

## **COGNITIVE CHANGE, STRATEGIC ACTION, AND ORGANIZATIONAL RENEWAL**

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*Organizational renewal requires that a firm's top managers make timely adjustments in their mental models following significant changes in the environment. Our initial propositions about the difference between renewal and decline focused on whether similar organizations in similar contexts differ in their ability to recognize significant changes in their environments. Analysis of longitudinal data from a matched pair of U.S. railroads suggested, however, that renewal hinges not so much on noticing new conditions, but on being able to link environmental change to corporate strategy and to modify that linkage over time. In the successful company we studied organizational renewal is a continuous process of first and second order changes in cognitive maps.*

Why are some firms able to adjust to changing circumstances while others fail to respond to environmental changes that threaten their long-run viability? Most corporations are governed by experienced directors, pay high salaries to talented managers, have access to consultants, and receive hourly information on how the market assesses their prospects. Yet with all of these advantages, many firms enter periods of declining performance. Some of these firms are able to renew themselves, others never recover.

Decline is even more vexing because firms frequently alter strategies and structures in response to environmental changes (Chandler, 1962). Nor is adaptation limited to successful

firms. Bowman (1982), for example, notes that the managers of firms with poor performance are active risk takers. With this evidence of responsiveness to changes in the environment, the question of why some firms are able to renew themselves while others are not takes on added importance and interest.

Kiesler and Sproull (1982: 548) suggest that '[a] crucial component of managerial behavior in rapidly changing environments is problem sensing, the cognitive processes of noticing and constructing meaning about environmental change so that organizations can take action.' Lenz (1981), Bartunek (1984), and Huff and Schwenk (1990) describe how environmental changes can prompt changes in 'interpretive schemes' or cognitive models of the world that may lead to organizational restructuring. We propose that the cognitive processes of 'noticing

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and constructing meaning' offer important insights into the phenomenon of organizational renewal.

More specifically, managers' mental models both facilitate and limit attention to and encoding of salient information about changes in organizational environments. Mental models help individuals cope with an overabundance of available stimuli (Kiesler and Sproull, 1982), but strongly held mental models may lead managers to overlook important environmental changes so that appropriate action at the organizational level is not taken (Hall, 1976, 1984). The persistence of mental models that are no longer appropriate would explain why organizational decline is often 'a protracted process' or 'a downward spiral' (Hambrick and D'Aveni, 1988), despite an abundance of managerial talent and cues of trouble. We propose that organizational renewal requires managers to change their mental models in response to environmental changes and that delays in this process will be associated with decline. We also propose a number of explanations for delays in the adjustment process and examine several distinctions between the mental models associated with renewal and those associated with decline.

The study investigates the link between changes in mental models and changes in organizational action by analyzing the causal assertions made by leaders of two initially similar U.S. railroads over a 25-year period. One firm, the Chicago and North Western (C&NW), engaged in radical restructuring during a period of radical environmental change and continues to be a viable company today. The Chicago, Rock Island and Pacific (Rock Island), on the other hand, showed steady decline until it went bankrupt in the mid-1970s.

Analysis of causal maps from these two companies shows significant differences in the timing of their responses to industry decline, but as we analyzed data from these two companies, we broadened the focus of our theoretical explanation from the importance of recognizing key environmental changes. Causal maps from the study underscore the critical link between managers' understandings of environmental conditions and firm strategy. One important way strategic renewal occurs for the C&NW is through incremental reassessments that ultimately lead to major changes in operating procedures. In fact, evidence for this company provides detailed support at the cognitive level for descriptions of

strategic change available for some time in the strategy literature from Mintzberg (1978), Quinn (1980), Pettigrew (1985), and others.

## **TOWARD A COGNITIVE EXPLANATION OF ORGANIZATIONAL RENEWAL**

Simon (1955) notes that individuals have limited data processing capabilities, yet these limited capabilities must be used to process vast amounts of ambiguous data (March and Simon, 1958). To make sense of the world, managers rely on simplified representations or mental models (Kiesler and Sproull, 1982). Defined by O'Keefe and Nadel (1978) as 'an aggregate of interrelated information,' mental models consist of concepts and relationships an individual uses to understand various situations or environments (Weick and Bougon, 1986). They serve as 'maps' allowing individuals to perceive environments on a larger scale, beyond the range of immediate perception (Weick and Bougon, 1986; Huff, 1990). A feature of mental models of particular interest to management researchers involves cause-effect understandings about the environment (Bougon, Weick, and Binkhorst, 1977; Eden, Jones, and Sims; 1979; Narayanan and Fahey, 1990). Narayanan and Fahey, who focus especially on the problems of organization decline, argue that

[c]ause maps provide a convenient shorthand to describe the lenses which filter data and a means by which data are interpreted. In this view, decision makers [can be] viewed as active selectors and interpreters of data (1990: 110).

### **Roles played by mental models**

Given human frailties as information processors, mental models allow individuals and organizations to make sense of their environment and act within it. The problem, of course, is that mental models may be, or become, inaccurate. Given cognitive limitations, mental maps will always be incomplete; inaccuracy may increase, however, as environments change.

Mental models can exacerbate a mismatch between data availability and information processing in three important ways. First, mental

models determine what information will receive attention. Nisbett and Ross (1980), show that individuals recall the elements or features of a stimulus situation that are most prominent in their mental models. Managers thus can be expected to focus their attention on environmental changes that are most salient to, or offer support for, their current mental models, while other potentially important changes in the environment may not be recognized (Kiesler and Sproull, 1982).

This problem is compounded because the stimuli gaining attention tend to be interpreted in relation to the individual's current mental model (Galambos and Rips, 1982) rather than seen as a signal of needed change. Even if events growing out of a changing environment are noticed, then, managers may not perceive a need for strategic renewal (Dutton and Jackson, 1987; Sapienza, 1987).

A third key finding from cognitive research is that mental maps direct action (Nisbett and Ross, 1980). Just as mental maps selectively limit information attended to and similarly slant how this information is interpreted, existing mental maps will also limit the range of alternative solutions to the issues that have been identified (Bateman and Zeithamel, 1989; Cyert and March, 1963; Duhaime and Schwenk, 1985; Dutton, Fahey, and Narayanan, 1983; Mintzberg, Raisinghani, and Theoret, 1976). Renewal efforts may be further hampered because actions that are consistent with existing models are likely to generate data that can once again be interpreted in light of existing mental models.

The accuracy of the mental model may improve as subsequent events provide information to modify erroneous understandings. As Weick (1983, 1987, 1990) suggests, 'incorrect' models can also lead to 'correct' action. Many researchers argue, however, that mental models often fail to change in a timely manner in response to a changing environment and that inaccurate models are associated with deteriorating performance (Hedberg and Jonsson, 1977; Hedberg, Nystrom, and Starbuck, 1976). Whetten's (1988) research shows, for example, that organizational decline is the result of significant changes in the environment that either go unnoticed, are improperly interpreted, or are addressed through inappropriate actions by top managers.

### Learning and change in mental models

Many researchers propose that organizational renewal hinges on learning—a process that necessarily requires additions to or changes in mental models (Huber, 1991; Fiol and Lyles, 1985). Mental models that can no longer accommodate or explain occurrences in the environment must be altered and new understandings of the environment must be developed.

One influential way of characterizing this process focuses on unfreezing, change, and refreezing (Lewin, 1947), three phases that have been applied to both individual and organizational learning. During the unfreezing stage, old beliefs are discarded in order to make way for new understandings. This process has also been referred to as unlearning and is considered a key preliminary stage in the learning process (Hedberg, 1981; Nystrom and Starbuck, 1984). Once old beliefs are unlearned, new understandings about the environment can be achieved, often via experimentation (Hedberg, 1981; Starbuck, Greve, and Hedberg, 1978). In the final phase, changes in mental models are solidified. New belief structures ultimately become 'frozen' as they are supported by the occurrence of anticipated events (Argyris, 1976; Hedberg and Jonsson, 1977; Nystrom and Starbuck, 1984).

