

PUBLIC PERCEPTIONS OF ELECTRIC POWER TRANSMISSION LINES

LITA FURBY,* PAUL SLOVIC,** BARUCH FISCHHOFF and
ROBIN GREGORY**

*Eugene Research Institute, 474 Willamette Street, Suite 310, Eugene, Oregon 97401,
U.S.A.*

Abstract

Electric power transmission lines have recently met a very significant amount of public opposition. The source of such opposition varies from case to case, and is often hard to identify. Stated objections have included land use conflicts, noise created by the lines, aesthetic concerns, and fears of health and safety threats. Despite the sometimes enormous costs and long delays caused by strong opposition to transmission line siting and construction, both utilities and governmental regulators seem baffled at why the public objects so vehemently. At the same time, opponents are often equally baffled at why their objections seem to go unheeded. As a step toward developing satisfactory solutions to the conflict, this article reviews and critiques the literature dealing with attitudes toward electric power transmission lines, and outlines a conceptual framework for understanding the determinants of those attitudes.

The purpose of this article is to review and critique the literature dealing with the formation and expression of attitudes related to the siting and construction of electric power transmission lines, and to develop a conceptual framework that outlines the determinants of those attitudes. Our goal is to provide a useful tool both for understanding public reactions to powerlines in the past, and for improving the powerline siting and construction process in the future.

General Background

Current and future transmission line needs

High-voltage (345 kV and above) electric transmission lines are an increasingly important part of our electrical supply system. Growing demand for electricity and difficulties of developing new electricity sources have augmented the need for transmission capability, which is achieved most efficiently by transmission at very high voltages. One complicating factor in planning such lines is the unpredictability of demand. In particular, recent demand projections have often been too high, leaving utilities open to charges of exaggerating the need for electricity in order to promote their own growth and justify new power generation at the ratepayers' expense. On the other hand, the utilities would also have been open to criticism if there had ever been a shortage of electricity: Americans are unaccustomed to and generally intolerant of interruptions in their power supply. Given the increasing costs and difficulties of siting and constructing new generating sources, one attractive method of assuring sufficient and reliable power is for utilities to share sources.

* To whom request for reprints should be addressed

** Decision Research, 1201 Oak Street, Eugene, Oregon, 97401, U.S.A.

Flexible intraregional and interregional transfer arrangements allow one geographical area to alleviate temporary shortages in another area. Permanent arrangements allow regions with an abundance of power (e.g., the Northwest with its hydropower) to provide electricity to regions with less generating capacity (e.g., Southern California).

Significance of public attitudes toward transmission lines

Transmission lines currently represent a problem area in the electric power system: they require considerable land for their corridors, and the use of that land for transmission lines may conflict with other land use practices or plans; they cause noise; they are perceived as visually unattractive; and they are perceived to cause health problems and safety risks for both animals and humans. As a result, high-voltage transmission lines have recently met a very significant amount of public opposition. Severe conflict was apparent during the 1960s in such states as Ohio, Virginia, Oregon and California (Fricke, 1964; Young, 1973; Mason, 1982). The 1970s saw even more intense opposition with Minnesota (Casper and Wellstone, 1981) and New York (Ray, 1978) being perhaps the most publicized cases, but others included those in Montana and Washington (Mason, 1982), South Dakota (Yankton, 1981), Ontario (Boyer *et al.*, 1978), Arizona and California (Mason, 1982) and Texas (Young, 1978). Opposition to transmission line siting and construction has sometimes caused enormous costs to the utilities, through long delays in gaining regulatory approval, litigation fees, and occasionally even vandalism. Such confrontations suggest that something about the decision-making process regarding siting and construction may not adequately address the public's concerns. In order to develop satisfactory solutions to this conflict, it is important to understand public attitudes toward transmission lines better.

Conceptual Framework

Overview

In our review of the literature we identified a set of key elements that appear to be important determinants of attitudes related to the siting and construction of transmission lines. Figure 1 presents these elements and a suggested scheme for conceptualizing the role each plays in determining the attitude formation process. Figure 1 is meant to be more of an organizing schema than a model of attitude formation and behavior. We are far from the level of understanding needed for precise modeling.

Some of these elements are fairly direct effects of the lines: property value effects, aesthetics, human health and safety effects, environmental effects, and economic benefits. Others are largely management-related issues: equity effects, process characteristics, and (to some extent) information and knowledge. For elements in each of these categories, people's perception of the element, along with their values associated with it, can play a role in determining their attitudes toward a powerline. Still other elements do not fall into either of these categories but instead overlay the entire framework: symbolic meaning, amount of information and knowledge, and conflict dynamics.

In the following sections, we review the literature pertaining to each of these key elements. Following the literature review, we discuss the most profitable directions of future research.

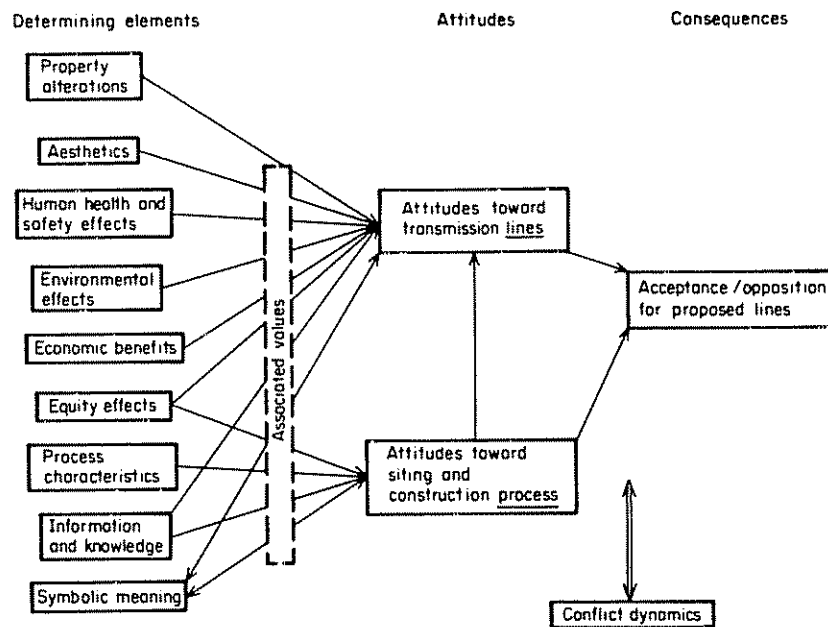


FIGURE 1 Conceptual framework

Historical perspective

Attitudes toward powerline rights-of-way and easements, particularly in rural areas, can be fully understood only if we examine the economics involved from an historical perspective.

The years from 1920 to 1930, when the rights of way for many of our cross-country transmission lines were purchased, was a period of low land values and depressed grain markets. Many farmers were in debt and had heavy mortgages. They were glad when an opportunity arose to sell rights of way for cash and gave little thought to the depreciation or severance damage resulting from such easements. Today [1955] the picture is entirely different and one in which we can hardly recognize the farmer we saw in the twenties. He is much more of a businessman and certainly under much less financial pressure. He has been subsidized by the government with high prices assured for his grain. After years of prosperity he is no longer in debt. Land values have increased, more intense use is made of the land, and he no longer wants the power line on his property (Crawford, 1955, p. 37).

