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TRIGGERS, TEMPLATES AND TWITCHES IN THE TRACKING OF EMERGING STRATEGIC ISSUES

OMAR A. EL SAWY
Graduate School of Business Administration, University of Southern California, Los Angeles, California, U.S.A.

THIERRY C. PAUCHANT
Center for Futures Research, Graduate School of Business Administration, University of Southern California, Los Angeles, California, U.S.A. and Departement des Sciences Administratives, Laval University, Quebec, Canada

A longitudinal investigation of group tracking of potential new applications and markets created by an emerging technology (cellular telephones) is used to gain more understanding of the shifts of cognitive frames of reference in the environmental tracking of emerging strategic issues. The dynamics of frame of reference shifts *is examined through the derivation and operationalization of the concepts of templates, triggers and twitches. The results posit that examining the frame of reference shifts can be more informative than examining the frames themselves. Implications for strategic management practice and research are addressed.*

This study was motivated by our interest to better understand the role of managers' cognitive frames of reference in the environmental scanning process, and their influence on strategic issue diagnosis. While the interplay between cognitive frames of reference and strategic issue diagnosis is highly debated in the strategic management literature, there are few empirical studies on the subject. Furthermore, there is little operationalization of cognitive frames of reference and their shifts in a form amenable to direct translation into corporate practice.

This study attempts to better understand the role of cognitive frames of reference in the scanning process related to strategic issues, and to operationalize this interaction in explicit pragmatic terms. This is done through the longitudinal investigation of the group tracking of potential opportunities created by an emerging technology (cellular phones).

The paper first articulates the relevance of the focus of this study considering the changing nature of the strategic scanning activity in organizations. Second, we review the literature on frames of reference and point to some of its contributions and limitations for application to corporate practice. Third, we present the methodology used. Fourth, based on the data collected from the longitudinal scanning process of 17 professionals and managers, we derive an operationalization of frame of reference shifts through the concepts of templates, triggers and twitches. Fifth, we derive further understanding of the issue tracking process, and conclude with the implications of these findings for both practice and research in strategic scanning.

THE EVOLVING ROLE OF ENVIRONMENTAL SCANNING IN STRATEGY FORMATION

The changing nature of strategic scanning

Strategy formation in dynamic environments seems to take place in a somewhat less deliberate and a somewhat more emergent fashion then conventional descriptions of strategic planning suggest (Mintzberg and Waters, 1985). These emergent modes, coupled with complex and high-tempo environments, are accompanied by the active and constant search for new opportunities, and a constant movement away from threats and ills, thus involving a large and continuous environmental scanning component (Aguilar,

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1967; Ansoff, 1984). This enhanced role of environmental scanning in strategy formation has manifested itself in organizations in North America and Europe in terms of the increasing interest in strategic planning methods which are heavily based on continuous environmental scanning, such as issues management (Heath and Nelson, 1986; King, 1987) and futures research, with the use of multiple alternative scenarios (Nanus, 1982; Malaska, 1985).

However, empirical studies indicate that formalized environmental assessment units are usually not successful in having their input integrated into the strategic management process even in the largest multinational corporations (Klein and Linneman, 1984; Stubbart, 1982). In examining the few examples of successful environmental scanning that have been reported, three distinguishing characteristics have surfaced. First, the scanning is carried out by people who are close to the action as part of their line responsibilities; such as at the divisional rather than the corporate level (Stubbart, 1982). Second, the scanning is done through personal and informal information sources outside the organization; for example, it has been shown that CEOs of small high-technology firms have their own informal personalized information systems that transcend the internally provided formal organizational information systems (El Sawy, 1985). Third, the scanning needs to be bounded in scope; for example, Lenz and Engledow (1986a) found that carefully targeted environmental scanning around specific issues affecting the direct concerns of line departments such as product functions, features and usage tend to be more successful than non-bounded efforts. Some corporations are starting to capitalize on these success factors by taking advantage of the habitual and automatic scanning that individuals do in the course of carrying out their day-to-day activities. Capture methods include peer networking (Mueller, 1986), providing incentives for instituting a strong 'see-and-hear' culture (Gilad and Gilad, 1986), and formally relying on designated 'corporate monitors' (Lenz and Engledow, 1986a).

This evolution in the modes and methods for environmental scanning points to four issues that still need to be better understood. First, there is a continued and pressing need to better understand the environmental scanning process as carried out by individuals and as carried out by groups, and their interactions. Second, the nature of environmental scanning by non-expert scanners (as opposed to experts in staff environmental assessment units) needs to be investigated. Third, as the number and variety of organizational actors engaged in direct and personalized environmental scanning increases, the shifts of cognitive frames of reference at the individual and group levels need to be clarified in operational and explicit terms. Fourth, ways of managing this scanning process such that it contributes effectively and efficiently to strategy formation need to be more carefully addressed.

Bounding the strategic scanning process

Two generic modes of scanning can be conceptually acknowledged: reactive and proactive. In the reactive mode of scanning or 'problemistic search' (Cyert and March, 1963), search is stimulated by a problem and directed towards finding a solution. In the proactive mode of scanning or 'surveillance', the scanning is exploratory and not directed towards any particular problem (Aguilar, 1967). These polar modes are not necessarily mutually exclusive and very often occur together (Etzioni, 1967). As the environment becomes more turbulent and complex, problem domains become fuzzier and there is an increased shift towards the surveillance end of the continuum (Radford, 1978); consequently, the gathering of relevant information becomes more unbounded and difficult.To limit this width of environmental scope there are at least three different bounding strategies: (1) limiting the consulted information sources to a handful of habitual and key strategic information sources (El Sawy, 1985); (2) limiting the types of environmental signals monitored, such as trend monitoring of key trends or specific critical events (Nanus, 1982); (3) limiting the number of emerging issues that are being tracked and further bounding them by an initial definition and consensus. This latter mode of scanning (referred to as tracking) is increasingly used by organizations, with applications in issues management (Heath and Nelson, 1986), technology assessment (Martino, 1982) and function-oriented environmental scanning (Stubbart, 1982). In this study we focus on this tracking mode of scanning, and we use it as a context to investigate the role of cognitive frame of reference shifts.

FRAMES OF REFERENCE SHIFTS

While several researchers have stressed that cognitive frames of reference and assumptions have an important effect on the interpretation of environmental signals and strategic problem formulation (Mason and Mitroff, 1981; Shrivastava and Schneider, 1984), there is little systematic empirical evidence in this area and little operationalization of the concepts, especially in the context of strategy formation. The only attempt at operationalization we know of is that of Shrivastava and Mitroff (1983), who studied the effect of four organizational frames of reference on one strategic decision across different organizations. While we have used some of their findings, this study focuses on a different direction: examining the shifts of frames of reference as opposed to their static contents.