The literature also points to a two-tiered conceptualization of individual and organizational learning (Argyris, 1976; Fiol and Lyles, 1985). Low level or single loop learning is reflected in changes in behavior rather than changes in understanding. This kind of learning results in incremental modifications or minor adjustments to existing interpretations (Watzlawick, Weakland, and Fisch, 1974). Higher level or double loop learning, on the other hand, involves a restructuring of the individual's mental models and results in significant changes in understanding. This higher level learning involves unlearning, the deletion of concepts or assumed associations between concepts in the environment, and the addition of new concepts and associations.

### Four hypotheses about organizational renewal

Because of the way they direct attention and guide the encoding of information, the mental models of firm leaders offer an explanation for

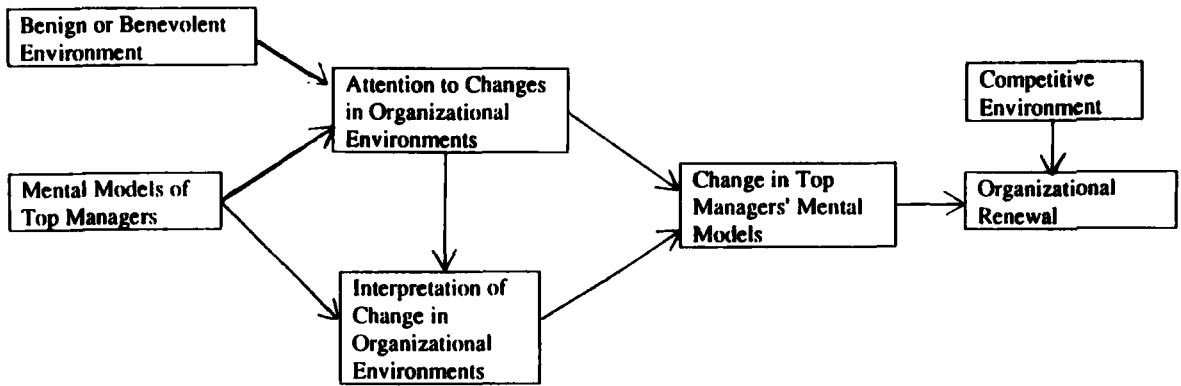


Figure 1. A cognitive model of organizational renewal

how organizations deal effectively with a changing environment, how they identify appropriate responses, and thus renew themselves. Our framework of the mental processes that contribute to this kind of updating is illustrated in Figure 1. The framework suggests that top managers' mental models must keep pace with changes in their environments, so that they have updated understandings of the settings in which their firms operate.

The initial hypotheses of this study address four issues related to this figure.

#### *Renewal requires a change in mental models*

The central hypothesis of the study suggests that organizational decline may result if managers fail to make significant changes in their mental models given a substantial change in the environment (Hall, 1976, 1984, Hedberg and Jonsson, 1977). No longer appropriate mental models may prevent managers from sensing problems, delay changes in strategy, and lead to action that is ineffective in a new environment.

The consequences of action also feed into the likelihood of changing strategy. Action expresses cause-effect beliefs, subsequent events either confirm (expected outcomes) or contradict (unexpected outcomes) those beliefs. Confirmation strengthens current mental models and thus future actions are expected to be based on currently held beliefs. Contradiction, on the other hand, requires reevaluation of current mental models. If the current set of beliefs is unable to explain the outcome, an adjustment or change in mental model is required. This line of

reasoning, added to our observations about managerial attention, suggests the first hypothesis:

*H1: Given a substantial change in the environment, firms that successfully renew their strategies will show more rapid succession or change in mental models than firms that experience organizational decline.*

What factors cause or contribute to a delay in the succession of managers' mental models? Three possibilities seem especially plausible:

*A munificent environment may confirm outdated mental models.* Delay in the succession of mental models may be the result of a munificent environment. One of Hambrick and D'Aveni's (1988) key findings is that significant weaknesses appear in failing firms as early as 10 years before bankruptcy, but go unaddressed for long periods of time because the environment remains either munificent or benign. In other words growth can hide 'a multitude of sins,' and a favorable environment might permit firms to enjoy profitability in spite of managers' outdated mental models (Whetten, 1988). Continued growth and profitability might even further confirm and strengthen outdated models, delaying change until growth slows or stops and the effects of inadequate mental models are felt (Hall, 1976, 1984). Hedberg and Jonsson (1977) suggest that munificence not only delays recognition of the need for change, but also slows or prevents the development of alternative models. These ideas suggest the following hypothesis:

*H2: Delays in the succession of mental models will occur in munificent environments.*

*result from inherent delays in the learning process.*

*Changes in the environment may not be noticed because they are not central to existing models.* As already noted, mental models specify the most important or central elements of organizational environments. More peripheral elements (as defined by the mental model) may become increasingly important as environments change, but go unnoticed by managers. This problem is compounded because '[m]ost strategic decisions do not present themselves to the decision maker in convenient ways; problems and opportunities in particular must be identified in the streams of ambiguous, largely verbal data' (Mintzberg *et al.*, 1976: 253).

Starbuck and Milliken (1988) suggest three ways in which managers' perceptual filters might affect noticing. First, individual habits and beliefs will influence what they notice. Second, because some stimuli are not actively noticed, they must change dramatically in order to attract attention. Finally, problems of noticing are institutionalized at the organizational level because resources are assigned to track those stimuli that top executives have identified as important, while other stimuli may go unnoticed simply because no effort is made to track them. This suggests a third hypothesis:

*H3: Delays in the succession of mental models will occur if managers fail to detect a substantial change in their organizations' environments.*

*Delays in the succession of mental models may be due to the time required for learning.* Many theories of strategic change suggest that changes in action do not occur until some level of stress or pressure to change exceeds the level of inertia or pressure for maintaining the *status quo* (Ginsberg, 1988). Similar pressures may be required to move managers through the learning process. Work that emphasizes experimentation (Van de Ven and Polley, 1992) and action (Weick, 1979, 1983) as the sources of insight, also suggest that time will be required before new mental models can be constructed. In short, the process of disposing of old beliefs and discovering new beliefs takes time. These time requirements suggest a final hypothesis:

*H4: Delays in the succession of mental models*

## RESEARCH METHODOLOGY

### Sample selection and time frame

The U.S. railroad industry was selected as a context for the study. This industry environment experienced a significant decline following the end of World War II. During the 25 year time period of the study, from 1949 through 1973, the number of major railroads fell from 135 to 69. The railroads' market share among major transporters fell from 58.4 to 38.4 percent, while the motor carriers' market share increased from 13.8 to 22.6 percent (*Moody's Transportation Manual*, 1989).

Our investigation focuses on the mental models of the top managers of a matched pair of firms. The need for careful matching led to the selection of two Midwestern railroads, the C&NW and the Rock Island.<sup>1</sup> Both firms shared a common geography and were roughly the same size. In addition, they had a remarkably similar traffic base. The Rock Island derived a slightly higher percentage of its revenue from agricultural products; the C&NW, which served the iron ore producing regions of Minnesota, received a slightly higher percentage of its revenue from mining products. Other traffic differences, however, are not significant ( $X^2 = 5.07$ , n.s.).

Since neither firm was a transcontinental railroad, both derived a large proportion of their freight revenue from 'bridge traffic'—freight received from and delivered to other carriers that neither originated nor terminated 'on-line'. Furthermore, both railroads had a single focus on railroad transportation at the beginning of this study's time frame so other domain activities should not mask the responses of each firm to environmental decline. Finally, these two railroads were selected because they experienced different fates, suggesting that in spite of geographic traffic, and size similarities, their responses to the changing environment may have differed. The C&NW remains viable today; the Rock Island sought bankruptcy protection in the mid-1970s and ceased to exist. Table 1 describes

<sup>1</sup> Two companies that were also matched in an earlier study by Hambrick and D'Aveni (1988).

performance characteristics of the two firms that illustrate their growing disparity.