Consistent with this analysis, public opposition to powerlines began to grow during the 1950s, with subsequent attitudinal changes paralleling economic changes. Presently, debt is a way of life for most farmers. However, unlike the 1920s and 1930s, private land is now in shorter supply and land values are much higher. Farmers are perhaps less willing to accept minimal compensation for selling easements because they need the money and want as much compensation as possible for encroachments on their land. Some of the most vociferous opposition has come from small farmers who see utility easements as symbolic of their more general economic plight and loss of control in the face of large institutions (such as big absentee-owner farms). One dramatic symptom of this historical turnaround is the fact that some of the same individuals who organized rural electric cooperatives and electrification in the 1930s

were among the most vehement opponents of high-voltage transmission line construction in Minnesota in the 1970s (Casper and Wellstone, 1981).

A similar relation between economic conditions and farmer attitudes toward powerlines seems to have occurred in Canada. During the late 1940s and early 1950s, there was a shortage of power in southern Ontario due to an expanding economy (and low rainfall which restricted hydro-electricity). Power was even shut off for short periods on a daily basis. These conditions increased the pressure for more electricity, and may have created positive public attitudes toward powerlines. Now, attitudes appear to be more negative, perhaps because the economy is less growth-oriented and power is readily available (Mitchell *et al.*, 1976).

Residential landowners went through an historical pattern similar to that of farmers. As long as suburban or rural residents lacked electricity, they were probably eager to obtain the convenience of electric service, and viewed the arrival of transmission lines as a distinct benefit. However, once electricity was widespread and a new generation grew up with it as a given, the positive symbolism of transmission lines seems to have declined. Concurrently, the value attached to an unpolluted environment has increased. Opponents of powerlines have expressed this change themselves:

There has been a very great shift in people's attitudes toward progress. People are a lot more concerned now about their air and their water and farmers about their land. . . . And to build a big powerline in the name of progress I think is old-fashioned (Casper and Wellstone, 1981)

The greater willingness of younger people than of older people to pay extra for pollution-free energy (Survey Research Laboratory, 1977) undoubtedly reflects this historical change (rather than simply an age difference) in attitudes.

Description and Discussion of Key Elements

Property value effects

Elsewhere we have reviewed evidence relating to the effect of transmission lines on property values (Furby *et al.*, in press). Here, we describe people's *perceptions* of that effect, since those perceptions are likely to shape their attitudes toward transmission lines.

In a frequently cited study, Kinnard (1967) reported a survey conducted in Connecticut in the mid-1960s. A questionnaire was mailed to 838 homeowners who had bought property in subdivisions which were either intersected or abutted by a high-voltage powerline right-of-way. Of these, 46% responded with a completed questionnaire. Of the 80% of respondents who indicated that they were aware that there was an electric powerline right-of-way in the vicinity when they made their purchase, 76% said that its presence did not affect their decision to buy or the price they paid. From this, Kinnard concluded that 'only a minority' of purchase decisions are affected by a powerline right-of-way. However, the low rate of questionnaires returned renders any such conclusions quite tentative. Although a 46% response rate is good as surveys go, all that can be said from this study is that 28% (i.e., 76% of 80% of 46%) of all of the homeowners within these subdivisions affected by a right-of-way said that it did not affect their purchase decision. That leaves 72% who either said it did affect their decision, who were unaware of it, or who did not

answer the questionnaire. Moreover, the sample does not include people who decided not to buy in the area because of the powerline.

In the same study, Kinnard also surveyed assessors, appraisers, builders, lenders, and realtors in the area, but again the response rate was too low for all of the groups (ranging from 25–54%) to permit any general conclusions. Of those who responded, however, a substantial majority felt that transmission line rights-of-way reduced the value of property that they intersected. For example, 71–79% of appraisers felt there would be a negative impact (the exact value depends on whether the property is a vacant or improved lot). For realtors the figures are 87–90%; for lenders, 63–76%; for builders, 62–70%. For properties abutted (rather than intersected) by a line, a smaller number, but still a majority in each group, thought that property values are negatively affected. The intersected vs. abutted distinction was smallest with realtors. Kinnard noted that both realtors and appraisers 'were particularly negative in their reactions toward the saleability or marketability of both acreage and developed residential properties either intersected or abutted by powerline rights of way' (p. 279).

Much anecdotal testimony by appraisers in the literature contradicts Kinnard's survey results (Furby *et al.*, in press). It is hard to know whether this discrepancy reflects non-response bias in Kinnard's study (with appraisers who believe that transmission lines do not affect property values being less likely to complete the questionnaire) or, alternatively, a self-selection bias in appraisers who choose to speak publicly or write about the issue.

However accurate Kinnard's conclusions are, they remind us that the perceptions of professional appraisers are of interest not only in their own right but also for their effect on other people's perceptions. Their opinions are likely to 'translate themselves into advice to potential buyers or sellers, and/or judgments about the market value of such properties' (p. 279). It is, therefore, unfortunate that there is so little systematic empirical evidence regarding appraisers' and realtors' perceptions of transmission line effects on property values, and that the existing studies are so dated.

About a decade after Kinnard's study, Mitchell *et al.* (1976) compared residents along a 230 kV line corridor in Ontario with a control group of property owners living along a parallel corridor one mile away. Both groups were asked about the line's effect on the value of the corridor residents' property. In each group, 25 people were sampled, of whom only 16 (64%) were actually interviewed for the survey (the others were not home, refused, etc.). Five of the 16 residents (31%) felt that their property's value had decreased, whereas 15 of 16 in the control group (94%) felt that the property of those living near the line had decreased in value. The very small sample size and the low response rate render these results difficult to interpret. If the group difference is real, it could mean that the non-residents are ill-informed and/or that residents are denying the effect that the non-residents perceive.

A second survey conducted two years later by the same group (Boyer *et al.*, 1978) compared residents near both a 500 kV and a 230 kV line with control groups living one mile from the transmission line corridors. Of the 25% of residents who agreed to fill out the questionnaire, approximately 70% actually returned it, resulting in 108 completed questionnaires spread relatively evenly across the four groups. In the two resident groups combined, 44% of those who had bought their property

after the transmission line was constructed reported that its presence was a consideration or a strong consideration in their decision; 69% said they felt the line affected the value of their property. In the control group, 78% said that the presence of a transmission line would be a consideration in their decision to buy land. Only 43% of the control group believed that the existing line affected the value of the property adjacent to it (but 45% said they didn't know, meaning that 79% of those with an opinion felt that it affected property values). As before, non-response bias blurs the meaning of these results. Even the most liberal assumptions leave a possible range of 31–62% for whom the transmission line was a consideration when purchasing property (leaving unspecified whether the line was considered to be positive or negative).

