encourage us to get together to solve problems. | .729<br>.836<br>.728<br>.760<br>α = .751 |
| Task-related training for employees | Our plant employees receive training and development in workplace skills, on a regular basis.<br>Management at this plant believes that continental training and upgrading of employee skills is important.<br>Employees at this plant have skills that are above average, in this industry.<br>Our employees regularly receive training to improve their skills. | 851<br>.675<br>.638<br>.852<br>α = .754 |

Note) cut-off values for Cronbach's alpha and factor loading are .55 respectively.

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[i] The number of sampled companies is 35 from three industries, electronics (10), machinery (12) and automobile (13). (The figure in parenthesis is the number of sampled companies) We ask nineteen persons of a sampled factory from plant manager to direct workers on the floor. Constituent respondents are plant manager (1), superintendent (1), production engineer (1), production manager (1), information technology manager (1), inventory control manager (1), accounting manager (1), human resource manager (1), new product development staff (1), quality manager (1), supervisor (4) and direct worker (5). (The figure in parenthesis is the number of respondents) The data were collected from 2004 to 2005. The companies were selected based on high reputation and position in terms of market share, and also random sampling. But the ratio of the latter is low. Then the sampled companies are mostly well known and old in history. In other words, most of them represent Japanese manufacturing companies in each industry.

[ii] The interviews were done during collecting the data for the High Performance Manufacturing project in 2004.