### Methodology

The strategy literature assumes that organizational actions are based on top managers' attention to and subsequent understanding of the environment (Andrews, 1987). Our interest is in the interpretations of our sample firms' top managers, how these interpretations change, and the subsequent impact of these interpretations on organizational responses. The methodology employed to track these questions, cause mapping, avoids the recall biases of interviews (Axelrod, 1976)—which would be especially problematic given the time frame of the study—

and provides detailed, rigorously collected information about managerial thinking that is not typically found in case studies.

Cause mapping is a form of content analysis that isolates the key assertions within a document that deal with causality, existence, or categorization, all basic issues for strategic decision making. Assertions can be 'mapped' to gain a larger picture of changing managerial beliefs, and both map structure and individual statements can be examined for changes over time. A detailed list of protocols, further described below, were used to identify and analyze these assertions.

The source of data for constructing cause maps in the study is the 50 letters to shareholders published by the two companies over the 25-year period of the study. Researchers have used material

Table 1. Characteristics of the sample firms

Year	Average miles operated		Total Tons (000s)		Freight traffic as a percentage of total freight and passenger traffic		Operating ratio*		Operating income as a percent of gross revenues	
	C&NW	Rock Island	C&NW	Rock Island	C&NW	Rock Island	C&NW	Rock Island	C&NW	Rock Island
1949	8,076	7,621	48,339	38,508	77%	81%	90.6%	73.3%	2.3%	16.0%
1950	8,001	7,610	54,818	37,140	77	80	83.9	72.8	7.6	16.6
1951	7,911	7,921	57,938	42,593	78	81	88.0	76.0	4.0	13.1
1952	7,905	7,916	55,633	42,803	78	82	86.2	72.1	4.9	18.5
1953	7,875	7,903	54,128	40,434	78	82	86.1	70.9	4.3	19.3
1954	7,876	7,895	50,085	38,858	77	81	88.1	75.7	1.2	12.8
1955	7,857	7,921	56,230	40,191	78	82	84.7	75.6	4.0	13.5
1956	9,362	7,597	57,999	40,782	81	82	87.8	76.7	1.3	12.0
1957	9,297	7,606	55,299	40,649	82	83	85.4	78.4	3.7	8.1
1958	9,309	7,584	51,022	39,950	83	83	82.9	78.0	5.0	8.2
1959	9,284	7,535	50,889	42,747	83	83	85.7	78.7	1.0	6.6
1960	9,521	7,533	52,926	40,603	85	82	86.2	80.2	0.0	4.0
1961	10,702	7,850	56,104	38,978	88	81	81.1	78.3	4.9	5.2
1962	10,547	7,843	51,774	39,525	88	81	85.9	81.5	0.0	3.1
1963	10,462	7,838	56,307	39,978	87	82	81.8	81.3	5.2	3.8
1964	10,432	7,792	58,600	40,655	89	84	85.5	81.6	4.9	3.5
1965	10,362	7,793	59,913	41,879	89	85	79.6	82.9	5.6	1.2
1966	10,220	7,467	64,033	45,304	88	87	79.4	82.5	6.7	0.1
1967	10,179	7,360	63,801	42,968	96	89	84.1	86.0	0.5	-6.3
1968	11,523	7,277	68,133	47,222	96	93	85.4	82.2	0.0	-3.0
1969	11,512	7,277	66,958	50,242	98	94	86.7	81.4	-6.5	-3.0
1970	11,265	7,177	70,187	44,447	98	94	81.3	81.2	2.7	-5.2
1971	10,929	7,507	67,324	47,592	98	94	80.8	79.6	4.0	-1.5
1972	10,556	7,495	70,711	47,597	98	94	78.5	80.7	5.2	-1.8
1973	10,249	7,385	80,200	49,125	97	94	77.3	81.8	5.3	-5.5

Source: Moody's Investor Services, *Transportation Manual*, 1989.

\*The operating ratio represents the proportion of operating expenses to operating revenues and is therefore a measure of operating efficiency. Obviously, a lower operating ratio is desirable.

from annual reports to identify corporate strategies (Bowman, 1978), to assess causal reasoning within firms (Bettman and Weitz, 1983), and to explain differences in joint venture activity (Fiol, 1989). Nevertheless, these data are not ideal material for revealing the mental models held by firm leaders. Annual reports, especially in more recent years, are typically prepared by public relations departments. Even before the widespread use of such offices no guarantee exists that letters to shareholders were drafted by the executives who signed them—and certainly the specific words used may well have been edited by others in the organization. Some systematic biases are also likely; unflattering information about the top management team, for example, will almost certainly be suppressed. Also important is the possibility that expression in an annual report may lag considerably behind an actual change in managerial understanding.

Our response to these legitimate concerns is that while annual reports may not be ideal, few rival data sources exist that can provide insight into the changing mental methods of top managers over time. This data source also has the critical virtue of being written in the time period of interest. Letters to shareholders are prepared over short, consistent intervals and are easily accessed. Further, informal conversation with executives indicates that they do have considerable involvement in preparing communications with investors, particularly in times of poor performance.

In the end, we used annual report data because we believe this document is too important not to be given close attention by top management, both in terms of early subject framing and later word level editing. Further, our focus in this paper is on *organizational* level understanding, changes in understanding, and the link between understanding and an organization's actions. Rank of authorship or change in specific authors is thus less important than it might be if we were trying to attribute responsiveness to a specific individual. Similarly, while statements in the annual report may not precisely mirror the time period of a change in understanding, over long periods the exact timing of changes in understanding is less important than overall patterns of change.

**Coding procedures**

The coding scheme used in this study was initially developed by Robert Axelrod (1976).

The analysis followed modifications by Huff, Narapareddy, and Fletcher (1990) of the coding manual developed by Wrightson for Axelrod (Wrightson, 1976: 291–332). Concepts in the text to be analyzed are connected by symbols indicating causal and definitional relationships. Instructions to coders indicate that concepts can be thought of as variables capable of being altered by the presence or absence of other variables. Statements containing these concepts are identified in source documents by the coder and influence relationships are placed into one of the nine categories identified in Table 2, maintaining to the extent possible the wording of the original document.

At the end of this procedure the phrases or concepts connected by codes are assigned an identifying letter. Individual concepts are examined for equivalency, following rules specified in the code book, in an effort to capture the essential parsimony of mental models. Variables judged to be essentially equivalent are recoded with the same letter. A 'map' or series of maps is then constructed by connecting concepts with arrows labeled with a symbol for the type of relationship involved. For example, the two sentences 'A further freak of weather delayed the opening of navigation on Lake Superior and on Lake Michigan. This inaccessibility retarded very materially the season's program for movement of iron ore.' would be coded as follows:

A further freak of weather (A)	+	delay in the opening of navigation on Lake Superior & on Lake Michigan (B)
inaccessibility [of navigation on Lake Superior & on Lake Michigan] (C)	–	season's program for movement of iron ore (D)

The coding procedure would equate concepts B and C and yield the following map:

A further freak of weather (A)	→	delay in the opening of navigation on Lake Superior & on Lake Michigan (B)	→	season's program for movement of iron ore (D)
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Table 2. Coding categories

Symbol	Definition
/+/ /-/ /⊖/ /⊕/ /a/ /m/ /o/ /=/ /e/	positively affects negatively effects will not hurt, does not prevent, is not harmful will not help, does not promote, is of no benefit to may or may not be related to, affects indeterminably affects in some nonzero way does not matter for, has no affect on, has no relation to *is equivalent to, is defined as *is an example of, is one member of

\*Categories not used by Axelrod.