Given the relatively limited number of studies directly addressing property value perceptions, and their rather severe methodological shortcomings, the empirical basis for understanding this issue is still very weak.

Aesthetics

The perceived physical change to the landscape is generally referred to as the 'visual impact' of transmission lines. That impact is assumed to be negative, diminishing the attractiveness of the visual landscape. Several types of empirical studies have examined the visual impact of transmission lines.

The two University of Waterloo studies described above (Mitchell *et al.*, 1976; Boyer *et al.*, 1978) included a general question about aesthetics, 'Does the appearance of the transmission line bother you?' The 1976 study found two 'yes' responses (14%) among 16 respondents. In the 1978 study, with 54 respondents, 36% objected to the appearance. About the same percentage (37%) of the control group in that study also reported that the appearance of the line bothered them (even though they did not live right next to it). Forty-eight percent of residents living next to it and 58% of those in the control group reported the line to be a prominent or very prominent landscape feature. As already mentioned, these results are subject to non-response problems.

By far the most extensive survey of people's attitudes toward the visual impact of transmission lines was conducted in 1972 by Response Analysis Corporation (see also Pohlman, 1973). Their nationwide interview study included 1962 individuals chosen to be representative of the U.S. population of adults 18 years and older. Unfortunately, their report does not indicate what response rate they achieved, making non-response bias difficult to assess. However, their sample was quite similar to the U.S. population of adults in terms of age, gender, education, and region of residence. When asked to indicate the two or three most unattractive things in their neighborhoods from a list of 14 items, 12% of the respondents cited high-voltage transmission structures, which ranked eighth behind such items as litter and trash (mentioned by 70%), poorly paved streets (49%), junkyards (48%), and telephone and electric utility poles (13%). Given that only 30% of the respondents indicated having high-voltage transmission structures in their immediate area (the percentage actually living near lines was unknown), 40% of those aware of high-voltage lines nearby considered them to be among the two or three most unattractive things about their area. This study also reported that (a) the identification of transmission structures as unattractive was most common among urban residents, followed by suburban residents, and then rural residents; (b) people with high-voltage structures

in their area were more likely to consider them generally unattractive than those who did not have them nearby, and (c) steel poles were preferred to other designs by a clear majority (67%).

A number of recent studies of the visual impact of transmission lines can be found in the literature on visual analysis and resource management (Priestley, 1983a). The most common research method involves showing respondents slides of transmission lines placed in a variety of landscapes and asking them to evaluate the visual compatibility of the lines, i.e., the degree to which the lines fit in or blend with the landscape, independent of the landscape zone's visual quality. Jones and Jones (1976) used this method with citizen groups in Idaho and Montana having different orientations toward the environment including a grange, wilderness association, Rotary Club, Lions Club, historical society, and mining association. The samples were relatively small (6-38 per group) and cannot be considered representative in any statistical sense. Nevertheless, the results indicated that there is considerable agreement across groups regarding relative compatibility of various scenes that include transmission lines, suggesting that individuals use the same visual features to judge compatibility regardless of their attitudes about land use and development. The groups differed in their mean ratings of compatibility, with the 'environmental/conservation' groups giving the lowest ratings, the 'intensive land-use, groups giving the highest ratings, and the 'general business' groups falling in between. Jones and Jones interpret these differences as reflecting *attitudinal* differences in these groups' degree of acceptance of transmission facilities.

Using a slightly different approach, Brush and Palmer (1979) had a group of 30 landscape architects and planners evaluate 124 photographs representing various combinations of landforms and land use types resulting from urbanization in the Connecticut River Valley. Each respondent performed a Q-sort, sorting the photographs into seven piles from lowest to highest scenic quality. Scores were assigned from 1 to 7, and then each photograph's score was obtained by averaging across all respondents. Multiple regression analyses showed that the number of utility poles had the greatest negative effect on the rated scenic quality of seven regional landscape classes (farms, forested hills, meadows, open water, wetlands and streams, towns, and industry). There were only two other variables with significant negative effects: length of utility wires and amount of barren ground in the far distance.

A similar study by Jackson, Hudman and England (1978) asked 1500 individuals to indicate their relative preference for 72 different scenes, a number of which included transmission lines of varying types and locations. Factor analytic results suggested that the salience of powerlines accounted for about 15% of the preference rankings, making it the second most important determinant of scenic evaluations (the first factor consisted of the degree to which human structures dominated the scene).

Another potential but apparently neglected source of information on attitudes toward the aesthetics of transmission lines is how much it is worth to people to put the lines underground. We have been unable to locate any systematic empirical studies on this topic. A related source is the judgments of aesthetics experts, including artists, who have sometimes been called upon to testify in legal proceedings designed to determine whether the costs of undergrounding are warranted by the gains in scenic beauty (e.g., Gussow, 1977). For the past several decades, decisions regarding aesthetics in design and siting have relied principally on landscape architects' professional judgments (e.g., Crowe, 1958; Johnson, Johnson and Roy, 1970). However,

the assumptions underlying these professional judgments have never been empirically validated.

It is clear from this review that most of these studies have found negative aesthetic effects of transmission lines in various settings, but they have rarely examined the role of specific structural and design characteristics of a line in determining people's reactions to it.

Environmental concerns

In discussing the determinants of attitudes toward transmission easements, we emphasized the importance of an historical perspective in order to fully understand current public concerns and opinions. The role of environmental quality issues must likewise be examined in historical context. By 1970, the public's attitude toward the environment had clearly changed. 'They resent the land being unnecessarily disturbed, whereas a few years ago no one cared . . . They now sometimes get violent when trees are cut down' (D. L. Sweet [the director of AT&T's right-of-way activities in five midwestern states], 1970, p. 39). This shift in attitudes toward the environment reflects a more general change, with the importance of efficiency and productivity decreasing and that of aesthetics, pollution, health, and safety increasing (Katz, 1971). The National Environmental Policy Act institutionalized this change by requiring that non-economic impacts be considered in decisions affecting the environment.

The following two subsections focus on studies of the role of environmental concerns in determining people's attitudes toward transmission lines. Our objective is not to review the literature on environmental effects or health effects *per se* (see BPA, 1982; Morgan *et al.*, 1983), but rather to examine people's perception of those effects and their resulting attitudes toward transmission lines.

Noise

High-voltage transmission lines produce a noise due to corona, which is a random high-energy discharge from the conductor. Its nature and magnitude vary depending upon weather conditions and type of current (AC or DC). Its aversiveness to the human ear is just beginning to be studied.

In a very small survey, Busby *et al.* (1974) interviewed 18 farmers along 765 kV lines in Ohio. Although never asked specifically about noise, five of the 18 mentioned it in the course of the interview. In a larger study, Fidell *et al.* (1978) asked 270 people living adjacent to 230 kV and 500 kV transmission lines to evaluate the noise created. Interpretation of their data is complicated by their failure to report the response rate. Of those who agreed to be interviewed, 42% reported hearing noise from the transmission lines. However, only 2% spontaneously mentioned powerlines or transformers as a source of noise annoyance. Measurements of noise levels at the interview site revealed about ten percent more people being annoyed than would be expected from previous studies on the general relationship between noise level and annoyance. Other studies (e.g., MacLaren, 1981) have noted the unique qualities of corona noise and the need for further research on how people experience it in the vicinity of transmission lines.

