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RESEARCH CENTRE

DISCOVERING THE RIGHT QUESTIONS ABOUT THE MANAGEMENT OF TECHNOLOGY USING CHALLENGE MAPPING

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WORKING PAPER NO. 85
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Abstract

One purpose of this study was to illustrate the application of a deliberate process of creative thinking which is designed not so much for creating good answers and solutions but rather more for discovering good questions and challenges in addressing an issue. This process is called Challenge Mapping[1]. Another purpose was to increase understanding of the term "management of technology" (MOT). Twenty senior managers from thirteen large North American corporations used the Basadur "Why – What's Stopping?" Analysis[2] to uncover specific MOT challenges that they face and create a Simplex[3] Challenge Map[4]. The Challenge Mapping process relates the challenges to one another and increases understanding of the situation both from a big picture and a specific standpoint. Virtually all of the challenges which were selected as most important had much more to do with changing how people in organizations think than with new technology itself. Conclusions and recommendations are provided for addressing the challenges and for future research.

INTRODUCTION

Shortly after joining the university, the senior author was asked to participate in a new project which had been initiated by members of our business and engineering faculty and administration. The project was to create an institute for the study and advancement of the "management of technology". I had never heard this term before, but soon found myself embroiled in discussions ranging from philosophical questions such as "Is this a sufficiently academic field for our faculty to become involved in?" to implementation details like "what is the best location for teaching seminars?" and "how would we get funding?". Most of the discussions seemed to concern the how rather than the why. We seemed to be concerned with what educational and consulting offerings to provide but after many hours of discussion, I realized that I still did not know the why?. What technology or management problems were we trying to solve by creating such an institute? What questions were we trying to answer? I was still very unclear what the term "management of technology" meant. It seemed that we were discussing how to implement the solution before achieving a clear definition of the problem which needed solving.

This article describes a study we performed to help discover the "why?". The study attempted to develop some clarity about what the term "management of technology" actually meant. Meanwhile, our institute eventually failed – it closed after a few years of painful attempts to lure customers to various offerings. I always felt that one of the main reasons was the lack of consensus from the beginning on what "MOT" really meant and on the specific purpose of the institute. What specific management or technical problems needed to be solved that such an institute could help with? Had we determined these, perhaps we could have more accurately identified our customers and met their needs.

My impression was that most individuals who were involved in the discussions believed that they already knew what MOT meant but some were unaware that others may have had substantially different interpretations and therefore different solutions in mind and thus different levels of commitment to its success.

Nonetheless, in recent years, "management of technology" has continued to become an increasingly prevalent phrase. There are frequent management of technology conferences which attract both academics and practitioners. Universities have introduced management of technology curricula. Seminars and consulting services in technology management abound. Such seminars and services are wide ranging and appear to cover a wide range of issues.

The literature has also grown. It can be divided into about six categories. Some writers describe MOT by explaining to whom the term applies. Others explain what is required to make it work, or what the benefits are, or what the goals and aims are. Still others explain it by convincing the reader that it is an important issue. Finally, some writers explain it by linking it in broad terms to other subjects such as change management and knowledge management.

For example, according to Berk (1989), technology management applies not just to manufacturers or high-tech companies but to every organization that develops, markets or uses technology. Frohman (1982) warns that companies using technology as a competitive weapon should not do so at the expense of other areas. They should create organizational structures that ensure close and consistent connections between business decisions and technological decisions. They should decide to support projects based on whether or not the project supports the business goal; protects or establishes technological leadership; solves customer problems; opens up new technology opportunities; and pursues technological advancement.

The Center for Advanced Studies in Management at The Wharton Business School, University of Pennsylvania, suggests four strategies for managing technology well: (1) nurture the research base; (2) global planning; (3) high-touch leadership; and (4) educate the people. Nurturing the research base involves facilitating and managing technology transfer from outside the organization. Due to a significant shortage of scientists, mathematicians, and engineers, managers will have to rely on co-operative research linking many companies, universities, and even government. Global planning means that management must understand not just the technology or products, but also the culture and religion of countries in which they work and learn about strategic planning in a global environment. With more and more multinational corporations, they will need to place much of the organization's manufacturing, research and marketing functions into the hands of local people or subsidiaries. Executives will also have to be open-minded enough to bring local people back to corporate headquarters in order to help with strategic planning. High-touch leadership means the ability to inspire, attract and motivate talented people from a wide range of environments and demographics. Given the declining pool of talented people, cash alone will not be the critical factor in attracting and retaining people. These people must feel that managers are deeply interested in their career development. Job descriptions must incorporate personal beliefs and value systems. Organizations will lose talented people, if they do not enjoy their jobs. Educating the people means that successful organizations will attract and retain their workforce through skills-building education. The most important ingredient in an organization's success is the quality of its workforce. In order to upgrade the workforce, the organization must keep its people learning. Telecommunications and computer technology will be applied to the learning process.