Our literature review uncovered five observations relevant to our purpose. First, there is no consensus on the semantic and operational definition of cognitive frames of reference. Many variants appear in disciplines such as psychology, philosophy, linguistics and artificial intelligence, and are applied in areas such as organization theory, strategic decision-making and political science. They are termed schemas (Bartlett, 1932), internal images (Boulding, 1956), paradigms (Kuhn, 1970), frames (Minsky, 1975), scripts (Schank and Abelson, 1977), templates (Pondy, 1984), cognitive maps (Axelrod, 1976), operational code (George, 1980), socially defined frames (Goffman, 1974), images (Morgan, 1986), models of reality (McWhinney, 1984), frames of reference (Shrivastava and Mitroff, 1983), and assumptions (Mason and Mitroff, 1981). Also, the dynamism within a frame of reference is treated variously and often lost. For example, many consider frames merely as 'formats' rather than dynamic themes or 'plots' (Wilson, 1983), or as only 'plans' rather than also the 'executors of the plans' (Neisser, 1976). Thus, any study would have to carefully examine all those nuances, and to further assess their operational appropriateness for the tracking context.

Second, the majority of the research conducted focuses on frames of reference held by individuals, as opposed to groups. Considering that the strategic scanning effort is increasingly carried out in organizations by groups or teams of individuals (Gilad and Gilad, 1986), it appeared necessary to us to reintroduce the interrelation between frames for individuals and groups (Starbuck, 1982; Shrivastava and Schneider, 1984).

Third, the shift of cognitive frames of reference is seen as being generated through the perception of new environmental information or the occurrence of new learning and ideas. Piaget (see Flavell, 1966) identifies two basic modes of learning: assimilation where new information is assimilated into old frames, and accommodation where old frames are modified because the new data do not fit the old categories. Similarly, Norman (1982) identifies a tripartite dynamic process of learning: accretion in which new knowledge is added to existing frames; structuring which involves the formation of new frames; and tuning which is the ongoing modification and integration of existing frames for better matching to the task at hand. Similarly, Boland (see Pondy, 1984) argues that the way reasoning occurs is through the interweaving of data with multiple frames of reference in a process of frame shifting. However, while this dynamism between frames is well acknowledged, there is little operationalization of those concepts.

Fourth, tension and conflicting processes between competing frames are seen as underlying the dynamics of frame shifting. Piaget's (Flavell, 1966) dialectic of assimilation and accommodation is based on mutual adjustment between structures and knowledge. Norman's (1982) tuning is based on the integration of dissonances. Similarly, theories of creativity have espoused frame of reference oppositions and shifts as creating new ideas. Examples of such approaches are Janusian thinking (Rothenberg, 1971), and bisociation in creation through the association of two self-consistent but habitually incompatible frames of reference (Koestler, 1964).

Fifth, Piaget (Flavell, 1966) has shown in developmental psychology that changes in cognitive schemata take place through cognitive functions which are invariant across both stages of development and contents. We can thus infer that the process of shifting frames of reference occurs through some universal and domain-independent operators, and potentially has enough regularities to be generically operationalized.

From these five observations it became clear to us that there was a very intimate and dynamic interplay between environmental scanning and

frame of reference shifts, and that they had to be studied together. As individuals scan, the new information and interpretations they acquire change their cognitive frames of reference, which in turn affect what they will perceive in their environment and how they will scan. It also became apparent to us that perhaps the missing key to understanding the role of cognitive frames of reference in strategic issue tracking was not in studying the frames of reference themselves, but rather in studying their *shifts* and the process through which this shifting occurred.

METHODOLOGICAL PROCEDURES AND USE OF ENVIRONMENTALLY TRIGGERED SIMULATION

The empirical data were collected through a group of 17 professionals and managers who were attending an evening MBA capstone course in the strategic management of information technology at the University of Southern California. The individuals in the group had a wide variety of backgrounds and occupations, were both male and female, and ranged in age from 25 to 36 years. Data were collected from the group for three consecutive months in 1986. The issue tracked was potential strategic opportunities created by the emerging technology of cellular phones. The methodological procedures are described below, and summarized in Figure 1.

1. After an initial group briefing about the tracking project, participants were given specially designed blank 'tracking forms'. Each form prompted for the information source, 'tidbit' content, the participant's inference, and a description of how this had changed

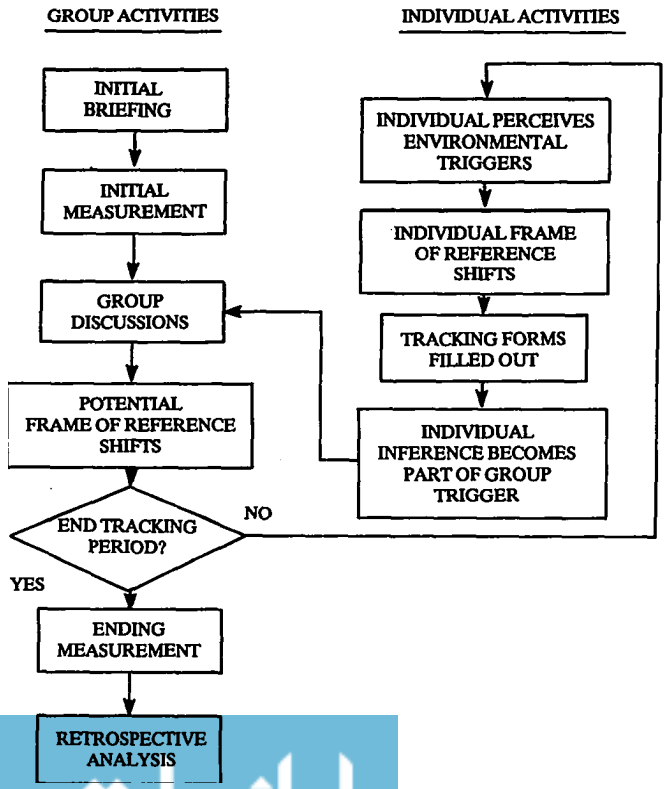


Figure 1. Studying the group tracking process using environmentally triggered simulation

their view of either the cellular phone market or potential applications.