Two coders were used to analyze the data and training of coders was based on documents similar to those used in this study. A random document was then chosen from the study material to ascertain intercoder reliability, which yielded a very satisfactory 93.4 percent agreement on the codes assigned. Agreement on whether or not a causal statement has been made is more difficult to obtain, since some of these statements must be inferred. In spite of this difficulty, we obtained an intercoder reliability of 93.0 percent on this part of the coding procedure. Applications of this method in three studies conducted by Axelrod, his associates (Axelrod, 1976: 227), and others (Huff and Schwenk, 1990; Narayanan and Fahey, 1990) have also enjoyed favorable results.

Once intercoder reliability was established, the documents used in the study were randomly assigned to the two coders. All passages for which one coder had some doubt were discussed with the other coder until a mutually satisfactory code could be assigned. The principles involved in resolving these issues were formalized into written coding protocols. The maps were constructed jointly. One author then identified instances of map change, discussing questionable decisions with the other two authors.

### Protocols for identifying map changes

The key construct for our analysis is a *change* in mental model or map, which we believe is basic evidence of managerial learning. To identify map change systematically, we set up seven protocols

for identifying *significant* change across maps. This is important because random noise due to alternative word use must be expected in any written document, and is exacerbated in longitudinal analysis of many documents. The protocols we devised focus on changes in concepts, relationships, and map structures.

### Categorical distinctiveness

The basic sign of new understanding is the use of a new concept or the deletion of an old concept. For example, the concept 'shorter average haul' appeared as a new variable in the map from C&NW's 1954 annual report in causal association with 'poor firm performance'; weather related explanations, which appear in early maps, disappear over time. Both examples were coded as significant changes in the maps involved.

### Generalization

Another sign of learning is the recognition that specific concepts have a family resemblance to other concepts. Replacement of a specific concept with a more general term is evidence of this kind of change. Individual snowstorms are mentioned in the 1949 map from the C&NW, for example, but in subsequent years the reports contain much more general discussions of 'unfavorable weather.'

### Pattern of inclusion

The introduction of a new category is an indication that learning has taken place; the sustained use of new variables is an even more important indicator of learning. For example, in 1950 traffic flows due to the Korean conflict were mentioned as an important concept linked to increased freight and passenger traffic in the C&NW's annual report. Because this concept was not included in subsequent maps, however, the temporary appearance of the Korean conflict was not considered an important change in managerial understanding. On the other hand, the concept of 'becoming more competitive' appeared and then consistently reappeared in successive C&NW maps; this was taken as a strong indication of macro level change in understanding.



*Linkage to other concepts*

The degree of learning is assumed to be incremental or low level when a variable change does not involve many linkages or does not disrupt the continuity of an existing causal chain. On the other hand, if a new concept results in new clusters, its addition represents a more significant change in understanding. The concept of 'efficiency' appearing in the C&NW letters can serve as an illustration of this more significant change. Efficiency appears in the 1953 C&NW letter as the result of increases in diesel locomotive power and as a causal input leading to improved firm welfare. It accounts for two causal linkages in the map. By 1958, however, efficiency is central to the mental map, with four preceding causal linkages and three proceeding linkages. The addition of the efficiency concept to the 1953 map was judged to be an incremental change since the accompanying linkages are few. In aggregate, however, the change from 1953 to 1958 as efficiency becomes a central concept in the map with seven total linkages represents a macro level change in understanding.

*Change in causal signs*

Magnitude of mental map change may also be determined by the change in signs between established relationships. When a change from a positive causal association (+) to the more neutral 'does not have a negative effect on' association ( $\ominus$ ) is an example of a relatively incremental change, some change in understanding has taken place, since the causal variable does not have as great an impact on the effect concept as claimed in the past. Sign reversals suggest a much greater change. One example of this kind of shift involves freight rates. Initially, higher rates are associated with higher revenues; 7 years later, however, lower rates are seen as necessary if revenues are to be increased.

*Changes in examples or subsets*

The degree of difference between examples or subsets can also be an indicator of magnitude. Simple additions or subtractions from lists of examples or equalities are coded as incremental changes in the map. A change of greater magnitude is represented by lists that are replaced

with new, unrelated variables. In the second case, the definition of the concept has changed—it no longer means what it did in previous texts—and this change is taken as an indicator of higher level learning.

*Replacement*

The final indicator of magnitude is the amount of continuity. If, from one map to the next, only a small proportion of the total concepts are altered, this suggests that the change in understanding is incremental. If, on the other hand, a major proportion of the map is altered, the change in understanding is considered more significant.

**RESULTS**

A comparison of the 25 Rock Island mental maps with the 25 C&NW maps show many early similarities that diminish over time, suggesting that the effort to find two initially similar firms that suffer different fates was successful. Tables 3 and 4 summarize the results of the analysis for the major concept groups contained in the C&NW and Rock Island, respectively. For each railroad, these tables show the number of concepts; the number of linkages; the occurrences of generalizations; and the changes in signs, examples or subsets, and linkage to other concept groups in each year. The complexity of the maps and of the changes that occurred over time, however, cannot be fully reflected in a table format. Important changes are therefore described throughout the discussion of results and illustrated with the relevant maps.

The early maps for both firms attributed declines in performance to weather, government programs, and regulation. A representative map for both firms is the 1951 map of the Rock Island found in Figure 2. Of the 30 concepts appearing in this map, 18 (or 60 percent) deal with issues of weather, government, and the economy. The C&NW map for the same year showed 15 concepts (or 50 percent) devoted to weather, government, and the economy.

The two railroads' views began to diverge in the late 1950s. As shown in Figure 3, the C&NW map shifts in 1956 as more concepts dealing with firm productivity, management, and firm-level

Table 3. CNW map summary

C&NW	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Weather/government																									
#concepts	10	8	13	8	5	2	3						1	3		1					2		1	1	4
#links	8	9	12	9	5	1	2						1	2		1					2		1	1	4
sign/exam/gen/link*				G																					S
Economy/strikes																									
#concepts	7	5	2	3	6	2	1		1	4	5	1	1	1		1	1	1		1	3			1	
#links	5	6	5	4	2	2	1		1	3	3	1	1	1		1	1	1		1	2			1	
sign/exam/gen/link*										S												S			
Competition																									
#concepts						3		5	5	4		3	4	1	1	2		3	5						2
#links					2			8	5	4		3	5	3	1	3		4	6						3
sign/exam/gen/link*				G						SE									L						
Management																									
#concepts							11	11							1			6	5			4			
#links							7	4							1			7	3			3			
sign/exam/gen/link*																									
Efficiency/productivity																									
#concepts			5	3	1		6	6	5	9	2	2		5	1	4									
#links			3	3	2		4	5	3	13	2	2		4	1	6									
sign/exam/gen/link*									L																
Firm-level cost issues																									
#concepts						4		4	5	2	1		3	3	2	3									
#links						3		3	4	2	2		3	3	2	4									
sign/exam/gen/link*																									
Sales/service/abandon																									
#concepts	4		2	1	3		10	1		1	2		5	1	6		3							3	3
#links	4		1	2	3		8	1		2	4		4	1	4		3							4	4
sign/exam/gen/link*												L													
Merger/Acquisition																									
#concepts						4						6	1		11	6	9	5	9	7	5		1		
#links						4						6	2		8	6	8	7	6	8	6		2		
sign/exam/gen/link*																E		L							
Diesel/equip/mainten.																									
#concepts	2	2	1	1	1	3	4					6	1	1	1									4	7
#links	1	1	1	1	1	4	4					6	1	2	1									3	5
sign/exam/gen/link*			L	LG			L	L							S										
Total map concepts	25	36	30	21	17	26	37	30	23	23	21	30	25	23	36	29	21	22	22	16	30	15	10	17	26

\*S = change in sign, E = change in example/subset, G = generalization, L = change in linkage

cost issues begin to appear. These concepts are directly linked to firm performance and account for 21 of 30 (or 73 percent) of the total concepts.