The need for continuous improvement will require workers to learn to think strategically and increase skills in individual and group innovative problem solving.

Badawy (1989) equates managing technology to managing change. He argues that senior management must become more adept at managing change while continuing to manage other corporate functions that promote stability and conformity. According to Badawy, managing technology requires organizations to develop and embrace new ways of doing things, new products, new processes, new markets and new competitors thus quickly moving ideas and technology from research and development through manufacturing to marketing. Effective strategic management involves close interaction between the technology side (R&D, engineering and manufacturing) and the business side (finance, human resources and marketing).

Noori (1990) also positioned the management of technology as a change process and summarized its importance, benefits, goals and aims as follows. First, there are five concepts on which general agreement does seem to exist: technology advancement is inevitable; the process is necessary for (manufacturing) survival; technology carries considerable unknown risk; there is a greater need for co-operation between business, government and labor; and the costs, benefits and values of technology need to be continually re-examined by companies in particular, and by society in general. Second, management of technology appears to encompass two critical elements: change and people. By integrating technological change with people, organizations can ensure survival in the new millennium. By learning how to manage technology, they are more likely to create more new products and processes than their competitors; develop a network to deliver quality products and/or services to market in less time and at a lower price than the competition; and have customers seeking them as suppliers. Third, in simple terms, MOT seems to be a process by which an

organization can manage change in processes and people. By this process, organizations strive to improve product quality and become the lowest-cost producer; set measurable goals for ongoing improvement; develop the necessary organization skills to train and educate employees; and create an environment that encourages employers and employees to actively seek out opportunities for valuable change.

Noori's summary indicates that while the general philosophy and aims of MOT appear fairly well defined, there is no clear or widely accepted definition of the term. The summary does not address what this change process is and why a process is needed. For example, what are the specific issues and problems that require a MOT process? What prevents organizations from achieving their MOT aims and from turning MOT philosophy into practice?. One purpose of the research reported herein is to better identify these specific issues and problems and thereby increase understanding of what MOT actually means.

The authors decided to try to clarify what MOT means by involving a group of managers who were concerned by the issue. The approach was to identify precisely what such managers believe to be their critical difficulties and challenges in "managing technology". Then perhaps we could better understand what the term actually means and design approaches to help managers solve such problems. This was the first purpose of this study. A second purpose was to demonstrate two related processes of creative thinking called the Why – What's Stopping? Analysis and Challenge Mapping which facilitate an individual or group to think through, clarify and define a complex, ambiguous, or strategic issue. These processes are part of the Simplex system for innovative thinking and are fully described in Basadur (1995); Basadur, Ellspermann and Evans (1994); and Basadur, Graen and Green (1982).

These processes help identify specific problems and challenges within a milieu of vague, global issues and convert philosophical motherhood statements into precisely targeted problem definitions. For example, relatively broad statements such as "morale is bad here"; "communication is our biggest problem"; "we need more employee involvement"; "we are a customer focused organization"; and "innovation is our first priority" are transformed into more specific, simply worded challenges such as "how might we help our employees take pride in their every day work?"; "how might we increase the amount of face to face contact every employee experiences with employees from other departments?"; "how might we make it easier for every employee to create and implement improvements to our procedures, products and services?"; "how might we reward our employees for trying to increase customer satisfaction?"; and "how might we make sure we bring to market at least one successful new product each year?" The success of the processes depends on the skill of the participants in applying them. This skill includes being able to use simple and specific words in asking questions and providing answers. This paper reports a case study in which a group of managers used these creative processes to the best of their abilities to develop a common understanding of the phrase "management of technology" (MOT).

METHOD

Twenty upper middle managers from diverse functional groups in twelve large North American companies participated in a day long workshop entitled "exploring issues in the management of technology". The objective of the workshop was to identify the most significant challenges in the management of technology. Participants were facilitated through the application of the Simplex process which separates creative thinking into three phases: (1) problem or

opportunity sensing and definition (problem finding); (2) solution finding; and (3) solution implementation. Workshop participants worked through only the first (problem finding) phase of the method. Rather than try to find answers (which is the second phase), the group set out to clearly isolate the right questions (the first phase).