2. After one week of scanning, initial frames of reference were tapped. Participants were instructed to generate a list of bipolar descriptors for each of the two frames of reference that the emerging technology was being tracked through: the potential cellular phone market and potential applications for cellular phones. Each bipolar descriptor was adopted only when consensus by the group was achieved. When the lists were produced, each member was asked to rate the individual positioning on each descriptor on a scale of 1 to 7.
3. Participants met twice a week during the 3 months. In the course of their jobs and daily lives, each time they came across a piece of information which changed their view about cellular phones and their applications they were instructed to fill out a tracking form and present its contents to the group. A group discussion (usually about 10–15 minutes) ensued, in which other members of the group would sometimes make new inferences. The first author acted as a procedural non-evaluative facilitator in the discussion, and filed the tracking forms in the group 'scanning diary' binder.
4. At the end of the 3-month period, ending frames of reference were elicited in a group meeting. The group was asked to generate new lists of bipolar descriptors for each of the two frames of reference (markets and applications), and they were again asked to rate their individual positioning on each of those descriptors. The group did not have access to the initial list when they generated the new list. Then they were given back the initial list of descriptors to rate them again, without access to their initial ratings.
5. At the same meeting these ratings were tabulated and the group was presented with the results of the ratings for the initial lists (both starting and ending) and the new lists. The group was then invited by the first author to discuss the results in an open discussion, and further asked to reflect on the tracking process in the preceding 3-month period, and to individually list some of the critical events that had changed the way they came to view the potential markets and potential applications for cellular phones.
6. The start–end list data and the group scanning diary data were analyzed. The content analysis of the tracking form responses was done by both authors independently to check coder bias due to participation in the tracking process. Only the first author participated in the 3-month tracking process, and he was as ignorant about the issue being tracked as the group members. There were only a few differences of interpretation between the two authors, and these were resolved through discussion. This is not surprising given, that the tracking form was structured and asked respondents to make inferences themselves.
7. A dialectic between theoretical concepts and the empirical data was carried out by both authors in the Singerian inquiry tradition which is suitable for ill-structured problems (Mitroff and Turoff, 1973). The derivation and operationalization of the dimensions of frame of reference shifts resulted from this iterative process between theory and data not giving priority to any of them. These were then used to express and articulate other inferences from the data about the frame of reference shifting phenomenon and the emerging issue tracking process.

The rationale for our choice of method and empirical context involved some difficult trade-offs. Capturing and interpreting data about the messy cognitive processes in strategic issue tracking that are subject to continuous environmental triggers is not easy (Mintzberg, Raisinghani and Theoret, 1976). The difficulty is compounded by the length of elapsed time during which the process occurs (weeks or months), and the obvious need for a longitudinal rather than a cross-sectional study. In the case of group tracking this is further compounded by the group dynamics of information exchange. In view of these constraints some compromises had to be made, and they need to be taken into account when generalizing the results. Our rationale is presented below.

First, there was the issue of choosing the source and method of data capture. Some researchers stress the messiness of the strategic issues and recommend the use of real-life field settings for research purposes (Mitroff, Barabba and Kilmann, 1977); others stress the necessity of developing objective measurement and rec-

ommend the use of controlled laboratory experiments (Schwenk and Cosier, 1980); while others recommend combining both (Schwenk, 1982). Still others point to a different alternative—free simulation—which enables some of the richness of the field to be captured in the laboratory (Chanin and Shapiro, 1985). We have opted to modify and extend this latter alternative in order to bring in messy unstructured data derived from the actual business environment into a synthetic setting on a real-time basis. We have termed this approach 'environmentally triggered simulation' (El Sawy and Pauchant, 1987), and it appears to be well-suited for studying processes that depend heavily on multiple environmental interactions over an extended time period. In brief it is a simulation method which allows the process under study to be naturally driven by real-time environmental triggerings, and yet can be carried out in a synthetic setting, where the control over rules of participation and organizational politics is high. While some of the internal organizational dynamics of power and authority in a real organization are lost, in this study these were not viewed as essential for initial understanding of frame of reference shifts in group tracking of emerging issues.

Second, we had to make choices about the appropriateness of group composition and size. We realized that a heterogeneous group of professionals and managers attending an evening MBA capstone course was only partially representative of a group of managers working in the same organization. They were loosely coupled, lacked the expertise of professional scanning staff, and possibly scanned with lower intensity than involved operating managers. However, while any results should be generalized with caution, our choice is not as unrepresentative as it might seem. Empirical evidence from research on other processes involving group judgements about uncertain future issues bolsters the validity of our choice; for example, in the case of Delphi panels, Preble (1984) has shown that there was no difference in judgements between intracompany panels of executives and intercompany panels of experts. Also, given the trend in the increased use of non-experts and line personnel for environmental scanning in corporations (Gilad and Gilad, 1986), it appeared that the characteristics of the group would become increasingly representative of corporate practice. Furthermore, our research context was closer to the exploratory surveillance end of the scanning mode continuum (as explained earlier), which typifies the early stages of emerging issue tracking, rather than the later intensive problemistic search activities; thus the scanning intensity issue was not as critical. Regarding a group size of 17, we understood that this could limit the inferences from the data analysis and their reliability. At the same time we also reasoned that an issue tracking group in corporate practice would almost never be larger than that, for practical reasons.

Third, we had to deal with the issue of group interaction. We needed an information-rich situation with high stimulation of frame of reference shifts while not sacrificing representativeness to corporate practice. There is uncertainty in the strategic management literature as to how groups should proceed to generate and structure frames of reference about complex problems. However, studies show (Schweiger, Sandberg and Ragan, 1986; Hart *et al.* 1985) that processes based on conflictual models such as dialectical inquiry or devil's advocacy (Mason and Mitroff, 1981) tend to produce a higher quality of problem dimensions, but lead to a relatively weak acceptance of the group's decisions by group members when compared to models based on consensus processes. We opted to preserve the opportunity for both conflictual and consensual processes by allowing the features of nominal group techniques and devil's advocacy. This trade-off would lead to an appropriate generation of issue dimensions while preserving an adequate level of consensus. It would also keep some balance between individual and group frames of reference, which is closer to the way environmental scanning is carried out in practice.

DERIVING AN OPERATIONALIZATION OF FRAME OF REFERENCE SHIFTS

As mentioned above, the operationalization of frame of reference shifts was derived iteratively from the interaction between the empirical data and the theoretical concepts based on our literature review. For simplicity of exposition the operationalization is presented before the data.

Our operationalization consisted of deriving a minimal well-defined set of descriptive elements related to frame of reference shifts, and explicit

dimensions that adequately characterized these elements. We needed to identify elements that could capture the dynamics of frame shifts, were domain-independent, were applicable for both individuals and groups, and had dimensions amenable to explicit representation in computer-based form for future construction of expert systems for issue tracking. Whenever possible we borrowed terms from the literature which would be easily remembered and used in a corporate setting. We introduced new terms only if there was no established term in the literature, or if the existing term was so generic or had suffered so much definitional abuse that it would potentially create confusion. We came up with three inter-related elements to describe frame of reference shifts: templates, triggers, and twitches.