In contrast, the Rock Island's cause maps continue to emphasize the industry throughout the 1950s and early 1960s. Letters to shareholders

still associate a large share of the railroad's problems with those of the industry. The firm's problems are seen as temporary and beyond its control. Evidence of a succession in mental models for the Rock Island does not appear until 1964, when for the first time its map attributes

Table 4. Rock Island map summary

Rock Island	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Weather/government																									
#concepts	4	11	9	4	10	2	10		7	20	8		2	4			2	2	3			5	4	7	11
#links	4	9	10	5	6	2	5		9	16	8		2	5			1	2	4			6	5	9	8
sign/exam/gen/link*																									
Economy/strikes																									
#concepts	1	9	8	5					1	6	2	9	3		4	4	1					3	1	1	
#links	2	7	9	5					1	3	3	5	4		3	4	1					2	1	1	
sign/exam/gen/link*																									
Competition																									
#concepts	7	8	1		3	1	1	1					2	1			9	1	5						
#links	10	7	2		1	2	1	4					2	1			6	1	1						
sign/exam/gen/link*																									
Management																									
#concepts							7	3																	
#links							4	2																	
sign/exam/gen/link*																									
Efficiency/productivity																									
#concepts						4		2				1				7	8	2							
#links						2		2				1				7	3	4							
sign/exam/gen/link*																									
Firm-level cost issues																									
#concepts				2						1		1	2			7	6		1				8		
#links				2						1		1	4			7	2		1				2		
sign/exam/gen/link*																							S		
Sales/service/abandon																									
#concepts			5	12	2	1		12	4	10	10	5	2	9	2	11	13	12	3	17				2	
#links			2	9	2	1		11	2	10	10	4	2	9	1	7	8	8	2	10				3	
sign/exam/gen/link*																EG	S								
Merger/Acquisition																									
#concepts																2	11	14	5	9	15	13	10	28	4
#links																2	11	13	5	8	14	14	10	21	4
sign/exam/gen/link*																									
Diesel/equip/mainten																									
#concepts	7		3	7	6	1	2		1							1		9	3		6	3	2	5	
#links	2		2	5	3	1	1		1							1		8	3		6	1	2	3	
sign/exam/gen/link*																GS		S				S			
Total map concepts	34	42	30	56	34	39	43	37	28	64	36	31	32	29	13	42	69	79	22	37	25	43	30	49	26

\*S = change in sign, E = change in example/subset, G = generalization, L = linkage

poor performance to firm actions that result in increased costs. Twenty-six of the 42 concepts (62 percent) deal with firm-level concerns or actions linked to performance in the 1964 Rock Island map. This map is illustrated in Figure 4.

For both firms, major changes in mental

models were reflected in more proactive strategies reported elsewhere in the annual reports and in the business press. Following a major change in mental models in 1956, the C&NW made plans for reducing costs, raising productivity, and increasing maintenance-of-way to improve its

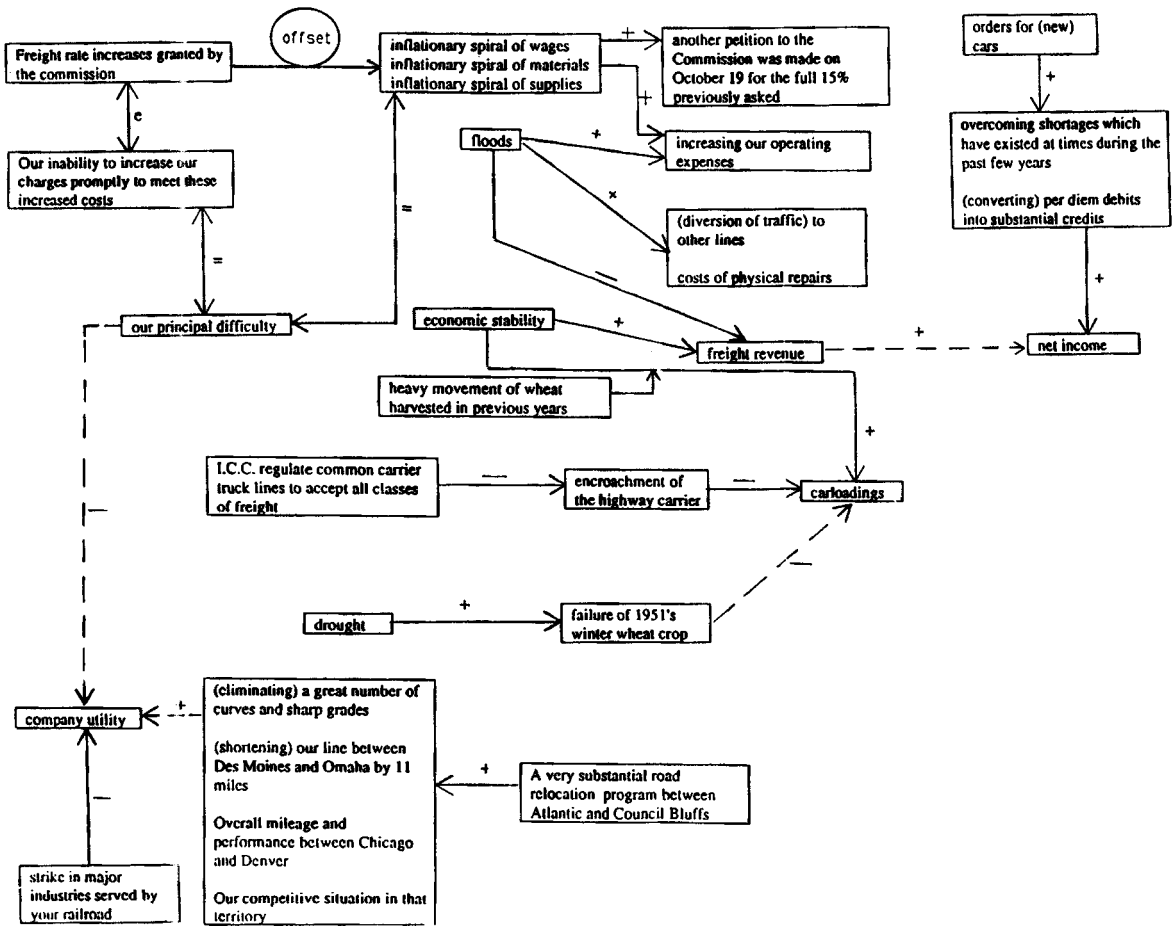


Figure 2. Cause map of the Rock Island, 1951

competitive position in the industry. The Rock Island, on the other hand, delays maintenance-of-way and does little to control costs. The Rock Island's managers see an 'upward spiral' of costs as the result of an inflationary economy that is beyond their control. The firm does attempt to increase sales to be in a better position when 'temporary economic adjustment' ends; but this action is in accord with past behavior. A major focus in the Rock Island maps is on what its managers would like others to do; they specifically emphasize the need for legislation to change regulatory policies. Not until 1964, when the Rock Island's financial resources are nearly depleted and its property badly deteriorated by deferred maintenance, do its leaders shift their mental models and adopt a plan of action—merger with the Union Pacific railroad.

In general, data from the 50 maps support three of our four hypotheses:

*Hypothesis 1.* All indicators of mental model change provide support for Hypothesis 1. The leadership of the C&NW—the firm that renewed its strategy and still survives—exhibits a definite succession in mental models in 1956. Furthermore, the mental models of the C&NW's leaders continued to change in both incremental and more significant ways throughout the study period. In contrast, the Rock Island's leadership does not experience a succession in its mental model until 1964, a full 8 years after the C&NW shift, a delay that may have been critical to the Rock Island's demise.