There are three steps in the first phase of the process. Once a problem or opportunity has been sensed (Step 1), participants deliberately view it as a "fuzzy situation" requiring clarification. For example, in this case, the fuzzy situation was "exploring issues in technology management". Fact finding follows (Step 2). Participants are prompted to share perspectives and stretch their thinking to generate information about what they know or think they know, what they don't know but wish they knew, what they may be needlessly assuming, what would be different if the situation were resolved, and what they have already thought of or tried. Participants then use these facts to create specific challenges they need to confront. Formulating these challenges is called problem definition (Step 3). How this is done is described below.

Each step of the Simplex process, including fact finding and problem definition, consists of a diverging thinking (non-judgmental, imaginative) stage followed by a converging thinking stage (judgmental and analytical). Groups using Simplex employ a process leader to facilitate and synchronize the group members in their flow of sequential diverging thinking and converging thinking. The leader models these thinking skills (and the supporting attitudes and behaviors) and builds the group's own capability to use the process. Participants are encouraged to remain open to and seek out fresh points of view while diverging, and to apply objectivity and good judgment while converging. Tables 1, 2 and 3 list the attitudinal and behavioral skills required for good diverging and converging thinking and for the separation of the two.

TABLE 1

Skills in Separating Diverging Thinking From Converging Thinking

A person skilled in separating diverging and converging thinking, and who encourages others to separate the two, does the following:

* avoids making negative judgments or analyzing during divergent thinking, whether working alone or in interactions with others;
* avoids prematurely jumping to a conclusion about what the "real problem" is;
* visibly values and welcomes other points of view as opportunities to strengthen a position rather than as a "threat" to one's ego;
* avoids prematurely criticizing a fledgling idea;
* visibly stays open-minded to new ideas and approaches;
* often pauses deliberately to try an unusual or creative approach to solving problems instead of automatically relying on an old approach;
* reacts positively to new, highly unusual ideas;
* disciplines self to realize there is always a better way than his/her way;
* deliberately avoids sticking to old ways and supports new, better ways even if other people receive credit for them.

TABLE 2

Skills in Diverging Thinking

A person skilled in divergent thinking, and who encourages others to practice diverging thinking, does the following:

* actively thinks up many and novel options;

* actively searches out many facts and different points of view;

* actively defines problems in multiple and novel ways to explore them from many angles;

* actively thinks up highly unusual, seemingly "wild" options and ideas;

* actively combines, modifies and builds onto thoughts to make new thoughts;

* actively gives credit for divergent thinking to others
  - thanks/praises another person who offers any idea without judging it to be "good" or "bad";
  - tells the other person several things that are good about the idea first, then tries to build and strengthen the idea;

* extends effort deliberately to create more options and ideas when it appears that all the options and ideas have already been exhausted;

* actively encourages others to practice the above behaviors.

TABLE 3

Skills in Converging Thinking

A person skilled in converging thinking, and who encourages others to practice converging thinking, does the following:

* avoids preconceptions and hidden motives when judging and selecting options;

* open-mindedly develops and uses multiple criteria to evaluate options;

* makes wise choices between broader, bigger picture challenges and narrower, more tightly focused challenges.

* does not "wait forever" to develop or polish the "perfect" choice; instead, moves ahead to the next step in the creative process and progresses as far as possible within the time limits; takes reasonable risks in doing so;

* pins down action plans clearly, simply and specifically;

* never leaves a problem solving meeting without an action plan, no matter how simple.

* bird-dogs and follows up on planned action steps and does whatever it takes to ensure that a new idea is successfully installed.

The process leader used the first 30 minutes of the workshop to sensitize and train the group in these basic thinking skills. This served also to "break the ice" and increase participants' trust and comfort levels. The participants were then randomly assigned into four groups for fact finding. Each group was asked to use the following five fact finding questions in order to prompt diverging thinking and to prevent premature convergence.

1. What do we know or think we know about the management of technology?
2. What do we not know but wish we knew about the management of technology?
3. Why is the management of technology a problem for us?
4. What have we already thought of or tried?
5. What would be different if the management of technology were no longer a problem for us?

Each group listed its responses to each question on a flip chart (active divergence), and then reached consensus on their most important ("key") facts (active convergence). These key facts were used in turn to divergently generate as many concrete, specific challenges as possible, listed as questions beginning with the words, "How might I...". Participants were encouraged and facilitated to defer judgment and to avoid prematurely assuming that any specific challenge was the "correct" one. Each "How might I?" would thus represent a personal MOT challenge. By discussion and consensus, the group then chose a small number of challenge statements they considered as the more important ones. This activity completed the initial divergence-convergence portion of the problem definition step.