Templates

Templates are frames of reference through which a particular issue domain is perceived. They guide attention and understanding processes related to that particular issue. The term 'template' has been used in the literature on managerial cognitive processes (Pondy, 1984) and in the field of social work (Blumenfield and Lowe, 1987). Etymologically, it draws its origins from the world 'temple', which is an edifice for the worship of a deity. In this sense templates can be seen as structuring and guiding the beliefs and the views of reality of the people who frequent them and use them. Templates have the following descriptive dimensions:

1. *Template-theme*: a narrative of the outline of the plot that the template carries. The term 'theme' is used in cognitive psychology (Sowa, 1984) and stresses a dynamic description, rather than a static end-point.
2. *Template-construct*: a verbal description of each of n bipolar constructs that together characterize the salient surface dimensions around which the theme of the template develops. The notion of bipolar constructs is drawn from Kelly (1955). For comparison purposes the relative positioning on a bipolar construct that characterizes the template can also be measured on a quantitative scale.
3. *Template-articulation*: the number of bipolar constructs (n) that describe this template. This dimension represents the degree of articulation of the template. The articulation dimension has been used in the context of cognitive structures by Scott (1969) and Stabell (1978).
4. *Template-consensus*: the degree of consensus between members of a tracking group on the constructs that characterize the template. This draws on the concept of logically integrated clusters of belief (Starbuck, 1982).

Triggers

Triggers are the stimuli which are impinged upon templates and which might cause them to shift. The term draws its origins from cognitive psychology (Norman, 1982), and has been used in strategic and management theory (cf. El Sawy, 1984; Lyles, 1981; Morgan, 1986) and in computer-based expert systems to assist managers (Jelassi, Williams and Fidler, 1986). In our context, triggers are described by the following dimensions:

1. *Trigger-source*: the source of information that the trigger comes from.
2. *Trigger-information*: a narrative description of the information that the trigger conveys.
3. *Trigger-latency*: whether the trigger stimulates or inhibits further template shifting. This is in essence the lagged or latent probabilistic effect that the trigger has on the template shift when it is exposed to subsequent triggers. Latency can be negative (inhibitory), zero (neutral), or positive (stimulating).

Twitches

A twitch is the result of a tension or conflictual process between (or within) templates initiated by a trigger. It can result in a template modification. The term is drawn from physiology (Irving *et al.*, 1987) where it is defined as a short movement with a sudden motion. We were unable to find a suitable term in use in cognitive psychology which could depict template shifts and also capture the notion that some trigger impacts could be transient and temporary, after which the template would return to its pre-trigger state. Twitch is both a verb (a process) and a noun (an explicate effect of a process). Although there is acknowledgement in the cognitive psychology literature that tension theories underlie the dynamics of twitching-like processes (see

literature review section above), the process of twitching is too murky to be captured directly. We were able to operationalize its dimensions indirectly through its measurable cumulative effects (twitch descriptors and twitch magnitude) and through its causes (twitch drivers).

1. *Twitch descriptors*: these operators describe the nature of the twitch and they can occur in various combinations. Their aggregation can be used as an indicator of twitch magnitude. Three types of such descriptors were identified:
   (a) Construct substitution twitches: adding a new construct to the template (add-construct), and/or dropping an existing construct from the template (delete-construct).
   (b) Construct articulation twitches: combining two existing constructs to form a new combined one (merge-constructs), and/or branching an existing construct into two new separate ones (branch-construct).
   (c) Construct tuning twitch: changing the orientation and/or magnitude of positioning on an existing construct (modify-construct). The term 'tuning' is borrowed from Norman (1982).
2. *Twitch magnitude*: this describes the relative aggregate modification in a template due to a cumulative trigger effect in a chosen period of elapsed scanning time. The twitch magnitude can be expressed through the aggregation of twitch descriptors.
3. *Twitch drivers*: these are the underlying constructs that are driving the template twitch. Among a set of twitch drivers for a template, the most powerful driver can be viewed as the one that most strongly influences the twitching process.

UNDERSTANDING THE ISSUE TRACKING PROCESS

Assisted by the operationalized concepts of triggers, templates and twitches, we were able to gain further understanding of the issue tracking process. We examined the template twitching process through both the content analysis of the longitudinal data from the tracking forms and the comparison of starting and ending templates. While each of those two sets of data captured different aspects of the process, we were able to use the findings from the content analysis data to help understand and validate the start–end data. These results, and the conclusions that we draw from them, are presented below.

Examining the template twitching process through content analysis of tracking forms

Fifty-one tracking forms were filled out by 13 of the 17 participants. As previously explained, the group was specifically asked to focus on two templates: the dynamics of the cellular phone market and other related technologies (market template), and potential impacts on providing new ways of working or new products and services (application template). The characteristics of the triggers and the twitches that described the template twitching process (shown below) apply to both templates.

Trigger sources for individuals

The sources of information reported were all printed media, and were either local newspapers (usually the business section), business trade publications (such as the *Wall Street Journal*), and computer and telecommunications trade publications. All the sources were publications that they routinely read. Only in 11 instances out of 51 occurrences was the information source a specialized telecommunications industry publication, suggesting that broader environmental sources of information accessed during routine scanning were indeed useful for focused emerging technology tracking.

Trigger information

Space precludes us from including the narrative information content of individual triggers. The respondents provided a total of 68 explicit inferences in the 51 tracking forms, split in two different inference presentation modes: statements (79 percent of total) such as 'generic cellular telephones cannot be competitive any longer in this specialized market' and questions and apprehensions (21 percent of total) such as 'how can data be keyed in while driving?' Both types of inference presentation modes generated discussion of similar nature in the group sessions.

Trigger latency

Triggers seem to have latent effects on twitching in the sense that they can influence the propensity of the template to twitch when bombarded by subsequent triggers. This latency can be inhibitory or stimulating. For example, a trigger which indicated that the use of cellular phones while driving was dangerous was inhibitory for one of the group members. For several weeks this group member would not consider any new applications, neither individually nor with the group, and resumed activity only after the effect of that inhibiting trigger was cleared through several triggers from other members of the group. These triggers conveyed statistics which showed that owners of cellular phones were safer drivers than non-owners, that 'no-hands' operation capabilities were being developed, and that having a cellular phone could improve other aspects of driving safety, such as being able to directly call for help in case of accidents. Inhibitory triggers seem to be strongly coupled to basic values and feelings, and can cause template rigidity.

