C E Center for Effective Organizations

Raising Awareness of Interpretive Processes in Knowledge Work

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ABSTRACT

In contrast to routine work systems such as traditional manufacturing where work is defined, repetitive, and embedded in clear, shared goals, knowledge work or non-routine work as in new product development is an inherently complex, uncertain and ambiguous process. While the core process in routine systems involves the production or manufacture of some product or process, in knowledge systems the core process is one of producing ideas about products or processes.

In spite of the trend toward increasing knowledge work in organizations, we know very little about how these tasks are performed or how we can facilitate the effective execution of non-routine work. If the core process of knowledge work is one of producing ideas about products or processes we can conceive the core of knowledge work to be essentially a cognitive activity, a thinking, reflexive, interpretive, sense making process.

It is only recently that the criticality of thinking and interpretive processes in non-routine domains such as product innovation has been recognized. There is a growing awareness that successful product innovations require that conscious attention be paid to the interpretive schemes that shape and frame how people make sense of their work.

Intervening at the level of interpretive schemes and bringing them to conscious awareness can be a very powerful means for improving the quality of thinking practices and interpretation patterns in knowledge creation environments. The process of surfacing and examining one's interpretive schemes can help both reverse the potential rigidities imposed by a particular interpretive scheme, as well as enable new and innovative perspectives of a situation.

Building cognitive maps is posited as a means of surfacing and examining interpretive schemes. SPIDER a software environment being developed for use by product planners of a major computer company is introduced as a tool which enables individuals to surface and examine their interpretive schemes. SPIDER allows product planners to create and exchange cognitive maps representing their understanding of the planning environment and engage in meaningful dialogue.

As we move towards the 21st century we are experiencing many unprecedented changes in the world of organizations and the nature of work. Intensified global competition, and rapid technological and social changes require that organizations respond to a turbulent market environment with newer, better, and innovative products faster than ever before (Purser and Pasmore, 1992). One outcome of this organizational turbulence and the race to maintain competitive advantage is the gradual shift of employment from routine to non-routine work (Pava, 1983).

In routine work systems such as traditional manufacturing the steps and procedures to transform inputs to outputs are known in advance. The work is well defined, repetitive, and embedded in clear, shared goals. Building the one-thousandth car on the assembly line is not radically different from building the first car. In contrast to routine work, knowledge work or non-routine work such as product development is an inherently complex process requiring multi-disciplinary expertise in order to achieve a complex synthesis of highly specialized state-of-the-art technologies and knowledge (Purser, Pasmore and Tenkasi, 1992). Requisite knowledge for new product is multi-faceted, multi-leveled, and detailed (Dougherty, 1992). While the core process in routine systems involve the production or manufacture of some product or process, in knowledge systems the core process is one of producing ideas about products or processes. Further, knowledge work is typified by high task variability, uncertainty, and competing, multiple goals. The work process is incremental, exploratory, and often times moves in circles through multiple pathways, where procedures for task accomplishment must be developed while the work is being performed. Other differentiations between routine and nonroutine work include; predetermined goals versus evolving goals; short versus long timeframes; and repetitive versus unique variances (Pasmore and Gurley, 1991). People who perform non-routine work are referred to as "knowledge workers" and can be found

in research and development laboratories, in strategic planning roles, in advertising departments, and in management positions (Purser and Pasmore, 1992).

In spite of the trend toward increasing knowledge work in organizations, we know very little about how these tasks are performed or how we can facilitate the effective execution of nonroutine work. As Purser and Pasmore (1992) note, if we take research and development work as an example, we find almost nothing in the management literature that relates directly to, how the process of creation and application of knowledge takes place. "The research and development organization functions like a "black box" component of an electronic system; inputs and outputs are identifiable, but the process of transformation remains mysterious and hidden from view" (P.2).