Next, a secondary divergence-convergence in problem definition was performed employing the "Why – What's Stopping? Analysis". Using the selected challenges as a starting point, the group

created a Challenge Map, with broader challenges placed higher and more specific challenges placed lower. When moving down the map from the top, the questions "What's stopping us?" and "What else is stopping us?" are used to elicit specific impediments and create narrower challenges. Conversely, when moving up the map, the questions "Why?" and "Why else?" are asked to identify potential benefits and create broader challenges. Judgment and analysis are deferred while the map is being built, permitting new and sometimes hidden or unexpected challenges to be discovered in both directions. The simple three-step questioning process in Table 4 is used to create and place each new challenge.

TABLE 4

The Simplex "Why – What's Stopping?" Creative Analysis

Step 1.	Ask the complete question: "Why...?" or "What's Stopping...?" of the selected challenge. (Also, ask "Why else...?" and "What else is stopping...?").
Step 2.	Answer in a complete simple sentence.
Step 3.	Transform the answer into a new challenge.

The "Challenge Mapping" and "Why – What's Stopping? Analysis" processes are integral to the Simplex process and are fully described in Basadur (1995) and Basadur, Ellspermann and Evans (1994). Challenges are always stated in "How might...?" format. The questions "Why?" and "Why else?" and "What?" and "What else is stopping?" are asked of a selected challenge to begin and then repeated with the new challenges resulting. During the group's extensive Why – What's Stopping? Analysis, some of the "How might I?" challenges from the initial divergence-convergence

portion of the problem definition step found their way back onto the map, and many new ones were created to fill in crucial links.

The group then selected three mapped challenges that appeared especially critical and merited further fact finding and more detailed exploration, then divided itself into three subgroups. Each subgroup was assigned one of the three selected challenges and worked together to identify the major impediments preventing its solution by asking the questions repeatedly: "What's stopping us?" and "What else is stopping us?". The three groups then reported their results to each other and created additional challenges to add to the challenge map. The whole group then selected the top challenges from the final map.

RESULTS

Fact Finding

Following are the key facts selected by each of the four random groups.

Group 1

1. We feel that a corporate culture based on change must be established.
2. We believe that it is vital to establish a clearly understood corporate vision, determine market needs, and align R&D efforts to it.
3. We want to know how to measure progress in the management of technology.
4. We want to know how to better communicate technology issues.
5. We believe we should be able to develop a list of ranked issues that are important in technology management.

The group provided the following additional summary statement:

"You are not working in a vacuum. There must be some set of values in the organization that says 'this is where we're going,' whether it has been written down and articulated or not. They are there, and you have to recognize them before you can figure out what you have to change to get to where you want to go."

Group 2

1. We want to break down, and structure, the management of technology problem so that we can personally take appropriate action.

2. We want to be able to balance the level of automation, to improve the effectiveness of the operation.

Group 3

1. We know that management of technology demands the integration of people with different skills into the process of technological change.

2. We know that management of technology must include simultaneous recognition of science issues, management issues, and politics.

3. We do not know how to optimize the process of moving the technology through the company.

4. We would like to leave with a model or checklist for selecting and targeting technology.

The group provided the following additional summary statement:

"When we talk about the generic management of technology, it's in the transfer process that it breaks down. You've got your smart research guys in one place, and your manufacturing guys in another, and it's the passing off between them, that's the challenge."

Group 4

1. We want a definition of the top 10 issues in management of technology facing the firms here today.

2. We want a method to transfer technology successfully from research to development and then down the line.

3. We want a way to manage a single corporate strategy across a company's multiple markets, labs, factories and locations.

4. We want a way to facilitate interfacing among the management of technology, the management of resources, and the business strategy of a company.

Problem Definition

The group agreed on the six challenge statements in Table 5 to begin the challenge mapping process.