Template twitching descriptors

Twitches in the form of construct substitutions and construct articulations were detected throughout the tracking forms. For example, the construct of regulatory legislation was introduced (add-construct) during the tracking process by an individual, and then started to reappear within other individuals' subsequent inferences in their tracking forms. As another example, the construct of the reliability of service disappeared for the total duration of the tracking period (delete-construct) after both technical and legislative reassurances were identified. Also some constructs became more articulated, such as the nature of data transmission which became differentiated for voice and data (branch-construct). Similarly, some constructs were combined (merge-constructs) as in the case of the merging of the service market and the equipment market into a combined market. While tracking forms did not give quantitative measures of position on constructs the descriptive qualifiers in the narrative gave clear indications of shifts such as 'this is more widespread than I first believed' (modify-construct).

Longitudinal description of template twitching

In examining the tracking form information on a longitudinal basis, we are able to find an orderly progression in terms of the nature of the prevalent type of issues that enveloped the template twitching process. Our inferences about the characterizations of each of the stages are shown in Table 1.

First, there was an initial 'hygiene factors' stage in which the focus of attention was on whether the technology actually worked satisfactorily, and on the identification of some of the technical problems, and then on whether adequate market seriousness existed from both the supply and demand side. Only after reasonable reassurances did the group start to notice environmental triggers that could twitch the market and application templates to generate market growth and new technological opportunities. This was the period in which the twitches

Table 1. Stages of template twitching in emerging technology tracking process

Tracking forms associated with triggers (total = 51)	Week Number	Characterization of stage envelope
1–6	1	Examination of hygiene factors for technology
7–10	2	Examination of hygiene factors for market existence
11–17	3–4	Articulation of market growth and new technological applications
18–25	5–8	Reconfirmation of technological and market adequacy
26–32	9	Legitimation
33–41	10	Operationalization of possibilities
42–51	11–14	Dialectic on specific features of markets and applications

seemed to increase the articulation of both templates with respect to opportunity generation.

After a period of opportunity generation there was a revisionist period in which there was a reconfirmation of technological and market adequacy, and twitching seemed to be driven by doubts, rather than the discovery of new opportunities. When there was reasonable reassurance that there was technological and market adequacy, a legitimation of the potential of cellular phone markets and applications occurred. At that point it was as though the templates had solidified and could not be twitched easily by doubts. For example, one participant reported the results of a survey by a major company in the cellular phone business which showed that only 3 percent of people surveyed knew what a cellular phone was. There was disbelief and surprise by the group, and their theory about the ubiquity of cellular phones would not twitch to accept disconfirming evidence.

After that point there was a period where there was a focus on the operational reality of possible applications and markets, and on issues such as costs, market positioning, infrastructure and demand. In that period the doubt about viability emerged again, but in a very mild form. Following that there was a period in which there was a focus on specific markets and applications rather than general issues. Each potential application discussed now seemed to have its 'built-in' reward and risk dialectic, suggesting that the process had reached a reasonable degree of maturity.

The progression bears some similarity to the early stages of Rogers' (1986) model of the diffusion of a technological innovation. However, our emerging technology tracking is somewhat more complex and proactive than the simple diffusion of innovation case, in that the group is trying to identify innovative applications based on this innovative technology. Also, the stages identified seem to be 'deprivation-specific'. Weick (1974) has suggested that Maslow's hierarchy of needs model in motivation theory can be applied in a general systemic sense when complexity is deprivation-specific. In Maslow's model a person's needs are arranged in a hierarchy of importance, and as soon as a need is satisfied it stops being a motivator of behavior, the needs on the next higher level emerging as the primary motivators. In motivation there is also a complementary model by Herzberg in which there are hygiene factors that need to be satisfied before any motivation can occur. It seems as though the early stages of the tracking process follow a Herzberg model, and examine hygiene factors for templates; then the process follows a Maslow model in articulating market growth and new application opportunities, and then reverts back to a Herzberg model as doubt sets in, and so on. Thus the template twitching process seems to be enveloped in a continuous dialectic or tension between 'go' and 'no-go' issues.

In addition, we detected some of the cognitive heuristics and biases that have been identified in judgements under uncertainty (Kahneman, Slovic and Tversky, 1982), and that appear in strategic planning contexts (Barnes, 1984; Schwenk, 1984). For example, there was an over-confidence bias and anchoring when the group would not believe that only 3 percent of people surveyed knew what a cellular phone was. Another heuristic that surfaced was reasoning by analogy. For example, there was an examination of the previous regulatory behavior of the Federal Communications Commission in other telecommunication areas in order to draw inferences about the case of cellular phones.

Examining the template twitching process through comparison of starting and ending templates

Starting templates

At the start of the tracking period the market template was articulated through eight different constructs, while the application template was articulated through seven. The template-constructs elicited and their ratings are shown in Table 2 (the end ratings of these same template-constructs are also presented in Table 2, but will be discussed later). There seemed to be more uncertainty about construct ratings in the application template than in the market template, as evidenced by the greater variance among construct standard deviations in the application template. The constructs exhibiting the highest standard deviation were the possibility of communication in non-traditional situations (CA1), and use in car or not in car (CA7) for the application template, followed by the tool/toy construct (CM5) in the market template. The market template theme was developed around

Table 2. Initial constructs elicited and their ratings (n=15)

	Constructs elicited	Initial rating		End rating		Absolute twitch magnitude for constructs*	
		Mean	SD	Mean	SD	Mean	SD
(1) *Market template*							
CM1	Growing service market . . . Shrinking	2.27	1.22	2.07	0.62	0.93	0.78
CM2	Growing equipment market . . . Shrinking	2.13	1.25	1.79	0.80	0.76	0.76
CM3	Expensive to use . . . Cheap	2 33	1.18	2.36	1.01	0.84	0.58
CM4	Expensive to purchase . . . Cheap	3.47	1.36	2.93	1.27	0.84	0.58
CM5	Tool . . . Toy	4.07	1.49	3.71	1.64	1.17	0.61
CM6	Unreliable service quality . . . Reliable	3.47	1.30	4.07	1.44	0.95	0.84
CM7	Provide effective communication . . . Ineffective	3.60	1.24	2.64	0.84	1.25	0.97
CM8	Limited servive area . . . General	2.43	1.02	3.29	1.20	1.04	0.88
	Mean for market template twitch					0.97	0.75
(2) *Application template*							
CA1	Communications possible in non-traditional situations . . . No change	2.71	1.73	2.86	1.61	1.08	0.85
CA2	Increases amount of available work-time . . . No effect	2.73	1.28	3.57	1.22	1.03	0.87
CA3	Creates new industries . . . No effect	3.33	1.45	3.07	1.64	1.02	0.97
CA4	Creates new companies . . . No effect	3.13	0.99	2.93	1.38	1.03	0.84
CA5	Link personnel more directly to home office . . . No change	2.67	1.29	2.57	1.28	1.17	1.01
CA6	Increases productivity . . . Decreases	3.27	0.70	3.29	0.99	0.89	0.59
CA7	In car use . . . Not in car use	3.07	1.59	3.79	1.63	1.37	0.79
	Mean for application template twitch					1.10	0.85

* Mean of absolute value of the difference between standardized ratings for each construct.

issues of growth, cost, utility, reliability, effectiveness and geographical limitations. Similarly, the template theme of the application template was articulated through the issues of non-traditional communications, availability of work time, creation of new companies and industries, interrelations, productivity and place of use. As we will see, the themes developed at the end of the tracking process were fundamentally different.