What is the process of transformation in knowledge systems?. The core process is one of producing ideas about products or processes. Thus one can conceive the core of knowledge work to be essentially a cognitive activity, a thinking, reflexive, interpretive, sense-making process, involving the transformation of equivocal and chaotic information inputs (eg. requests for new products, market need data, technical ideas) into a codified and valued set of concrete outputs (eg. product designs, prototypes, or strategic decisions) (Purser and Pasmore, 1992). The emphasis is on on-going sense-making and learning. Further one can surmise that the quality of outputs generated by knowledge work systems will be directly dependent on the quality of thinking and interpretive processes evidenced in these environments.

Despite the obvious importance of thinking and reflection in knowledge work, it is only recently that the criticality of thinking and interpretive processes in non-routine domains such as product planning (Boland, Tenkasi, and Te'eni, 1992) and product

innovation (Nonaka and Kenney, 1991; Dougherty, 1992; Purser and Pasmore, 1992; Tenkasi and Purser, 1992), has been recognized. A brief review of the traditional approaches towards understanding research and development and product innovation will clarify the point.

At one level we have studies which deal with structural aspects of innovation and knowledge development (Burns and Stalker, 1961; Galbraith, 1982; Allen and Hauptman, 1990). One of the earliest research efforts examining the impact of structural conditions on innovation was carried out by Burns and Stalker (1961). In their study of electronic firms, they found that firms which were more successful at responding to the demand for innovation displayed a more "organic" form of organization. In contrast, the innovation laggards were being encumbered by their highly bureaucratic or "mechanistic" organization structure.

Another set of studies emphasize the overall cultural conditions required for innovation (Pelz and Andrews, 1966; Kanter, 1983; Kanter, 1988). A good example of this tradition is Pelz and Andrew's (1966) pioneering research which examined the conditions under which scientists and engineers did effective work. Achievement was high under conditions that appeared inconsistent. On the one hand effective research environments were characterized by sources of stability and confidence and on the other sources of disruption or intellectual conflict. They concluded that if both conditions were present the creative tension between them promoted achievement.

A third set of studies conceptualize R&D as an information processing system. Most research under this framework has had an "information input" focus, that is the way information enters an organization , and an "information exchange" focus which

investigates the channels of communication through which information then flows. Representative areas of inquiry include; 1. The technical information acquisition patterns of engineers and scientists (Allen, 1977; Chakrabarti, Feinman and Fuentenvilla, 1983). 2. The sources of information used in different stages of the innovation process and their relationship to R&D performance (Utterback, 1971; Rothwell, et.al, 1974). 3. Original stimulus to innovation and its relationship to technical and commercial success (Myers and Marquis, 1969; Goldhar et.al., 1976). 4. Communication patterns and networks and information processing internal to the R&D laboratory (Allen and Cohen, 1969; Allen, Tushman and Lee, 1980).

While these different streams of research have extended a general framework in getting our hands around an elusive phenomenon such as research and development, we still do not have a direct handle on the actual processes of creation and application of knowledge in non-routine environments. The micro-level processes of thinking and interpretation as it relates to product innovation remain as obscure as ever.

IMPORTANCE OF UNDERSTANDING THINKING AND INTERPRETIVE PROCESSES IN KNOWLEDGE WORK

There has been a growing recognition that thinking and interpretive processes play a significant role in product innovation, and form the transformative core whereby equivocal and chaotic information inputs are turned into unique and codified concrete outputs (Henderson and Clark, 1990; Brown and Duguid, 1991; Nonaka and Kenney, 1991; Dougherty, 1992). Innovation is a consequence of changes in a scientific community's "way of seeing" or interpretive view (Brown and Duguid, 1991). Moving away from the perspective of innovation as problem solving, Nonaka and Kenney (1991)

reconceptualize innovation as an 'information creation' moment. They propose that information creation is synonymous with 'meaning creation' and product innovation can be viewed as a restricted sub-set of this process. The tools in this creation process are often metaphors and analogies or other such devices which help in examining current thinking practices, and facilitate rethinking or discarding old ways of thinking. Henderson and Clark (1990) observe that nonroutine innovations require new "architectures" in which innovators break out of existing procedures and know-how and reconfigure components of design and procedure into a new framework.