TABLE 5

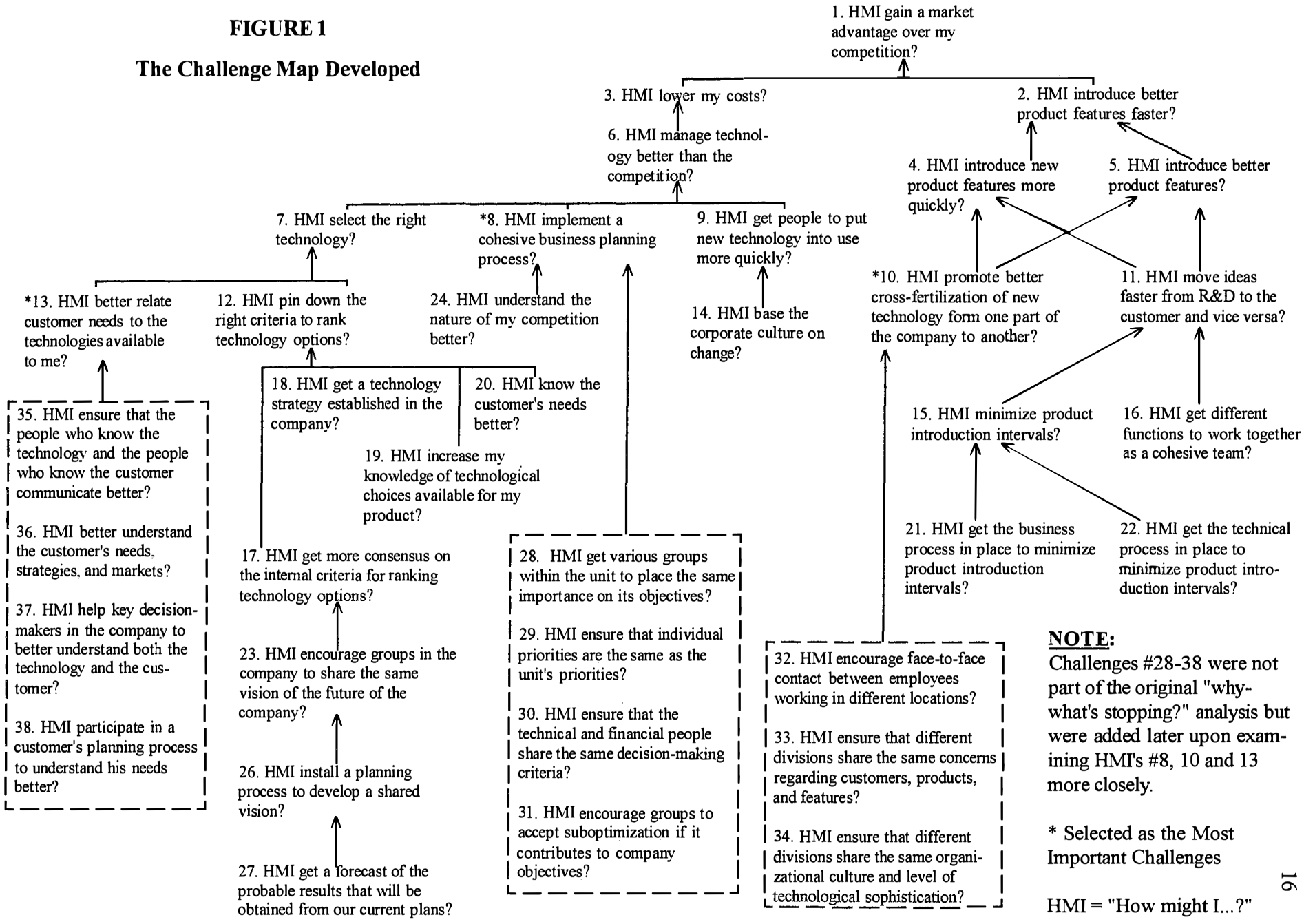
Six Challenges Selected to Begin the Challenge Map

- How might I promote better cross-fertilization of new technology from one part of the company to another?
- How might I move ideas faster from R&D to the customer and vice versa?
- How might I pin down the right criteria to rank technology options?
- How might I better relate customer needs to the technologies available to me?
- How might I base the corporate culture on change?
- How might I encourage different groups in the company to share common business objectives?

The Challenge Map created using the six challenge statements in Table 5 as a base is shown in Figure 1. There were 27 challenges on the map, and they are numbered from 1 to 27. (Figure 1 shows 11 more challenges which were added by probing the top three challenges from the map as described below.

FIGURE 1

The Challenge Map Developed



NOTE:
Challenges #28-38 were not part of the original "why-what's stopping?" analysis but were added later upon examining HMI's #8, 10 and 13 more closely.

* Selected as the Most Important Challenges

HMI = "How might I...?"

Most Critical Challenges Selected from the Map

The three challenges selected as standing out above all the rest on the map as the most critical appear in Figure 1 as Numbers 8, 10 and 13 and are shown in Table 6.

TABLE 6

Top Three Challenges Selected from the Challenge Map

8. How might I implement a cohesive co-ordinated business planning process?

10. How might I promote better cross-fertilization of new technology from one part of the company to another?

13. How might I better relate customer needs to the technologies available?

Major Impediments to Solving the Three Most Critical Challenges

The three top challenges were probed further by asking "What's stopping us?" and "What else is stopping us?" repeatedly to uncover the impediments to solving them. The answers to the questioning reported by the groups were as follows:

Group 1

"The major impediment stopping us from implementing a cohesive co-ordinate business planning process are:"

(i) The various groups within the unit do not place the same importance on the objectives of the unit.

"People have different priorities depending on how they view the problem or what their background is, and that makes implementing a co-ordinated business planning process a little difficult."