Ending templates

At the end of the tracking period the group articulated each template through eight constructs, as shown in Table 3. There seemed to be the same uncertainty about construct ratings across both templates, as evidenced by similar variance among construct standard deviations. The constructs exhibiting the highest standard deviation were the rapidly growing/constrained market in metropolitan areas construct (CM2.3) in the market template, followed by the shirt pocket/luggable construct (CA2.4), and in car/not in car construct (CA2.2) in the application template. The market template theme was developed around issues of growth, regulation, technical improvement, competition and new applications. Similarly, the application template theme was articulated through the issues of utility, safety, data transmission, size, purpose of use, privacy, freedom and place of use.

Comparing starting and ending templates

Twitch descriptors, twitch magnitude, and twitch drivers were identified and derived by comparing the starting and ending templates.

Twitch descriptors. Comparing Tables 2 and 3, there was a total of five new constructs out of a

Table 3. Ending constructs elicited and their ratings (n=15)

Template construct		End rating Mean	End rating SD	Items present in initial list
(1) *Market template*				
CM2.1	Regulatory turmoil . . . Highly structured regulation	2.67	0.82	
CM2.2	Rapidly growing market (national) . . . Stagnant	3.47	1.46	(A)
CM2.3	Rapidly growing market (metropolis) . . . Constrained	3.53	2.13	(A)
CM2.4	Rapidly growing market (rural) . . . Dormant	5.60	1.30	(A)
CM2.5	Technology rapidly improving . . . No change	2.60	1.06	
CM2.6	Many competitors (equipment) . . . Monopoly	2.93	1.10	
CM2.7	Many competitors (national service) . . . Monopoly	4.33	1.50	
CM2.8	Rapidly expanding applications . . . No new ones	2.67	1.17	
(2) *Application template*				
CA2.1	Safe operation possible in car . . . Unsafe at any speed	2.80	1.37	
CA2.2	In car . . . Not in car	4.53	1.64	*
CA2.3	Data transmission adoptable or feasible . . . Not feasible	3.47	1.25	
CA2.4	Shirt pocket . . . Luggable	4.00	1.66	
CA2.5	Personal use . . . Business use	5.00	1.07	
CA2.6	Private . . . Not private	4.67	1.29	
CA2.7	'1984 big brother' effect . . . Not 'big brother'	4.27	1.33	
CA2.8	Useful tool . . . Toy, gadget status	3.80	1.37	*

(A) CMI AND CM2 in initial list were combined and then branched into CM2.2, CM2.3, CM2.4.
* Were in initial list.

total of eight in the market template (add-construct), as for example, a construct related to regulation (CM2.1) which was added to the ending template. There were six constructs that were dropped from the initial template (delete-construct) as for example the construct related to expense of use (CM3). Two constructs from the initial market template, growing/shrinking market (CM1) and growing/shrinking equipment markets (CM2), were combined in the ending template (merge-construct), and then split into three other constructs (branch-construct) differentiating between growth of the market at the national, metropolitan, and rural level (CM2.2, CM2.3, CM2.4). Similar twitch descriptors can also be identified for the application template. Our operationalization of twitch descriptors also allows for expression of the interaction between the market and application templates. For example the tool/toy construct (CM5) moved from the market template at the beginning of tracking to the application template at the end of tracking (CA2.8).

Twitch magnitudes. These can be expressed through the aggregation of twitch descriptors above at the construct substitution, combination and tuning levels. The twitch magnitude at the substitution level is self-evident from combining the add-construct and delete-construct descriptors. The twitch magnitude at the combination level can similarly be evidently expressed through the aggregation of merge-construct and branch-construct descriptors. The twitch magnitude at the tuning level for each construct (modify-construct) involves an arithmetic calculation of the means of the absolute values of the difference between standardized scores (where mean=0 and standard deviation=1) for each subject. By absolute value we mean that both positive and negative shifts for construct positioning were treated as equal. These absolute twitch magnitudes for construct tuning are shown in Table 2. They were aggregated for each template (and divided by the number of constructs constituting the template plot) producing a mean twitch magnitude of 0.97 for the market template, and 1.1 for the application template.

It is to be noted that a comparison of the initial and end-standardized ratings for both templates on all constructs showed no significant difference according to a paired t-test. This is an

indication that a comparison of before and after ratings done in the usual static way cannot detect the presence of twitches, necessitating a more change-sensitive method.

Twitch drivers. We were unable to determine twitch drivers through direct questioning. Although we had asked the participants at the end of the tracking period to individually list the critical events that had changed the way they viewed the potential markets and applications for cellular phones, we could not infer any obvious twitch drivers from these data. Fifteen respondents provided 34 entries of which 27 were different from one another. Four of the respondents asserted that group discussions changed the way they viewed the two templates but were unable to pinpoint specific events. The remainder listed anywhere from one to five events which were very often broad generic issues such as finding out about technological capabilities, markets, and public perception. This suggested that it might not be possible to determine twitch drivers through direct retrospective reports, and an indirect method was needed. Our content analysis data showed that the template twitching process seemed to be enveloped in a continuous dialectic between 'go' and 'no-go' issues (as already discussed above), suggesting cognitive tension throughout the tracking period in the evaluation of the potential of the emerging technology, and corroborating the tension theories suggested in the cognitive psychology literature. Thus, in order to strongly influence the twitching process and produce large twitch magnitudes, the twitch drivers would also produce high tension levels in the group template.