Dougherty (1992) makes a strong case for viewing innovation as an interpretive process, and emphasizes that the management of innovation should pay attention to the interpretive schemes that shape and frame how people make sense of their work. According to her, the advocation of rational tools and processes, the infusion of market research information, and the redesign of structures while important, are not enough to manage innovation. Her recent study provides a good example of how intervening at the level of interpretive processes is critical for product innovations.

Interpretive Processes - Theoretical perspectives

Many phenomenologists advocate the view that all knowledge and meaning is rooted in the subjective view of the knower (Mead, 1964). Meaning can only be understood from the point of the knower who assigns idiosyncratic meanings to his or her own actions and to the actions of others through a process of interpretation (Rabinow and Sullivan, 1979). Equivocality, plurality, and multiplicity of meanings in the stream of organizational action is inescapable. Social systems and organizations are marked by multiple, contradictory, causal explanations for any event (Weick, 1979).

What is the source from which such varied interpretations arise? There is an established body of research in cognitive psychology that suggests that thought, perception, interpretation, and action are embedded in an individual's cognitive schema (Turk and Salovey, 1985). Interpretive or cognitive schemas are cognitive structures that contain knowledge about a domain, including a specification of the relationships among the principal attributes of the domain (Bartlett, 1932). Once established they serve as a guide to perception and behavior and influence the manner in which relevant new information is assimilated. These schemas usually operate at a pre-conscious level and direct the perceiver to selectively attend to incoming stimuli, encode, store, and ultimately retrieve information in a particular domain. They serve to organize experience and provide rules for activating anticipated behavioral sequences for how an individual or others should act in various situations (Weick, 1979).

Because schemas operate at a preconscious level they are generally impervious to change and refractory to disproof (Ross, 1977). Schema perseverance can result in many dysfunctional consequences for organizations. The groupthink phenomena (Janis, 1972) can be regarded as one such dysfunctional consequence arising out of being dominated by a single schema, and where this domination becomes self-reinforcing (Weick, 1990). Having become true believers of a specific schema, group members direct attention toward an environment and sample it in such a narrow way that their initial beliefs become self-validating, and they become more fervent in their attachment to the schema. What the group fails to appreciate is the extent to which their perceptual direction and sampling are becoming increasingly narrow under the influence of growing consensus and enthusiasm for a restricted set of beliefs. This schema rigidity leads to serious misjudgments of a situation.

Interpretive schemes and their impact on product innovation

The compelling influence of interpretive schemes on product innovation is well illustrated in Dougherty's (1992) pioneering study of new product development efforts across multiple firms. In this study, the first field attempt at linking interpretive schemes to product innovation, Dougherty examines and establishes how differing interpretive schemes of the various players involved in product development can be a major barrier to the linking and collaboration essential to successful product innovation. Data regarding 18 new product efforts which incorporated new or unfamiliar technology in five firms were collected by interviewing 80 people from different departments who worked on these products. Two of the firms were in computer/communication industries and three in chemical industries. Some products were commercially successful, and some were failures. The principal research question guiding the study was; why innovators fail to develop a comprehensive appreciation and understanding of the product? Her findings suggested that, uniformly in all the unsuccessful cases, the key players involved in product innovation, namely, the research scientists, field staff, manufacturing engineers, and business planners, interpreted and understood issues around technology-market linking and new products in qualitatively different ways from each other and were not able to reconcile these differences.

The differences in interpretation centered around three themes. The first theme was what people see when they look into the future, including issues that are most uncertain. Each stakeholder made different sense of the nebulous future by looking at disparate aspects of it. What they saw seemed uncertain, while what they failed to see, did not seem particularly uncertain or even noteworthy. The business planner worried about positioning against competition while the field person worried about identifying the right potential customers. Each partitioned the product into separate sources of

uncertainty, which kept them from developing a more comprehensive understanding of the market. The second theme comprised people's understanding of the development process itself. Each department concentrated on different subsets of the overall process. People not only ignored the activities they did not deal with directly, or even argue over relative priorities. Rather, they completely glossed over the concerns of others, and tended not to appreciate their complexities. The third category concerned how people understood the task itself. All but the planners understood product development in concrete, hands-on terms, so all the departments had difficulty in making sense of the planners' reports.