*Hypothesis 2.* We found some support for Hypothesis 2, that delays in the succession of mental models are associated with environmental

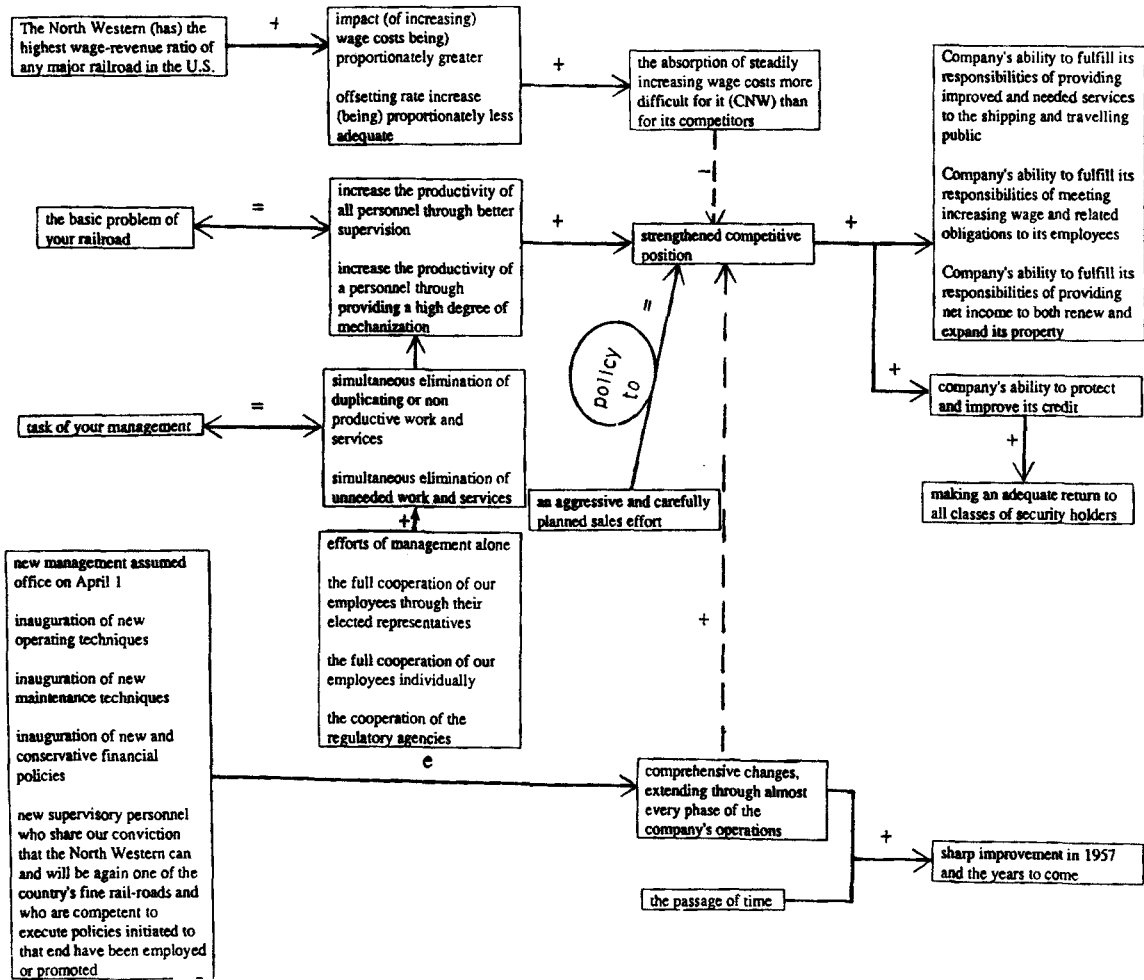


Figure 3. Cause map of the C&NW, 1956

munificence. As Table 1 indicates, the Rock Island did enjoy relatively high performance in the early 1950s due to post-war economic prosperity and a surge in business activity associated with the Korean War. The C&NW, on the other hand, did not experience the same degree of prosperity. Relative prosperity may have accounted for the Rock Island's tendency to view traffic declines as part of a 'temporary economic adjustment which will be of comparatively short duration.' In other words, the firm's relative prosperity may have masked symptoms of decline in the railroad industry that were apparent to other observers, including the leaders of the C&NW. Huff and Schwenk's (1990) study of the oil industry indicates a similar inattention to environmental issues when firm performance deviates from industry averages.

*Hypothesis 3.* We did not find support for Hypothesis 3, that delays in the succession of mental models result from a failure to detect substantial changes in the environment. The maps for both firms indicate that changes in the environment were quickly noticed. The Rock Island's managers see disturbing trends as early as 1950 (eight concepts in the 1950 letter to shareholders are concerned with competition from trucks, airlines, barges, and pipelines), but fail to associate these trends with a larger shift in the environment. Its managers easily reconcile this new competition with their existing mental model that blames declines in freight traffic primarily on external forces over which the managers have little control. In fact, seven of the eight concepts relating to competition are seen as resulting from disadvantageous government