Biological effects

Another major environmental concern is the effect of transmission lines on plants and animals. Concern over interference with birds' migratory paths was recently a

significant source of opposition to a 500kV line in southern Oregon (Envirosphere, 1983). Potential electrical field effects on other animals (such as dairy cows) have been of concern as well, and are likely to take on increasing significance as human health effects become a more prominent issue (see below).

A 1980 survey in Minnesota (Genereux and Genereux, 1980) studied landowners' perceptions of the animal and human health effects associated with a ± 400 dc kV line that crossed their properties and had created enormous controversy during the 1970s (Casper and Wellstone, 1981). After a mailed questionnaire produced a return rate of only 19% (from a total of 115), it was supplemented by phone administration to another 233 persons and by results from a similar questionnaire administered by a state representative. The transmission line protest group (GASP) produced another 56 completed questionnaires. Combining these data raises obvious methodological problems. Furthermore, sampling procedures were questionable, as evidenced, for example, by the fact that 37% of the respondents did not even live on the land they owned that was crossed by the powerline. Twenty-nine percent of the respondents said their livestock appeared to suffer adverse effects which they attributed to the powerline (another 26% said they didn't know whether their livestock had suffered such effects). The most frequently reported symptoms were breeding problems, aborted or deformed offspring, stress or nervousness, and changes in milk production. Twenty-two percent of respondents said they had noticed unusual behavior in their animals (nervousness, restlessness, ill temper). Thirty-one percent said they believed that the powerline had affected nearby wildlife.

While there remains great uncertainty as to the effects of electric and magnetic fields on animals, it is a topic that is receiving increasing attention in the media (e.g., Squires, 1985) and as such we might expect greater public concern about it in the future.

Human health and safety issues

In the 1978 University of Waterloo survey (Boyer *et al.*, 1978), 35% of those living along a line were aware of controversy over possible health effects, while 32% of the control group (living a mile away) said they were aware. Fifty-nine percent of the on-line group said they were concerned or very concerned about health effects (apparently some people are concerned even though they aren't aware of any controversy). Genereux and Genereux (1980) found that 35% of all landowners whose land was crossed by a DC transmission line (and 48% of those actually living on that land) reported suffering adverse health effects that they attributed to the powerline. The most frequently reported symptoms were headaches, respiratory problems, fatigue, and stress. As mentioned above, serious sampling and data collection difficulties make it unwise to draw any general conclusions from either of these studies.

An interesting secondary analysis of the Genereux and Genereux study (Gatchel, Baum and Baum, 1981) discusses whether the symptoms reported can be attributed to stress (resulting from opposition to the line, worry over the health effects, etc.) rather than to electrical effects *per se*. Evidence for analogous stress effects has been found with residents in the Three Mile Island area (Baum *et al.*, 1981). Gatchel *et al.*, concluded that the type and frequency of symptoms might indeed be due to stress. This possibility makes the study of *perceived* health effects especially important. Not only do such perceptions shape attitudes toward transmission lines, but they may actually produce their own health effects.

Perceptions may also shape jury decisions. A dramatic demonstration of the importance of perceived health risks is the 1985 ruling by a Texas jury ordering Houston Lighting and Power Company to pay more than \$25 million in punitive damages to a local school district for 'reckless disregard' of children's health in siting a 345 kV transmission line on school property ('Cancer Risk,' 1985). The jury also ruled that if the utility did not remove the powerline, it would have to pay the costs of relocating the school buildings on the property (estimated at \$64 million).

In contrast to Genereux and Genereux, who asked people what symptoms they attributed to the transmission line, Nolfi and Haupt (1982) surveyed health effects along a ± 400 DC kV line in California without mentioning the line. They interviewed 128 households, representing a response rate of 62%. These households included 438 individuals, 245 of whom were within 0.14 miles of (but not always directly adjacent to) the transmission line ('powerline group') and 193 of whom were 0.65–0.85 miles from it ('control group'). People were asked how many days during the previous two weeks they had experienced nine specific symptoms. None of the symptoms studied was reported more frequently by the powerline group than by the controls, leading the authors to deny any relationship between proximity and health problems. However, they did find a statistically significant relation between two symptoms (sore or dry throat, and stuffy nose or respiratory congestion) and whether or not one lives directly adjacent to the line (but they dismiss this as being questionable because of the small frequencies involved). The authors themselves point out that their sample was too small to draw conclusions about infrequent health effects, and that some potential symptoms (e.g., miscarriages, cancer) were just not mentioned. Furthermore, the transmission line was not operating for most of the two-week period to which the symptom frequency questions referred (Banks, 1984).

As long as the health effects of powerlines remain ambiguous, people will undoubtedly be tempted to see powerlines as a source of health problems.

Psychometric analyses

One broad strategy for studying the perception of health and safety is to develop a taxonomy for hazards that can be used to understand and predict responses to their risks. A taxonomic scheme might explain, for example, people's extreme aversion to some hazards, their indifference to others, and the discrepancies between these reactions and experts' opinions. The most common approach to this goal has employed the *psychometric paradigm* (Fischhoff *et al.*, 1978; Slovic *et al.*, 1984, 1985) which uses psychophysical scaling and multivariate analysis techniques to produce quantitative representations of hazards and people's perceptions of them. In the psychometric approach, people make quantitative judgments about the current and desired riskiness of diverse hazards and the desired level of regulation of each. These judgments are then related to other judgments about the hazard's status on various characteristics that have been hypothesized to account for risk perceptions and attitudes (e.g., voluntariness, dread, knowledge, controllability, catastrophic potential, threat to future generations, etc.).

Many of the risk characteristics are highly correlated with each other, across a wide domain of hazards. For example, voluntary hazards tend also to be controllable and well known. Analyses of these interrelationships suggest that the broader domain of characteristics can be condensed to two or three higher-order characteristics or factors. Figure 2 illustrates the factors that emerged from one study of 81