Dougherty (1992) attributes the differences in interpretation patterns as emanating from different "thought worlds". Much akin to a schema, an individual or group of individuals engaged in a certain domain of activity who have a unique understanding about that activity constitute a thought world (Douglas, 1987). Two aspects of thought worlds are relevant to product innovation: their "fund of knowledge" that is what they know, and their 'systems of meaning" or how they know (Fleck,1979). What is already known influences the method and content of cognition. A thought world also evolves an internally shared system of meaning which provides a "readiness for directed perception" based on common procedures, judgements, and methods. Thought worlds with different funds of knowledge and systems of meaning cannot easily share ideas, and may view one another's central issues as esoteric, if not meaningless. So ideas that do not fit in with one's system of meaning may be reconfigured or rejected outright.

For new product development, departmental thought worlds can selectively filter information and insights. Because of different funds of knowledge, a certain thought world is likely to best understand certain issues, and further, ignore information that is

equally essential to the total task. This also reduces the possibility for creative joint learning, since members of a department may think that they already know everything (Dougherty, 1992).

Thought worlds can have an all pervasive influence on an actor's perception and interpretation. As Dougherty found in her study, each departmental thought world was truly concerned with the successful development of the product. Each had an important insight into the product or market that was essential to the new product's development. However, each emphasized different aspects of development, and conceived of the whole in a totally different way. As lucidly worded by Dougherty (1992) "Nor is the problem like the proverbial set of blind men touching a different part of an elephant. It is more like the tales of eye witnesses at an accident, or of individuals in a troubled relationship- each tells us a "complete" story, but tells a different one" (pg. 191).

Improving the quality of thinking processes by raising awareness of interpretive schemes

Intervening at the level of interpretive schemes and bringing them to conscious awareness can be a very powerful means for inducing change. This is an essential step for improving the quality of thinking practices and interpretation patterns, since these processes emanate from the preconscious interpretive schemes. Weick (1990) suggests that diagnosis of organizational schemata is a very robust method for researchers to understand much of what goes on in organizations, how it's members arrive at the conclusions they do, and why they persist in conclusions that seem dated. Surfacing schemas is the first step towards reversing the potential rigidities imposed by a particular interpretive scheme. Many organizations and groups operate on increasingly impoverished views of the world, and if they have to innovatively adapt to changing environmental conditions, they have to cultivate a sensitivity to thinking practices that

move beyond simplicity; thinking practices that complicate rather than simplify the world (Jacobs, 1977). One suggested way for complicating thinking practices is by making it possible for individuals to portray their original understanding of a situation, and re-examine these displays and come away from those re-examinations with different interpretations and perspectives of what they might mean. Such a process allows for meta-inquiry, that is the ability to think about one's thinking.

Brown and Duguid (1991) feel this re-registering of one's understanding can be a powerful source of innovation. Innovating organizations adopt new points that allow them to see beyond the closure-imposing boundary of a single world view. They continually look for innovative ways to impose new structures, ask new questions and develop new views. By asking different questions, by seeking different sorts of explanations, and by looking from different points of view, new answers emerge. In similar lines, Dougherty (1992) indicates that in the cases of successful product innovations, people described several instances when they broke out of usual perspectives and re-registered their understanding of the situation or problem.

Bringing together actors with different interpretive schemes and dialoguing at the level of interpretive dynamics is another suggested method to complicate thinking practices, and develop a better appreciation of the issues at hand. According to Dougherty (1992), successful product innovators created collaborative mechanisms that took into account their unique interpretive dynamics. Interactions at this core level of understanding facilitated appreciation of each other's perspectives, and consequently their unique knowledge could join together to produce new insights and new facts.