(ii) Many individuals' priorities are not the same as the units priorities.

"This leads into some personality issues in generating a cohesive plan."

(iii) The technical and financial people do not share the same decision-making criteria.

"These could be any two groups in a company, but technical and financial groups are at diametric ends of the continuum. This is tied up partially in the value systems of the two groups. Without a focusing mechanism at that level, there are implementation problems."

(iv) Groups are not rewarded for making their own departmental objective secondary to the objectives of the company as a whole.

Group 2

"The major impediments stopping us from promoting better cross-fertilization of new technology from one part of the company to another are:"

(i) The physical separation of plant locations limits the frequency of face-to-face discussion.

"It still means something to be able to walk to the next office and discuss something as opposed to telephoning or flying down. With physical separation, it takes a lot of extra effort to synchronize, and the path of least resistance often is not to bother."

(ii) Different divisions have differing business concerns, including different market/customer priorities, product life cycles and features (including P&L goals).

"How are the divisions being measured? What are their business concerns? For one thing, they may have different markets and customer priorities in terms of timing or whatever. They will respond to their own priorities because they are being measured by their own profits and losses."

(iii) Different divisions have differing cultures, organizational structures, and levels of technological sophistication.

"When you have physical separation of different business units, you end up with different cultures, different organizations, and this could even lead to different levels of technological sophistication depending on the age of each division and what their history is."

Group 3

"The major impediments stopping us from better relating customer needs to the technologies available are:"

(i) The people who know the technologies are not the same people who know the customer.

"The marketing guys in a company may think they know the customer's needs and problems, but in fact, the guys on the technology side may know something about where the technology is trending that negates everything the marketing guys know".

(ii) We do not understand the customer's needs, problems, strategies and the market well enough.

"Your customer may have immediate needs and problems that he wants a solution to, even if these do not reflect what you know the market trend is. Your customer wants you to make buggy-whip handles so he can make the buggy whips, but you know that technology is gone and there's something else coming down the road."

(iii) Decision-makers may not know either the technology or the customers well enough.

"The top decision-makers in a company may not be familiar with either the details of technology or the specific situation of the customers."

(iv) We do not devote enough time to helping customers in planning. If we did, we'd understand their needs better.

"You can help yourself and the customer by helping him in the planning process. By doing that, you will understand his needs better. The message here is to get as close as you can to the customer and exchange with him your own understanding of the market and technology."

Additional Challenges Added to the Challenge Map

These "What's stopping us?" facts (impediments) about the three most significant MOT challenges were turned into 11 additional specific sub-challenges using the "How might I?" format and located on the challenge map in the dotted boxes depicted in Figure 1. The dotted boxes

indicate that these were not part of the original "Why – What's Stopping?" creative analysis, but were added after a further examination. They are numbered 28 to 38 as follows.

How might I:

28. ... get various groups within the unit to place the same importance on its objectives?

29. ... ensure that individual priorities are the same as the unit's priorities?

30. ... ensure that the technical and financial people share the same decision-making criteria?

31. ... encourage groups to accept suboptimization if it contributes to company objectives?

32. ... encourage face-to-face contact between employees working in different locations?

33. ... ensure that different divisions share the same concerns regarding customers, products, and features?

34. ... ensure that different divisions share the same organizational culture and level of technological sophistication?

35. ... ensure that the people who know the technology and the people who know the customer communicate better?

36. ... better understand the customer's needs, strategies, and markets?

37. ... help key decision-makers in the company to better understand both the technology and the customer?

38. ... participate in a customer's planning process to understand his needs better?

The group then selected the most important of these additional challenges by consensus. They were numbers 30, 33, 35 and 36 as shown in Table 7.

TABLE 7

Most Important Additional Challenges Derived by Probing the Three Most Critical Challenges

How might I:

30. ... ensure that the technical and financial people share the same decision-making criteria?

33. ... ensure that different divisions share the same concerns regarding customers, products, and features?

35. ... ensure that the people who know the technology and the people who know the customer communicate better?

36. ... better understand the customer's needs, strategies, and markets?

SUMMARY, DISCUSSION AND RECOMMENDATIONS

By consensus, the most important challenges in the management of technology that were identified were: How might we (1) implement a cohesive, co-ordinated planning process organization-wide?; (2) crossfertilize new technology much faster and better among the various parts and divisions of the company?; and (3) better relate customers' needs to available technologies? These three challenges appear to be much more problems of skills in managing behavior rather than problems of technological know how. In fact, virtually all of the sub-challenges identified as supporting these three top challenges had to do with leading and managing people – getting people to think differently and work together toward common goals.