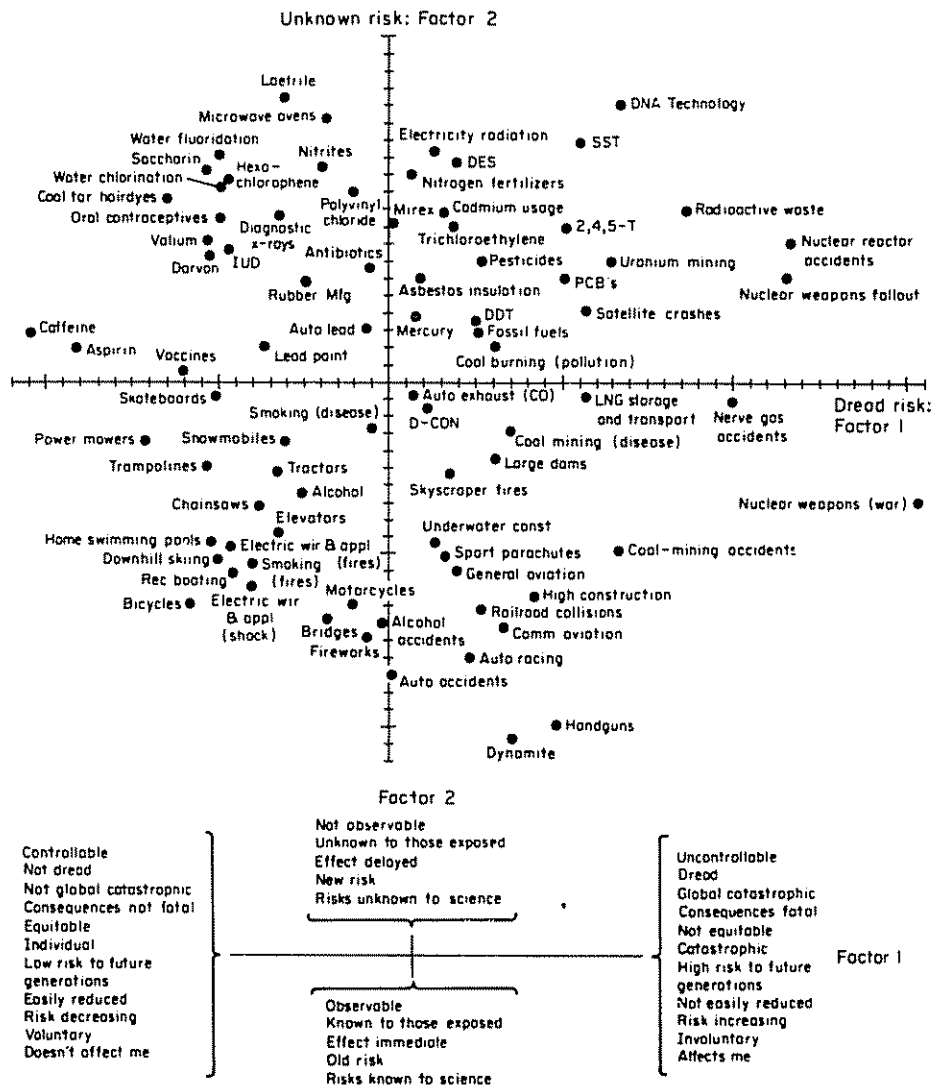


FIGURE 2. Hazard locations on Factors 1 and 2 derived from the interrelationships among 18 risk characteristics. Each factor is made up of a combination of characteristics, as indicated by the lower diagram (Source: Slovic *et al.*, 1985)

hazards, each rated by college students on 18 risk characteristics. Two main factors were obtained. Hazards located at the high end of the vertical factor (e.g., DNA technology, various chemicals) tended to produce risks that were judged new, unknown, and delayed in effect. Hazards at the other extreme of this factor (e.g., dynamite, automobile accidents) had the opposite characteristics. High scoring hazards on the horizontal factor (e.g., nuclear reactor accidents, nuclear weapons effects) were associated with risks that were judged to be uncontrollable, dreaded, catastrophic, fatal, and inequitable. Hazards low on this factor (e.g., caffeine, power mowers, skateboards) were seen as causing injuries rather than fatalities, to single individuals. We have labelled the vertical factor as *Unknown Risk* and the horizontal factor as *Dread Risk*. This factor structure has been found to be similar across

groups of laypersons and experts judging large and diverse sets of hazards.

Research has shown that lay people's risk perceptions and attitudes are closely related to the position of a hazard within the factor space (Slovic *et al.*, 1982). Most important is the factor 'Dread Risk': the higher a hazard's score on this factor (i.e., the further to the right it is in the factor space), the higher its perceived risk, the more people want to see its current risks reduced, and the more they want to see strict regulation employed to achieve the desired reduction in risk. In addition, the informativeness or 'signal potential' of an accident or mishap, which appears to be a key determiner of its perceived seriousness, is systematically related to both Dread Risk and Unknown Risk factors (Slovic *et al.*, 1984). As a result, mishaps associated with hazards located in the upper-right quadrant of the space are likely to receive extensive media coverage and to produce 'ripple effects' that are very costly to the agency or industries responsible for their management.

A psychometric study by Slovic *et al.* (1985) included 'electricity radiation from high-voltage transmission lines among a set of 81 hazards judged by a group of college students. As shown in Figure 2, this hazard was judged to be high on the Unknown Risk factor and a little above average on the Dread Risk factor. The upper-right quadrant of the factor space, where this hazard fell, is generally populated by hazards for which public concerns are high and acceptance is a volatile matter. The results of this study are at best suggestive, due to the non-representative nature of the sample. Furthermore, the (inappropriate) use of the term 'radiation' in describing the hazard from high-voltage transmission lines may have enhanced people's concerns.

A more elaborate psychometric study, focusing specifically on 50/60 Hz electric and magnetic fields was conducted by Morgan *et al.* (1985). The participants in this study were 116 alumni of Carnegie-Mellon University, many of them engineers. They were asked to evaluate the potential hazards from 50/60 Hz fields produced by high-voltage transmission lines and by electric blankets. They also evaluated the hazards associated with 14 other substances and technologies. The sixteen hazards were rated on nine risk characteristics used in studies by Slovic *et al.* (1985). Additional questions were asked about the significance of the risk posed by each potential hazard and the adequacy of existing measures for controlling such risks.

The results showed that these individuals viewed exposure to electric and magnetic fields from large transmission lines and from electric blankets as among the least risky of the 16 known and potential hazards they considered. Forty-eight percent judged electric blankets as least risky of the hazards and 19% judged transmission lines as least risky.

On the basis of the ratings for transmission lines on the nine risk characteristics, the similarity between this potential hazard and hazards investigated in other studies could be assessed. Hazards that appear to be most similar in character to transmission lines in two such studies (labelled A and B) are shown in Table 1. The similar hazards from Study A (e.g., space exploration and non-nuclear electric power) are not ones whose risks are particularly controversial. However the similar hazards from Study B are mostly chemicals, which are a source of much concern these days.

Factor analysis of the risk ratings produced a space (Figure 3) similar to that of previous studies (see, e.g., Figure 2). Electric and magnetic fields from large power-lines again appeared in the high unknown, high dread portion of the space. The risks from electric blankets were judged relatively unknown but much less dreaded.

TABLE I
Ten hazards in studies conducted by Slovic *et al.* (1985) most similar to transmission line fields

Study A		Study B	
Hazard	'Distance'	Hazard	'Distance'
Earth orbiting satellite	1.75	Nitrogen fertilizers	1.35
Space exploration	2.24	Polyvinyl chloride	1.68
Solar electric power	2.94	High tension lines	1.87
Non-nuclear electric power	3.07	Cadmium usage	2.01
Fossil electric power	3.12	Airborne lead from autos	2.21
Food coloring	3.17	Chlorination of drinking water	2.30
Hydroelectric power	3.18	Trichlorethylene	2.45
Food irradiation	3.22	Nitrites	2.46
Food preservatives	3.25	Mercury	2.47
Water fluoridation	3.29	Mirex (insecticide)	2.49

Source: Morgan *et al.* (1985).