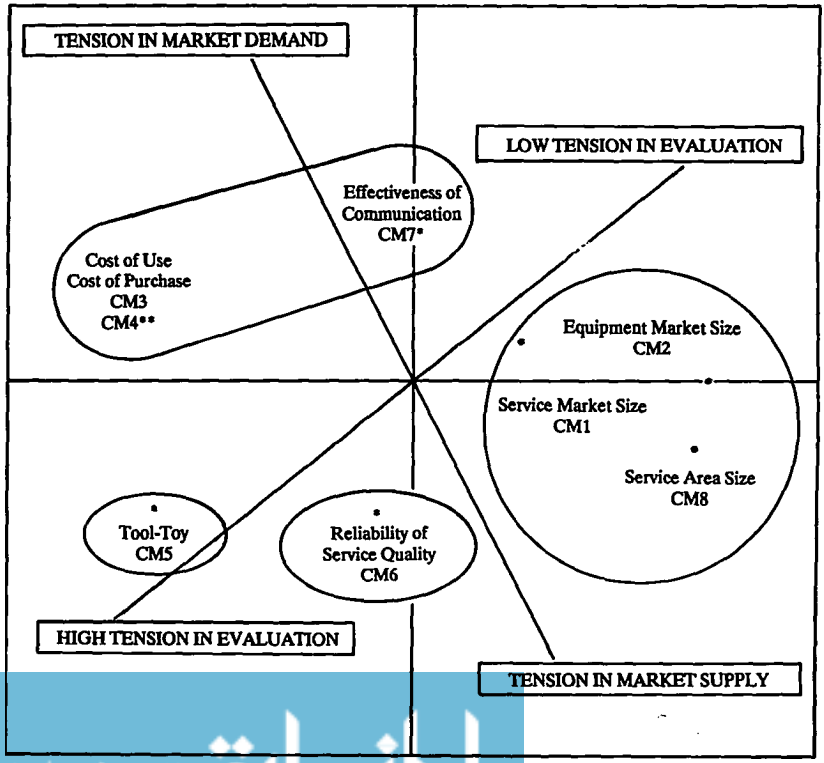
We then also realized that we could make use of the salient template constructs (the ones articulated by the group) to uncover the twitch drivers. Based on the tension theory, we operationalized the discovery of twitch drivers through three manifestations of salient constructs most closely associated with them: (1) a large twitch magnitude with a relatively low variance across the group over the time of the tracking period; (2) continued salience at the end of the tracking period; and (3) conflicting twitch interaction with other constructs. For detection of the first manifestation we looked at the means of the absolute twitch magnitudes for each of the initial constructs. As indicated in Table 2, two constructs exhibited a much higher absolute twitch than the others for the market template: the tool/toy construct (CM5) and the effective/ineffective communication construct (CM7). However, the standard deviation of the absolute twitch magnitude for CM7 was relatively much higher (0.97) than that for CM5 (0.61), indicating that the twitch magnitude for CM7 was much less consistent across the group, and suggesting that the tool/toy construct (CM5) was the construct most closely associated with a twitch driver. For the application template the car/not in car construct (CA7) was the construct most closely associated with a twitch driver through similar reasoning. It is interesting to note that those constructs were not always the ones exhibiting the highest standard deviation at the beginning or end of the tracking period, suggesting that the one-time static measurement of the consistency of the construct ratings across the group (as opposed to the twitches) would not be able to identify twitch drivers. Also, they could not be identified through the order of mention of the constructs by the group.

The second manifestation we wanted to examine was continued salience. This was measured through the explicit mention of the same construct both at the beginning and the end of the tracking process. As shown in the last column of Table 3, only two constructs qualified: the tool/toy construct (CM5 to CA2.8) and the car/not in car construct (CA7 to CA2.2). These were the same two constructs that had been identified through the first manifestation above.

For detection of the third manifestation of conflicting twitch interaction with other constructs we performed metric multidimensional scaling (MDS) on the construct twitch magnitudes for each of the two templates through the ALSCAL program on the SAS package. The measures of proximity used were the Pearson correlation coefficients between the absolute non-standardized construct twitch magnitudes. The MDS best-fit two-dimensional solution for the market template is shown in Figure 2. Stress value (which is a badness-of-fit measure) based on Kruskal's Stress 1 formula was 0.126, indicating a good fit (see Kruskal and Wish, 1978). We used both a neighborhood interpretation and a dimensional interpretation to understand the map as recommended by Kruskal and Wish (1978). Based on a neighborhood interpretation, four clusters

appear: (CM3, CM4, CM7), (CM1, CM2, CM8), CM6, and CM5. The rotated axes of the map chosen were judgementally based primarily on the 'go/no-go' tension content analysis findings (high tension in evaluation/low tension in evaluation), and secondarily on plausible market dynamics (tension in market supply/tension in market demand). The two clusters constructs furthest apart along the 'tension in evaluation' axis are CM5 and the (CMI, CM2, CM8) cluster. The tool/toy construct (CM5) is furthest on the high-tension end, and appears to cause what we have called a 'thorn in the side' phenomenon. Thus it seems to inhibit the twitch potential of the (CMI, CM2, CM8) cluster and vice-versa. While the fit was not as good, the application template MDS map exhibited similar characteristics with the car/not in car construct. Space precludes us from including the details. Again, these were the same two constructs that were identified through the other two manifestations.

As a complementary method of confirmation, factor analysis performed on the twitch magnitudes revealed similar results. For example, in the market template a factor analysis of the eight constructs yielded three factors. The factor analysis results are shown in Figure 3, superimposed on the MDS map for ease of comparison. The tool/toy construct (CM5) loaded negatively (−0.68) with three other constructs on factor 1: growing/shrinking service market (CM1, 0.94), growing/shrinking equipment market (CM2, 0.56), and limited general service area (CM8, 0.80) indicating a dissonant loading, while all the remaining four constructs loaded positively on the remaining two factors, indicating consonant loading. This confirms the findings uncovered by the MDS where the tool/toy construct (CM5) was most distant from the same three constructs with which it loaded dissonantly in the factor



igure 2. Multidimensional scaling of the twitch magnitude for market template constructs