Some of the difficulties which were identified with how people in organizations think include the following. Various groups within organizational units place different levels of importance on the unit's objectives. Furthermore, often the individuals within a unit have their own

personal priorities depending on their backgrounds and their own personal thinking and problem solving styles that are not synchronized with the units' priorities. Different functional groups, such as technical and finance, often have very different criteria for deciding the merits of a new idea and there are inadequate management skills or methods to induce such groups to implement a common set of criteria for the good of the company as a whole, long and short term. The people in most organizational sub-units: (eg. teams, groups, departments, divisions and functions) are rewarded for achieving the specific objectives of their own sub-unit. In other words, they live in organizational "silos" and think vertically, "up and down" within the confines of their own sub-unit. There are inadequate incentives for people to think horizontally, across functions, departments and divisions. Many decisions that are right for the company as a whole, and for its customers, require some sub-units to sub-optimize their own goal achievement for the greater good. It is perhaps somewhat amazing that our organizational leaders have not found ways to make it attractive for all individuals and sub-units to transcend such narrow, vertical thinking.

In these days of short term profit pressures, many organizations have downsized so drastically to reduce costs that it is difficult for their people to advance ideas that have longer term and sometimes more risky (although much higher impact) paybacks. Many organizations do not know how to create meaningful strategic plans that identify and align specific short and long term objectives that are understood by all the individuals in the organization. Even fewer have the ability to involve all levels of the organization in strategic thinking to develop such specific, aligned objectives and integrated strategic plans.

A well known definition of leadership is the process of influencing followers to agree on and work toward common goals and objectives. It appears that in today's era of rapidly accelerating

change, leadership also requires the ability to change how people think, to open (closed) minds and keep them open permanently. This research would indicate that there is much room for improvement in leadership skills among today's managers of large corporations. A much more creative leadership style is needed, with new skills in designing organizational structure and changing how others think.

A surprising number of organizations are still structured along the outdated scientific management approach. Designed to efficiently produce a stable set of products, the organization arranges work around functional specialization – manufacturing, sales, engineering, marketing, R&D, finance, accounting. Each function pursues its own goals, and often works in a separate building or even a separate location. Managers succeed by pursuing functional goals, not overall organizational goals. Surrounded by specialists in the same field, they regard other functions as less important, or even as competitors. This arrangement hardly fosters the teamwork required to create new products and services. Many important organizational problems fall "between the cracks". Some are not even addressed; others are bounced back and forth ("that's not our problem, it's engineering's problem"). Customers themselves are passed from one department to another when they phone in for information. Each function's work is often broken down into smaller and smaller tasks, with people doing the same task day after day. The theory is that this builds expertise: by doing a simple task over and over again, a person becomes very good at it. But in practice, this design causes people to view their organization as a group of separate functional chimneys. They pursue narrow goals that benefit their own function but that prevent the entire organization from succeeding. Innovative projects often suffer from interdepartmental squabbling. Rather than co-operate as a team, the departments soon find opportunities to quarrel over who should receive credit

for a certain project or who needs more resources. Achieving vertical functional goals becomes more important than reaching overall, organizational objectives.

When someone successfully leads others in meeting important functional goals, that person can be said to exercise strong vertical leadership. Vertical leadership emphasizes technical excellence in a particular field, such as accounting or marketing. When one leads others to meet interfunctional, organizational goals, one can be said to exercise strong horizontal leadership. Horizontal leadership emphasizes teamwork and long-term thinking. Some functions might have to sacrifice short-term goals for the benefit of the entire organization. Horizontal leaders use informal networking to get things done, rather than hierarchical approval. They encourage people outside their own narrow domain to see the "big picture." Organizations need to structure themselves in order to develop strong vertical and horizontal leadership at the same time. Innovation cannot flourish under vertical leadership alone.

Some organizations have established matrix teams that try to achieve teamwork even as they maintain functional priorities. But these efforts have failed for several reasons. Functional priorities often take precedence over interfunctional objectives. The organization's reward system often favors individual efforts to meet functional goals, not teamwork to meet organizational goals. As they lead their teams across functional barriers, the few skilled horizontal leaders ruffle the feathers of others who are less flexible and more used to thinking vertically. Because promotions often follow functional lines, horizontal leaders often end up low on the promotion list. Until organizations place horizontal leadership and organizational goals on the same level as vertical leadership and functional goals, matrix teams will not work.