Note: The distance measure was $\sum_{i=1}^9 d_i^2$ where i is the index running over the nine risk

characteristics and d_i is the difference between ratings for the i^{th} characteristic. The smaller the difference, the greater the similarity. There were 90 hazards in Study A; 81 hazards in Study B.

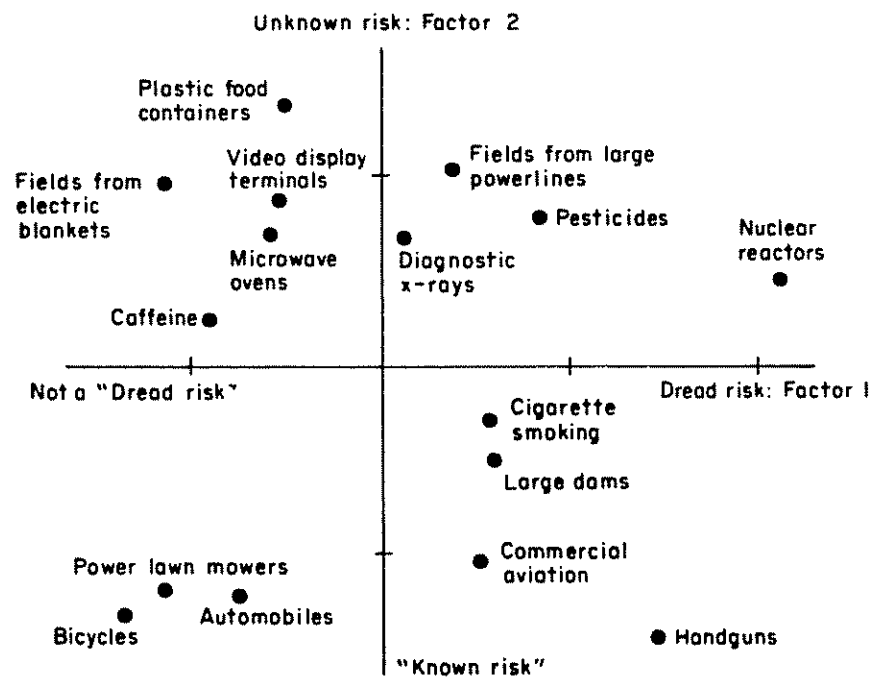


FIGURE 3 Result of the factor solution for the sixteen known or potential hazards addressed in the study by Morgan *et al.*, 1985.

The location of large powerlines in the factor space allows an informed conjecture about how well-educated people are likely to respond to these potential hazards. It suggests that such people are likely to want significant, but not severe, regulatory control of transmission lines. Should 'events' occur that imply health problems due to transmission lines, they will likely be seen as having high 'signal value', which would produce considerable media publicity and a great deal of concern. It would obviously be useful to have similar information for segments of the population other than graduates of Carnegie-Mellon University.

Economic benefits

The elements we have considered thus far generally contribute to a *negative* attitude toward transmission lines, but it must not be forgotten that various benefits obtained from electricity tend to have the opposite effect. As discussed in the Historical Perspective section, the comfort and convenience that electrification brings to our lives, and the economic efficiency it provides to business and industry, can be powerful determinants of attitudes toward powerlines. These benefits can easily be overlooked in a society that has become so accustomed to uninterrupted and unlimited electricity everywhere that many people fail to realize that alternatives to transmission lines included brownouts, blackouts, and other disturbing scenarios. Changes in the salience of electricity benefits (e.g., historically, or after a major blackout) might be expected to have quite significant effects on attitudes toward transmission lines. However, there have been no empirical studies as yet that address this issue.

Equity issues

Transmission lines are just one example of a number of development projects that are frequently objectionable to those living near them. Popper (1981) has dubbed such projects Locally Unwanted Land Uses or LULUs (which include airports, highways, nuclear power plants, strip mines, prisons and military installations). LULUs usually offer benefits to some locality or region other than the one suffering the costs. It is this inequitable apportionment of costs and benefits that often triggers public dissatisfaction and conflict, especially among those who feel they are suffering a disproportionate share of the costs.

Equity and fairness are increasingly common issues in discussions of many public policy decisions including those dealing with power generation and transmission. Individual landowners and even whole communities sometimes feel unfairly imposed upon, forced to involuntarily shoulder the burden of providing benefits to others (usually urban populations). A Minnesota farmer put it this way: 'Why do you have to avoid towns? ... Why not put it [the transmission line] right over all the towns. They're the ones that are getting the benefits' (Casper and Wellstone, 1981, p. 71).

There is, of course, no perfect solution to the inequity problems. It may be necessary sometimes for a few individuals to sacrifice more than their fair share for the common good. Furthermore, judgments about fairness have multiple determinants which are only partially understood (Furby, 1986). In any case, the perception of unfairness can be a source of divisiveness and social disruption. Methods of minimizing the degree to which people feel unfairly imposed upon are therefore of interest. One such method is to use decision-making procedures in the siting process that are perceived to be fair (see later section on Process Characteristics), as the

outcomes of those procedures are then more likely to seem fair as well (Tyler, 1984).

Another method for reducing the ill-will engendered by the perceived inequities that sometimes result when siting and constructing transmission lines might be simply to increase monetary compensation offered to the landowners. It may well be that the prevalent practice of limiting compensation amounts to the 'market value' of the affected property (see Furby, *et al.*, in press) leaves most owners feeling unfairly used by the rest of society, as they usually are not wanting to sell their property when it is taken. A larger monetary compensation might reduce the feeling that they have suffered a net loss and thus made an unfair sacrifice, while at the same time costing the beneficiaries (i.e., ratepayers) relatively little. In addition, monetary compensation could be considered for those who do not own land used by the line but who nevertheless are affected by its presence.

We have found no empirical tests of the degree to which compensation rates affect perceived inequities. However, at least one utility (Ontario Hydro) has assumed the effect to be important, as evidenced in their doubling the compensation rate (from \$5 to \$10 per pole in a field) in the face of dissatisfied landowners in the early 1950s. An excellent recent discussion of the strengths and weaknesses of compensation in the context of siting locally unwanted facilities is provided by O'Hare *et al.* (1983). These investigators argue strongly for the value of compensation in promoting community acceptance of such facilities. Their discussion of five case studies of siting problems provides a valuable start towards understanding the conditions necessary for compensation to be effective in achieving public acceptance of a facility.

Symbolic meaning

A salient determinant of opposition to lines seems to be their symbolic interpretation as an invasion of one's home territory. In his analysis of the Minnesota conflict, Priestley (1983b) points out that

What the protesters seemed to be most concerned about was not the powerline's tangible effects, but its symbolic effects as an intrusion into their turf. The most obvious themes in the public statements of those active in the powerline protest concerned their strong sense of identification with the land, and their sense that the powerlines would constitute both a real and a symbolic violation (p. 14).