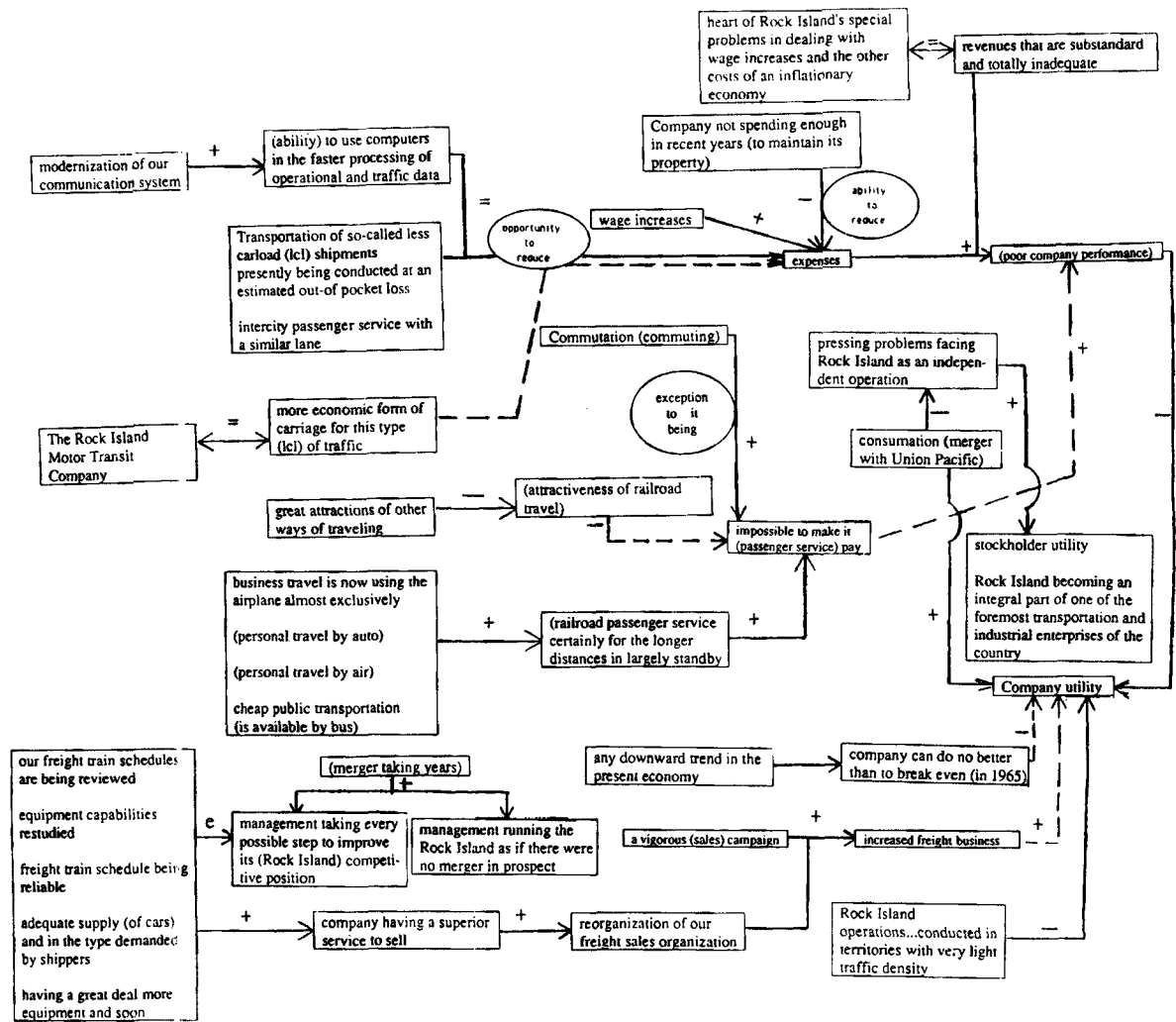


Figure 4. Cause map of the Rock Island, 1964

regulatory activity and not from any internal company weakness. Threats from increased competition begin to disappear from the Rock Island's map in 1954, when leaders of the firm indicate that any traffic declines are part of a 'temporary' phenomenon, and are not seen in the maps during the years 1957 through 1961.

The C&NW's managers, on the other hand, saw declines in traffic as important concepts signaling permanent changes in the environment that would require internal changes. The 1956 letter to shareholders is indicative of this new thinking, noting that 'the C&NW has ... the highest wage-revenue ratio of any major railroad in the United States,' which requires the railroad 'to increase the productivity of all

personnel.' Greater efficiency and lower costs, in turn, are expected to lead to a strengthened competitive position for the C&NW. Nearly all of the coded concepts from the 1957 and 1958 letters to shareholders are related to improving productivity or increasing the railroad's competitiveness.

These results suggest that organizational renewal requires that managers not only notice changes, but that noticing must lead to new understandings and the adoption of appropriate responses. This is a theme to which we will return later.

*Hypothesis 4.* Although many signs of learning can be found in the maps, they are not completely consistent with the literature used to

generate Hypothesis 4. The maps of the C&NW do exhibit definite signs of unlearning and learning. Prior to the major succession of mental models that occurs in 1956, concepts are continually added and deleted from the maps—a sign of the experimentation that is usually associated with the learning process. When the succession of mental models occurs, new plans based on these new causal attributions are instituted. This signals an end to the unlearning and change phases.

The new map, however, does not 'refreeze.' New concepts and connections continue to appear. For example, the C&NW's acquisition of other railroads and a proposal to merge with another railroad are all pursued in an effort to improve the C&NW's average length of haul and other traffic characteristics (changes that are reflected in the size of the C&NW's system and increases in its tonnage as shown in Table 1). In 1961, 5 years after the succession in mental maps began, the company begins to focus on the fact that its business is not only 'highly competitive,' but also 'cyclically sensitive' (6 of 26 concepts).

By contrast, the Rock Island never appears to engage in a process of unlearning, and when change does occur, subsequent maps are immediately refrozen. Little significant change in the map occurs from 1949 to 1964; when the change does occur, it is sudden and complete. In 1964, the focus of the mental model shifts from general economic and industry factors to firm-level factors, with only 10 of 42 concepts concerned with the industry and general economy. A merger with the Union Pacific appears in the model for the first time and is proposed as the only way for the Rock Island to 'remain a viable and independent operation.' From 1964 until the end of the study period the maps continue to focus on the merger. In 1964, 10 of 42 concepts deal directly with the merger. By 1970, the merger is the central focus of the mental model and all concepts deal with either the merger itself or with actions taken to remain solvent until the merger is approved. Interestingly, government action continues as an important concept throughout this period. Government action (and inaction) is described as hindering completion of the merger and thwarting company efforts to remain in business long enough for the merger to be consummated. Overall, the Rock Island's maps

show little or no evidence of experimentation. Managerial thinking appears to move from one 'frozen' state to the next.

## **RENEWAL AS A LEARNING PROCESS**

To summarize, a change in a mental model is definitely associated with strategic renewal for the C&NW, but inattention to changing environmental conditions is not the key distinction between the C&NW's renewal and the Rock Island's decline. Nor does the issue seem to be the time required for a new understanding to take hold as suggested in Hypothesis 4. Instead, the evidence suggests that what distinguishes the C&NW from the Rock Island is whether the learning process occurs at all. The C&NW's unlearning took at least 6 years, and the process of learning does not appear to end during the remaining 19 years of the study period. The Rock Island's managers, in contrast, exhibit no sign of a learning process. Instead, their shift from one mental model to another was immediate.

To further explore the question of how the C&NW managed to renew its strategy, we examined the maps in more detail, focusing exclusively on explanations of performance. Furthermore, to capture the impact of incremental as well as larger shifts in understanding, we explicitly compared changes in each map with maps from 5 years previous.

The results of this analysis show that even in the first 6 years of the study period the maps of the C&NW include many small signs of incremental, low level changes in understanding about firm performance. In 1949, for example, the company offers a quite detailed explanation for their 'great loss in revenue' as shown in Figure 5. By 1954, another year of 'disappointing' results, more general references to a downward trend in the economy occur. Yet poor performance is also more extensively linked to internal factors. Many of these unfavorably compare the company to its competitors. The company also begins to describe ways it could more actively address its poor performance, including application to the government to eliminate unprofitable routes and the wider use of diesel power. All of these factors are causally linked to the C&NW's narrower margins.