Building cognitive maps has been advocated as a means of surfacing interpretive schemes. Schematas can exist as cognitive maps that members infer from their organizational experiences (Axelrod, 1976; Bougon, Weick and Binkhorst, 1977; Weick and Bougon, 1986). Organizational members edit their own organizational experience into patterns of personal knowledge and a representation of that knowledge is called a cognitive map. The map consists of the concepts and the relations a participant uses to understand organizational situations. Weick and Bougon (1986) suggest that building cognitive maps can be evocative since they can reveal an individual's personal cause and effect logic. This in turn forces the individual to confront the reasonableness and validity of tacit cause-effect assumptions. Thus building a cognitive map provides an occasion to think carefully, deeply, and deliberately about an issue. Further exchanging cognitive maps can facilitate dialogue at the level of interpretive dynamics. This perspective sharing process can enable collaboration and coordinated action among different thought worlds in a more effective fashion.

SPIDER- A PROJECT WITH PRODUCT PLANNERS

We are developing SPIDER as a computer aided tool for people to in a structured way portray their interpretations and causal understandings of a situation, reflect on these interpretations, and share their interpretations with others in dialogue. We are working with product planners from a large international computer manufacturer. These managers will use SPIDER to represent knowledge of their planning decisions and exchange and critique that knowledge among themselves. Project members from the company come from engineering, marketing, sales and production departments. Each participant is involved in making quarterly sales forecasts of the company's major products over a three-year time horizon in units and dollars. The departments are different thought worlds

with unique viewpoints and effective communication among them is very difficult to achieve. Currently, it requires substantial effort for the planners to represent their own context of assumptions and understandings of the planning situation and in exchanging those representations with others in a meaningful dialogue.

SPIDER, the software we are developing, creates a web of links among cognitive maps, spreadsheets, text, and graphs. SPIDER will be used for representing and sharing a planner's: a. Understanding of a product's behavior in the market, b. financial forecast of a product line, c.underlying assumptions and preferences about competition, technology, economy, customers and so on, and d. inquiries, reactions, and critiques of others plans.

Cognitive maps portray an individual's interpretation of a product line situation. The cognitive map is a graphic portrayal of factors in the situation and their causal interrelationships, similar to influence diagrams or decision nets. Traditionally, a researcher has constructed a decision maker's cognitive map for his or her own purposes, and has taken it be a rather static representation (Axelrod, 1976). Our use of cognitive maps is unique in that these planners are constructing their own maps, exchanging them, critiquing them, modifying them and generally making them their own representation and communication device.

An individual's financial forecast is represented by a multi-dimensional spreadsheet in which each row is a product forecast that is linked to a subsidiary spreadsheet giving market indicators, underlying factors and calculations standing behind the forecast. Also, each row can be linked to cognitive maps, giving a broader view of the product and market context.

A sample top level screen in SPIDER is shown in figure 1. In this example, the current forecasting project includes several information themes, including a matrix of sales forecasts and a cognitive map for a family of products. Clicking on the bubbles in the cognitive map or the rows in the spreadsheet will create links to other windows. In these windows, underlying assumptions and beliefs are handled by text and graphic capabilities. Managers interpret their situation by moving back and forth between elements in a map, calculations in a spread sheet and layers of assumptions. Their interpretations build as they add elements to their map, group elements into higher level constructs, and elaborate on the web of assumptions and beliefs.

SPIDER is not only a collaborative tool for inquiry among a group of disparate product planners, but it is also an important tool for better self-understanding by an individual planner. Most of the knowledge represented in the multi-layered web of links among the cognitive maps, spread sheets, texts and graphs is usually held by an individual tacitly. The intellectual effort and careful self-examination required to construct a cognitive map, its related spreadsheet, and its layer of assumptions is a source of new understanding for the managers involved. This in itself an important learning experience. But the principle benefit of SPIDER as a collaborative technology should come when individuals exchange their representations, compare their interpretations with those of others, and communicate new understandings and inquiries back to their colleagues. The ultimate test of success for SPIDER however would be manifested in the planners' ability to coordinate the product planning process and to improve the quality and accuracy of their forecasts.

Conclusion

SPIDER and its underlying theory is a beginning in what we hope will be an extended effort to develop tools of self reflection and dialogue among knowledge workers. Environments such as SPIDER, by enabling individuals to surface their preconscious interpretive schemes, examine their thinking patterns, and improve their thinking practices in dialogue with others can contribute substantially to new innovations both technical and social.