As one Minnesota farmer put it, 'If you'd've told me I'd be fighting the state like this, I'd've said, "You're nuts!" But we've been invaded!' (Wasserman, 1979, p. 39).

The attachment to one's personal property can be the product of a number of factors. Interviews with farmers protesting the Minnesota line suggested that ancestral ties, commitment to working on the land, and the hard work associated with the land all played a role (Casper and Wellston, 1981; Priestley, 1983b). In addition, property itself is often both a symbol and a means of exerting control and power in one's life (Furby, 1978). The Minnesota farmers had already felt the squeeze of the large corporate farms. The intrusion of the transmission line exacerbated their increasing sense of a loss of power and control. As one farmer put it, 'The powerline represents control, something else in control of our lives . . . We have been feeling this control over our lives coming' (Casper and Wellstone, 1981, p. 303-304).

The presence of transmission lines can also constitute a continual reminder of all the other issues surrounding their construction. This aspect was also articulated by the

Minnesota farmers: '... every time I see the towers, every time I walk in the fields, it kind of brings back all the memories of fighting the thing, and in a way every time I see it, I feel more bitter' (Casper and Wellstone, 1981, p. 120). In this respect, the physical presence of the line becomes a source of continual stress because of its symbolic meaning. As the Gatchel *et al.* (1981) study concluded, some of the health effects reported by people living near the completed line may well be due to such stress.

Information and knowledge

Naturally, what people know about a particular issue affects their attitudes (McGuire, 1969). Two aspects of such knowledge are of particular interest for attitudes toward transmission lines. One is exposure to current-event information about transmission lines, such as regularly appears in the press (e.g., utilities' plans for new installations, reports of public opposition to controversial lines). The second is exposure to scientific information about such issues as the economics of alternative types of installations, or the biological and health effects of powerlines. Empirical studies specifically linking the amount of exposure to such knowledge and attitudes toward transmission lines are, however, few in number.

The public's knowledge of electric power planning and operations was examined to some extent in the Response Analysis Corporation's (1972) nationwide survey. It reported that 63% of the adults surveyed felt that either none or only a few additional lines would be needed in the next ten years (another 23% said that they didn't know how many lines would be needed). This was at a time when the industry experts were forecasting large increases in transmission line mileage. Half of those surveyed didn't know if there was state or local control over the type of high-voltage transmission structures that are put up in their community. These results clearly suggest a lack of general information about transmission lines. Studies of how individual landowners deal with the utilities during the planning and construction of a line also have found that people are generally very poorly informed about the regulatory process with regard to transmission lines (Young, 1973; Casper and Wellstone, 1981; Gale, 1982).

A study by Tichenor *et al.* (1980) reported that high levels of knowledge about a controversial transmission line in Minnesota did not necessarily accompany a particular attitude, suggesting that raising knowledge level per se might not be expected to have a predictable effect on attitudes. However, at least one case of a utility's deliberately attempting to increase public knowledge about a proposed transmission line suggests that such an effort may reduce negative reaction and opposition (Rydant, 1984).

The provision of information has been examined more specifically with respect to health effects in the aforementioned study by Morgan *et al.* (1985). Besides characterizing people's perceptions of risks from electric and magnetic fields, this study also examined experimentally the effects of information on attitudes and perceptions. After producing the data summarized in Table 1 and Figure 3 above, participants in the study received detailed but non-technical information regarding:

1. The nature of electric and magnetic fields;
2. What is known about possible undesirable health impacts of exposure to 60 Hz fields;
3. How the fields from transmission lines compare in strength with other Hz fields (this information was mostly pictorial).

After receipt of this information, respondents again evaluated the risks from electric and magnetic fields produced by transmission lines and electric blankets. Provision of information moved the evaluation of transmission lines further into the upper-right quadrant of the factor space (Figure 3). Possible effects of electric and magnetic fields from transmission lines were seen as more dreaded, less equitable and less well known to science. Similar changes occurred in the characterization of the risks from electric blankets. For both transmission lines and electric blankets, provision of information also increased people's concerns that existing control measures were not adequate and increased the tendency to 'feel sure that this is a risk.'

Though few in number, these studies suggest that people may not be very well informed about powerlines, and that providing factual information can alter their attitudes.

Process characteristics

The nationwide survey conducted by Response Analysis Corporation (1972) described above included several questions pertaining to people's perceptions of the decision-making procedures used by electric companies. In response to one question, 68% of the respondents said the companies were either somewhat or greatly concerned about the appearance of transmission structures. Forty-six percent answered 'yes' to: 'If you and your neighbors opposed new transmission structures in your area, do you think the electric company would consider your feelings, or not?' (20% said they were unsure). Unfortunately, drawing conclusions from these results is somewhat problematic, given that the non-response rate for this study was not reported.

The public appears to be quite concerned about being left out of the transmission line planning process. In years past, this perception was probably accurate. Utilities sometimes tried to conceal their plans for a line before construction began, in order to minimize both the possibility of political opposition and the cost of land acquisition (Porter, 1980). More recently, more utilities have realized the value of involving the public early in the planning process, both because such involvement is sometimes mandated (e.g., *Guidelines for Linear Development*, 1977), and because there is evidence that public opposition is less likely when people are informed and involved from the beginning (DeVore, 1969; Ewald, 1969; Fraggalosch, 1980). Such involvement is also in keeping with the shift in public values with respect to the environment and the political process. 'In a society that aspires to be free and open, such judgments can be made only through discussion, argument, persuasion, contention, adjustment and interaction among the individuals and groups with a stake in the outcome' (Katz, 1971, p. 196). The utility industry has often been ill-equipped to deal with non-engineering problems such as this shift in values and the resulting public opposition to transmission lines. Kipp (1969) pointed out that highway agencies faced a similar situation in the mid-1950s when the federal government authorized the construction of thousands of miles of limited-access highway to meet increasing transportation demands. Public resistance unexpectedly appeared once construction began, and only a collaborative effort between social scientists and transportation engineers in the form of detailed community planning studies managed to reduce the community-highway conflict.

If opposition is prompted by feelings of being ignored, an obvious antidote is

including the public in the process. Means for doing so include environmental impact hearings, citizens' advisory councils (e.g., Pennsylvania Power & Light, 1982), and community approval requirements. These, of course, require considerable expenditures of time and money on the part of utilities (and often by private individuals and public entities as well). There may, however, be much to gain from such expenditures. Studies of procedural justice (Tyler, 1984) suggest that increased public participation generally enhances perceptions of process fairness. Furthermore, when the public is forced to consider the various alternatives (e.g., more small generating facilities and consequent increased fuel transportation costs; expensive underground lines; inconvenient and costly energy conservation measures), it may be more willing to live with the shortcomings of whichever option is selected, after the shortcomings of alternatives have also been made salient.