Learning how to think differently is not an easy task for most managers, especially those who are engineering and business graduates. Often they have learned to exercise only highly structured, solution-oriented, analytical thinking. When they become managers of organizations, these individuals need to be careful that they don't rely solely on programmed problem solving methods and highly structured procedures. They need to become more comfortable with innovation. They need to recognize the value of learning new processes that help people to cope with uncertainty, ambiguity, poorly structured problems and other situations requiring non-programmed thinking skills. Because these processes are strange to them, they regard them skeptically. Leaders trying to involve colleagues in the innovation process must prepare to encounter this skepticism. It shouldn't be surprising if others are slow to support the idea of investing in learning and applying creativity and innovation processes.

The challenge of crossfertilizing new technology faster and better is obviously directly related to the above discussion. People confined to narrow vertical functions (with a reward system that encourages them to pursue narrow vertical goals) get little opportunity to receive helpful critique and input from their peers in other vertical functions, or to offer feedback to those people. They complete projects more slowly and with less fresh thinking, and fail to understand how their work aligns with others' and with overall corporate goals. People also find themselves "reinventing the wheel", unaware that colleagues have already completed certain projects or tasks. The lack of familiarity with what people in other areas are doing is in itself enough to keep people from opening up a dialogue. The physical separation caused by different locations further reduces face-to-face contact and informal discussions which could lead to greater understanding and the sharing of similar over-arching concerns regarding customers, products, services, and technological advances

and sophistications. Leaders could try creative approaches to getting people in such circumstances to work together. For example, designing a project with a stretch target requiring close cooperation, even a project outside of the workplace, could help people learn more about each others' similarities and differences.

Better relating customers' needs to available technologies requires the people who know the technologies to get to know the customers better and discover the customers' own problems and challenges. In Japan's Toshiba Corporation, scientists and engineers newly hired into R&D positions are required to spend at least the first six months of their new career working in sales (Basadur, 1992). Why? To ensure that the new hires learn that the first step in the innovation process is to learn what problems customers are having. Such problems are considered "golden eggs", and new products are simply solutions to customers' problems. Getting to know customers helps one to discover and even stumble upon important problems that they are experiencing. There are probably many other creative ways in which organizations can deliberately increase such educational interactions for technology people. Providing the opportunity for participation in a customers' planning process is one example. It is important for key decision-makers on technology ideas and investments to increase their understanding of both the technology and the customer. Otherwise, truly well-informed decisions cannot be made consistently. Time must be invested in creating such opportunities. It must become an important priority. However, such initiatives often remain merely "ideas" – unimplemented due to the pressure of short term day to day crises and activities that contribute to their quarter's bottom line.

CONCLUSIONS AND FUTURE RESEARCH

Managers must develop new creative leadership skills. They must be able to use new tools which help people think differently and more strategically and which help them clearly identify and align the objectives and challenges of every part of the company. Furthermore, these same skills and tools must stretch down further in the organization. Individuals must learn how to align their own objectives and activities with more strategic organizational goals. Managers must learn to devise creative ways to increase face-to-face interaction among diverse parts of the organization and with customers to build understanding of customers' problems. In other words, managers must put creative thought into devising and implementing such people processes which overcome the management of technology (MOT) challenges identified in this research. Such processes must be customized for each organization. The importance of devising these processes must be accepted and not relegated to secondary priority bending to imminent crises and pressures.

Similar research with representatives of small- and medium-sized enterprises should be conducted to explore differences and similarities compared to large corporations. This would likely provide valuable insights on solving the challenges uncovered in this research. Also, this research focused only on the fact finding and problem-definition portions of the Simplex method. It would be useful to conduct a longer research workshop that could work the issue through all three phases. Solutions created and implemented could be monitored and shared for other corporations to adopt and implement and for further research to build understanding.

REFERENCES

Badawy, M.K. (1989) Management of Technology. The Enemies are Within. Industry Week, March 20, 238, pp. 39-43.

Basadur, M.S. (1995). The Power of Innovation. London, UK: Pitman Professional Publishing.

Basadur, M.S. (1992). Managing Creativity: A Japanese model. Academy of Management Executive, 6 (2), pp. 29-42.

Basadur, M.S., Ellspermann, S.J., and Evans, G.W. (1994). A New Methodology for Formulating Ill-structured Problems. OMEGA: The International Journal of Management Science 22, pp. 627-645.

Basadur, M.S., Graen, G.B., and Green, S.G. (1982). Training in Creative Problem Solving: Effects on Ideation and Problem Finding in an Applied Research Organization. Organizational Behavior and Human Performance, 30, pp. 41-70.

Berk, S. (1989) Managing Technology for a Competitive Edge: An AMA Survey. Management Review, Jan-June, 78, pp. 49-51.

Frohman, A.L. (1982). Technology as a Competitive Weapon. Harvard Business Review, January-February, pp. 97-104.

Noori, H. (1990) Managing the Dynamics of New Technology Issues in Manufacturing Management. Prentice Hall.

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