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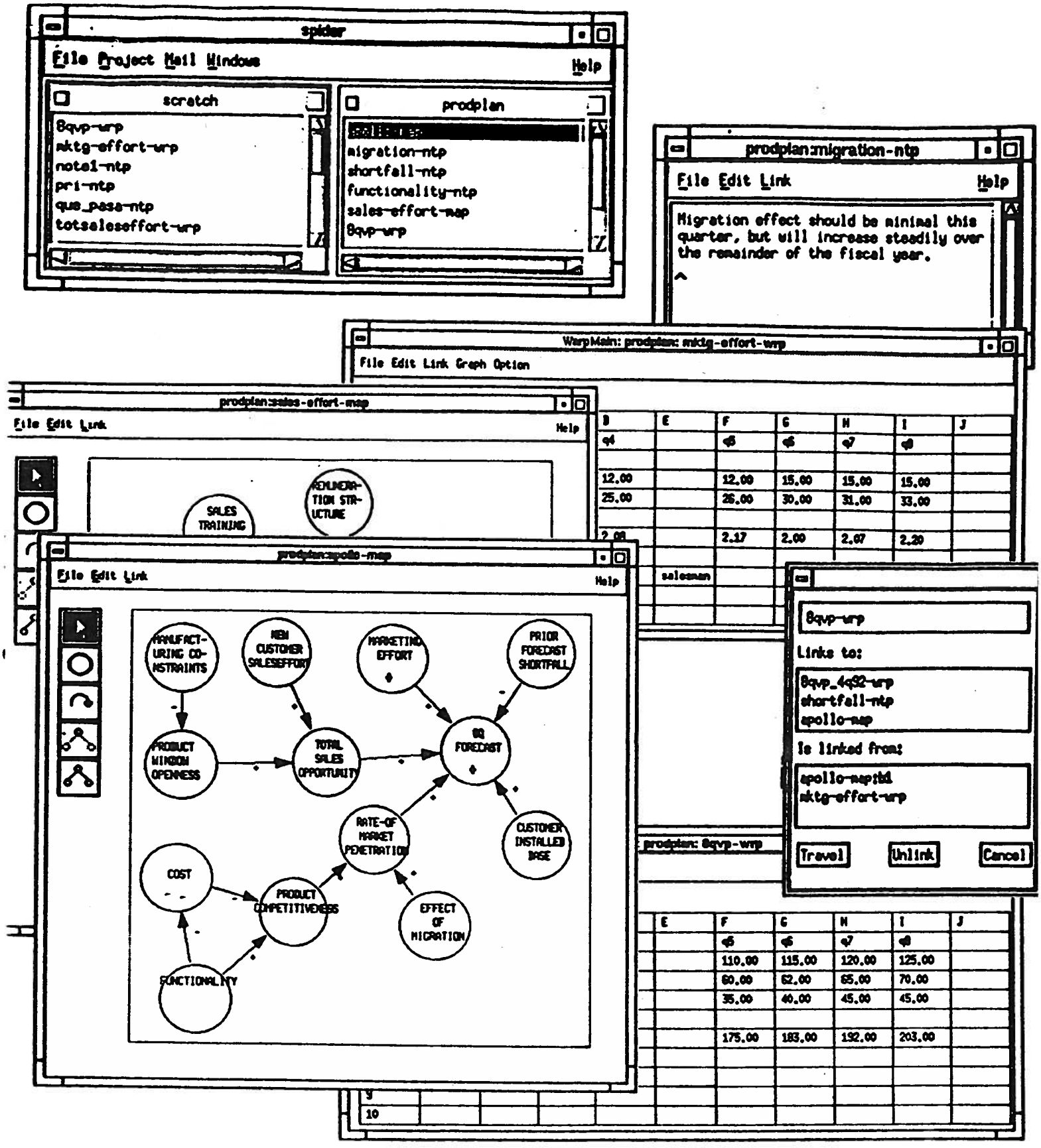

Figure 1: A sample screen from SPIDER showing multiple windows.