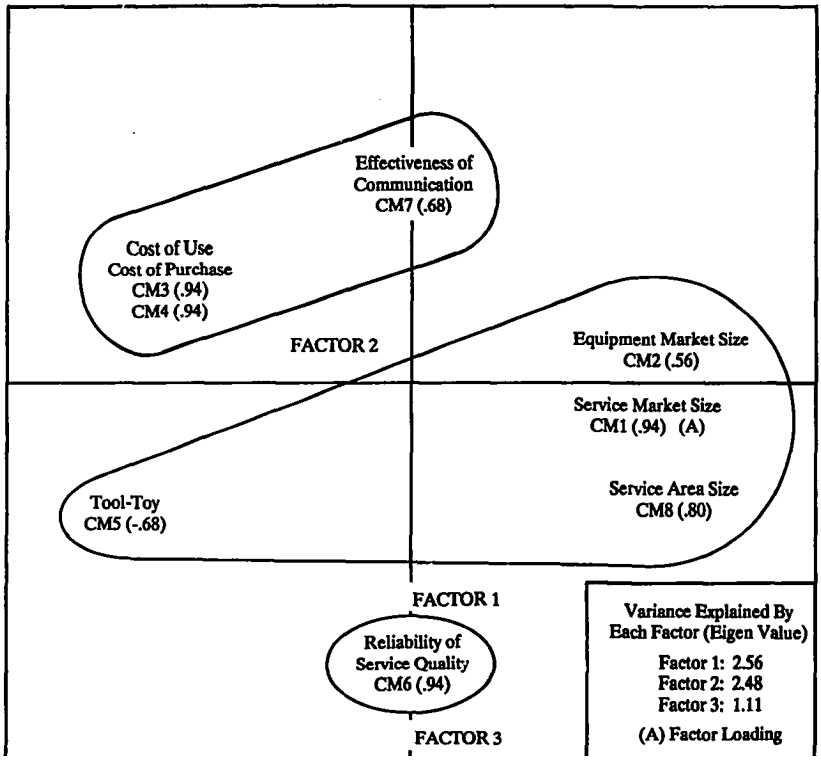


Figure 3. Factor analysis of the twitch magnitude for market template constructs superimposed on multidimensional scaling map

analysis. The same dissonant/consonant loading pattern was found for the car/not in car construct in the application template. While being cautious about the factor analysis considering the small sample size, it appears from those results that twitch drivers can be identified by the dissonant/consonant pattern found in a factor analysis.

Based on the above results that identified the same constructs through a triangulation of three different manifestations, we believe that we have been able to provide a method of identifying twitch drivers based on a cognitive tension theory and through salient template constructs. It is to be noted that we could not detect these tension patterns with MDS or factor analysis when they were performed on the starting or ending construct ratings instead of the construct twitch magnitudes. Again, it showed that it was the twitch rather than the template that provided the understanding.

Conclusions about the template twitching process

Based on the results above of the content analysis, and supported by the comparison of the measurements at the start and end of the tracking process, the following conclusions can be made about the template twitching process:

1. The template twitching process can be studied in an explicit way, and can be operationalized through the concepts of triggers, templates and twitches. We believe this is a necessary first step for being able to design and build an expert system for strategic issue scanning.
2. We have presented evidence that template twitching occurs due to both environmental scanning and group discussion. It is an observable phenomenon which is easier to capture than the latent template itself.

3. The template twitching for an emerging technology tracking group process is enveloped by an orderly progression of stages driven by cognitive tension, each of which can be characterized in terms of the nature of the prevalent issue. This suggests that the tracking process can be improved and accelerated through the management of these stages.
4. It appears that individuals are unable to identify twitch drivers through direct questioning based on retrospective reflection.
5. It was possible to infer the latent twitch drivers through the comparison of two sets of time-separated measurements of the salient constructs that characterize the template in question. It is thus possible to identify the 'thorn in the side' critical issues that need to be further focused on by an expert.
6. It was not possible to identify the twitch drivers through the comparative statics of templates. Neither the order of mention, nor the change in the mean positioning on the construct for the group, helped to identify the twitch driver.
7. Combining 5 and 6 above we can infer that *twitches are more informative than templates*. Bougon, Weick and Binkhorst (1977) have shown that in a structure of causality there is much more order understood from the pattern of relations between the variables than through the content or nature of the variables themselves. Perhaps similarly in longitudinal issue tracking, twitches capture more order than the raw templates themselves.

IMPLICATIONS FOR STRATEGIC MANAGEMENT PRACTICE AND RESEARCH

Given the above findings we can conclude that this longitudinal study of group tracking of an emerging technology has helped us to gain more general understanding of the shifts of cognitive frames of reference in the environmental scanning process. It has also illustrated and operationalized a research methodology for studying that phenomenon. The methodological caveats notwithstanding, the study results suggest that studying the dynamics of frame of reference shifts can provide new insights for understanding the environmental scanning process, that may be more useful than just studying the comparative statics of frames of reference.

These findings have implications for both research and practice. From a practice perspective the issue tracking procedures we have used in this study can be used in corporate settings to formalize the continuous group scanning function with professionals and managers. The use of tracking forms, group scanning diaries, regularly scheduled periodic group discussions and the elicitation of template constructs at regular intervals is directly applicable in corporate settings. In addition, all this activity can now be operationalized and communicated between the members of a scanning group through the concepts and dimensions of triggers, templates and twitches as a non-ambiguous and shared language of understanding. Second, this method of group tracking seems to be a viable training method for managers who want to learn more about a specific area of the environment quickly and effectively. Third, pending further validation we have provided a method to identify twitch drivers which provide the critical issues that need further investigation by experts. This identification can potentially provide the cues that are crucial for strategic advantage. For example, in our case of cellular phones the early identification of the tool/toy twitch driver could spark the development of further market research targeted to clarifying consumer attitudes and behavior with respect to this issue. Fourth, understanding the orderly stages that the twitching process in issue tracking is enveloped by provides a way for improving the issue tracking process. So, for example, in the case of emerging technologies, the hygiene factors can be presented to the group at the outset to speed up that early stage. Fifth, given that the explicit operationalization of template twitching is possible in a form amenable to computer-based storage and processing, it is a fruitful venture to build an expert system for group tracking of emerging issues coupled with a facility for different forms of group interaction. Finally, we hope that this study will provide more impetus for reflective practitioners to encourage action research in the area of environmental scanning.

From a research perspective there is a rich set of questions that need to be answered. We do not claim that our study is other than exploratory; nor do we claim that our findings do not suffer

from limitations of generalizability and reliability. However, even with those limitations and the little we know, the study has provided some insights and better-articulated hypotheses to help further the practice of environmental scanning for strategic purposes.

The extent of generalizability needs to be tested through replications in different conditions. We need to know how the findings of this study might change under different contingencies such as the type of issue tracked (technological issue versus public health issue, opportunity versus threat), the scanning mode (surveillance versus tracking), the tracking stage (early versus later), the group composition (experts versus non-experts, inter-company versus intra-company, homogeneous versus heterogeneous), the various types of scanning diaries (computer-based versus paper-based, periodic review versus no review), the variants of group interactions, different reward/risk arrangements, the number of issues tracked simultaneously (single versus multiple), and the methodology used (environmentally triggered simulation versus field study). Similarly, there is a need to replicate the study under similar conditions with another emerging technology to further validate the results. Furthermore, there is also a need to focus on more specific aspects of the process such as the nature of inhibitory and stimulating triggers, or different methods of identifying twitch drivers. All the above will help us to understand the template twitching process and provide prescriptions for improving environmental scanning.

On a more introspective note, we hope that this paper provides the strategic management community with a trigger that stimulates much twitching in the templates through which it views emerging issue tracking.

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