As already noted, weather related explanations

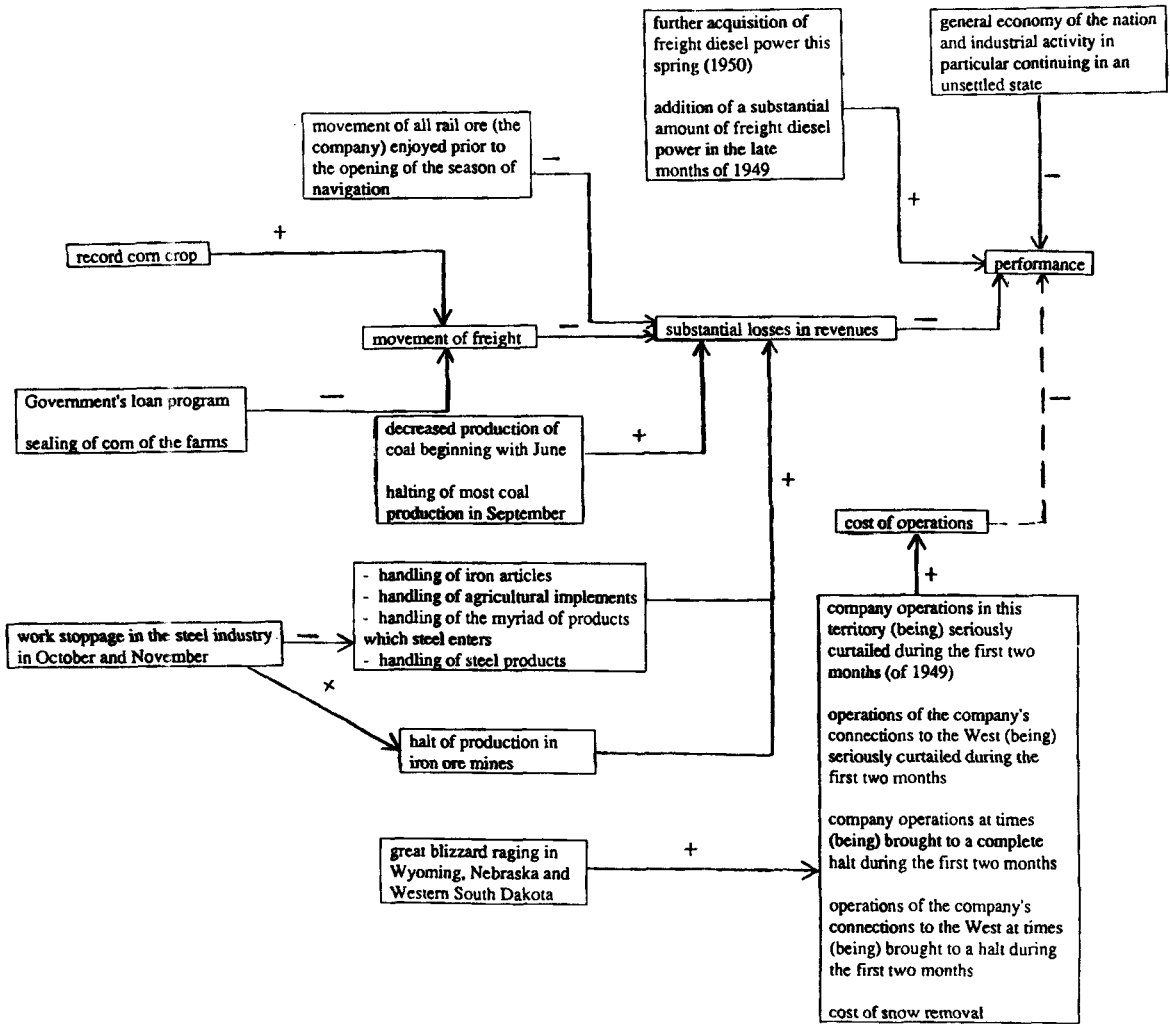


Figure 5. Cause map of the C&NW, 1949

for poor performance which appear in the early years become more generally expressed and are then dropped in later reports as an explanation for performance results. Government programs also begin to decrease in frequency and are no longer linked to overall firm performance. This appears to be an example of the 'unlearning' that is necessary before high level or second order learning can occur.

High level learning occurs as the culmination of this series of incremental changes. In 1956, the C&NW map shifts to reflect even heavier emphasis on firm productivity and firm level cost issues than in previous years and productivity and cost control now are seen as directly affecting firm performance. The 1956 map, which we categorized as showing

a major difference from preceding documents, was shown in Figure 3.

The new concepts in this map (which include 'new operating techniques,' 'new maintenance techniques,' 'new conservative accounting policies,' 'new supervisory personnel,' and 'the passage of time') are well linked to other concepts. The report now ties the fact that 'the C&NW has ... the highest wage-revenue ratio of any major railroad in the United States,' to a new consequence—the necessity that the railroad 'increase the productivity of all personnel.' This, in turn, is expected to lead to a strengthened competitive position for the C&NW (another new concept) which suffers along with the rest of the railroad industry from



receiving a declining share of the total intercity freight revenue due to competition from other modes of transportation (a long established concept).

Another significant change that appears in this document is the recognition that the railroad industry is highly competitive. As a result, managers now believe that rate reductions are needed in order to challenge trucks and barges, which are becoming increasingly competitive. This is a particularly interesting example of change in a mental model. In the C&NW's early maps, *increasing* freight rates is a concept with a positive causal link to firm performance. In the 1958 map, which follows the 1956 shift in understanding about the competitive nature of the industry, the relationship between rates and firm performance reverses. At this time a *decrease* in rates is positively linked to performance. The increasingly competitive nature of the 'transportation industry' (yet another example of an increasingly general concept) is cited as the reason why railroads must be allowed to lower rates. The need to reduce rates, in turn, further increases the need to reduce costs.

Another interesting aspect of the C&NW's strategic renewal is how the definitions of concepts change over time. In 1951, for example, efficiency was defined as increases in load per train. In 1958, following changes in strategic action, efficiency refers to higher productivity and streamlined operations.

A comparison of the 1956 and 1951 maps shows that a major proportion of the 1956 map contains new concepts. In 1951, 50 percent of the concepts concerned weather, government, and the economy. In the 1956 map 73 percent of the concepts deal with productivity, management, firm-level cost issues, and overall firm performance. This change, combined with changes in the definitions of long established concepts, illustrates a shift in thinking that we believe exemplifies strategic renewal. While annual reports may lag actual strategic learning, as discussed previously, it seems highly unlikely that such a major change in the way in which performance is discussed in this public document does not also reflect a major shift in understanding inside the company.

As noted above, revitalization of the mental map can also be linked directly to strategic action. When the mental model of the C&NW's leaders shifts focus in 1956, plans for cost

reduction, increased productivity, and maintenance of way are undertaken to assure a competitive position in the industry. After taking into account the railroad's higher proportion of passenger train miles, management also begins to reduce its activity in this low profit, high cost operation (see Table 1). Overall, the railroad undertakes changes in action designed to make it more efficient and productive.

These changes in strategic action appear to be part of a larger process of experimentation that furthers the learning process. The emphasis on productivity, introduced as a well connected concept in 1956, becomes even more central in subsequent years. Nearly all of the coded concepts from the 1957 and 1958 annual reports aim at improving productivity or increasing competitiveness.

In spite of this emphasis on efficiency, the C&NW's operating ratio remained stubbornly high throughout the 1950s, as shown in Table 1. The failure of the company's programs to reduce the operating ratio may be the reason why new concepts and connections continue to appear in the C&NW maps as actions confirm or discredit beliefs and lead to new strategic action.

The need to cut costs, reduce rates, improve traffic characteristics, and offset the cyclical nature of the business are all concepts that develop over time, prompting new programs to increase productivity. By 1965, these concepts are linked to the company's 'intention to diversify into contracyclical businesses when appropriate opportunities become available,' an intention that led to the acquisition of two chemical companies. Diversification is predicted to have a positive effect on net income in 1966 and the years ahead. The next year 'the objective of the chemical diversification program' (again, a more generalized concept) is described as 'cushioning your company against ... adverse aspects of rail operations.' This focus on 'cushioning' and revenue gains continues until 1968 when 'growth' is identified as a company performance objective. By 1973, however, after a year of poor performance, 'management's objective' is again equated with the more conservative aim of 'making North Western an ever *stronger* company.' An interesting foray into a more aggressive definition of performance was apparently reviewed by managers who chose to retreat to previously established concepts.

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felt, 1984). Less explored by these resource-based researchers is the influence top managers have on the accumulation of assets and resources. Our study suggests that the mental models of firm leaders play a critical role in directing the path of the resource accumulation process, and the link between mental models and patterns of resource acquisition may be a potential addition to the resource-based theory of the firm.

## CONCLUSIONS

Though we have examined organizational responses to a declining environment, we believe that our findings are also applicable to firms operating in rapidly growing industries. In both situations, top managers' mental models must keep pace with a changing environment. Just as declining industry conditions can trap some firms in a downward spiral, a rapidly growing environment can leave some firms behind if their top managers' mental models fail to consider important new areas of opportunity or technological developments. Even in comparatively static environments, firms whose top managers' mental models fail to acquire important new concepts may be severely handicapped over time.

These possibilities for further generalization make us especially enthusiastic about the cognitive theories we have used in this study of organization renewal. All firms need to assume that their actions must fit a changing environment. Classic works in the strategy literature assume the importance of firm leaders in achieving this renewal, but many writers are vague about exactly how firm leaders have an impact on performance. We have suggested that three key managerial activities involve: (1) attention to environmental changes, (2) the interpretation of stimuli, and (3) the matching of perceived problems with solutions. Each of these tasks relies on managerial beliefs about causality.

Our data suggest that the process of developing new beliefs about causality is not easy. Managers who fail to consider changes in their beliefs during periods of major environmental change may set their firms on a course of a protracted, downward spiral. Organizational leaders who can manage these activities may win the battle of organizational renewal.

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