An alternative to including the public in the decision-making process is including a representation of its values. Relatively detailed techniques have been developed to identify those values with respect to transmission line routing. One example of this approach is a study by Hendrickson *et al.* (1974) which applied a method based on multi-attribute theory to the problem of siting transmission lines. Initially, the investigators identified criteria believed to influence people's evaluations of routes: aesthetic, economic, health and safety, water quality, air quality, cultural and recreational, and animal and health impact. Representatives of the public then assigned weights to these criteria, either explicitly or implicitly by rating various viewscapes showing different types of transmission line routing. Technical experts judged the impact of alternate routes for each of the criteria. All of this resulted in a rating score for each route based on both technical and public judgment. Whether such an approach can satisfy the public remains to be seen. In a study evaluating the use of a multi-attribute methodology for assessing visual impacts only, public reaction was fairly critical of this approach, stressing that value judgments must be made on an individual case basis, and that the public must be allowed to question any and all assumptions or preconceptions (Enk *et al.*, 1981).

Public participation is becoming an issue not only for transmission line siting but also for need forecasting and project justification. Case studies of public opposition to specific transmission lines (e.g., Fraggaloch, 1980) show increasing public disagreement with the utilities' forecasted need for more power, and increasing public demand for participation in longer-range planning and energy decisions. In addition to the desire to be counted, the distrust seems due to the errors in energy need projections made during the 1970s. There is also a significant portion of the population that favors smaller-scale technologies that eliminate the need for large transmission lines. Even utilities that have incorporated the public into their siting procedures have thus far strongly resisted any public involvement in the larger decision about the need for new energy facilities (Fraggaloch, 1980). Such participation may only be achieved through state and local regulatory mechanisms requiring public input in the assessment of energy needs (e.g., Minnesota Environmental Quality Board, 1982).

Public attitudes and perceptions are reflected not only in individual citizen's opinions, but also in representative public bodies. Sweet (1970) reported a questionnaire designed to assess how such public bodies view the procedures used by companies involved in right-of-way management including telephone, gas, water, and electric companies. The questionnaire was mailed to a number of public agencies around

the country, but neither the sampling procedure nor the response rate was reported, rendering the results of questionable utility. Given this caveat, the power companies generally had a reasonably good image with public agencies. For example, 93% of the agencies responding said the power companies' initial requests for siting authorization were made in a reasonable manner; 99% said the utility worked in accordance with the agency's specification; 94% said that the utility did not disrupt normal community activities; 75% rated power companies' images as 'good.' The power companies received somewhat lower marks in several other respects: 27% of the agencies said that utilities sometimes failed to obtain agency authorization before starting work; 26% said the utility's follow-up after completion of the work was only fair or poor; 11% said they had received unfavorable reaction or comments from the community as a result of utility company work. Sweet summarized his own conclusions from the study rather emphatically:

It seems to me the message is loud and clear—many of us [utilities] are not satisfying the various public agencies

- We have some problems in the area of applying for permits or licenses
- Our construction leaves something to be desired.
- They want to be in on the planning of our new facilities
- Finally, they are asking for more and better liaison.

I personally think we had better listen to what they are telling us and take action, otherwise tomorrow there may be legislation passed which we don't like (p. 39).

Given the methodological limits of this study and the pivotal role of public officials in creating and coping with public agencies, there is a need for more research of this type.

Attitudes toward the siting and construction process are represented in Figure 1 at the same level as attitudes toward the line themselves. Both are influenced by a number of determining elements, and both can directly affect acceptance of or opposition to a proposed line.

The dynamics of opposition and conflict

The various elements discussed thus far appear to play a significant role in determining attitudes toward transmission lines. However, while knowledge of attitude determinants is important, it does not tell the whole story when it comes to understanding when and how public opposition will be manifested. A large body of research has demonstrated that the relation between attitudes and behavior is not always a close one. There are clearly factors other than attitudes that play a role in the development of community conflict. Those factors are often difficult to define, but they generally relate to the dynamics of how conflict escalates or dissipates.

Tichenor *et al.* (1980) attempted to analyze the role of the press in communicating information about community conflict over high-voltage transmission lines. From their study of the Minnesota case, they concluded that it is the organization of opposition groups that is the primary ingredient in the development of conflict rather than the manner in which the media presents the issue. Although the news media can affect any opposition group's success by the amount of coverage that they give it, they do not create the malaise.

Some have claimed (e.g., Mitchell *et al.*, 1976) that opposition dissipates over time, and thus that residents in an area traversed by a transmission line may oppose

it during the planning and construction phases but eventually will adapt to it. The study by Boyer *et al.* (1978) sheds some light on this issue by comparing the attitudes of the respondents in their Ontario survey at the time the first line was constructed to their attitudes two years later when a second line was proposed. Unfortunately, most of the on-line sample had not lived on their property prior to construction of the line, so that only 23 people provided responses to the question about their attitude toward construction of the original line. Of those 23, 42% had been opposed or very opposed, while only 13% said they had been favorable or very favorable at the time of construction. For the control group (living approximately one mile away), 11% said they had been opposed or very opposed while 32% said they had been favorable or very favorable to construction of the original line. A second line was proposed for construction two years after the first (1973) in the same 500 kV corridor. The on-line group reported a fairly constant level of opposition across this two-year time period: 45% reported that they were opposed or very opposed and only 17% said they were favorable to addition of the second line. Furthermore, when asked which alternatives they preferred for increasing electric capacity, 28% of the on-line group chose a new corridor rather than the addition of a second line to the existing corridor (while only 5% of the control group did). Thus, those living on land traversed by a transmission line are more opposed to it at the time of initial construction than those living at some distance, and several years later they remain as opposed as they were before to the construction of a new line.

One temporal pattern that has emerged in several cases of serious conflict over transmission lines is a shift from little or no mention of health effect issues during the early stages of opposition to an increasing focus on them as the conflict continues. Anecdotal evidence suggests that this is not necessarily the result of increased education about or concern over health problems *per se*. Rather, those opposing the line learn that negative health effects carry more weight in regulatory and legal battles than any of their other concerns such as aesthetics and property values.

A better understanding of the dynamics of conflict is important to minimizing future conflict over transmission lines. That understanding can probably be obtained best only from detailed case studies such as the one conducted in Minnesota.

Discussion and Conclusions

We have seen that there has been considerable research related to public attitudes toward transmission lines spanning a period of several decades. However, many of the individual studies are of limited validity or generalizability, due to small or non-representative groups of respondents. Also, we have seen that attitudes toward transmission lines have shifted significantly over time, making many of these studies seriously out-of-date. Moreover, most studies have focused on a single element of the picture (aesthetics, health effects, property values, etc.) without attention to the potential interactions among all of the elements.

As a result, the cumulative knowledge provided by all of these studies is not sufficient to allow precise statements about the organizing scheme presented in Figure 1. The literature does seem to indicate that each of the elements of the framework in Figure 1 has some importance in determining perceptions and attitudes. We do not, however, know enough to predict which of these elements will be most problematic in a particular siting situation. Issues that cause great concern in

some siting controversies often are less salient in others. Indeed, each transmission line siting presents a unique combination of characteristics, and it is unlikely that we will be able to predict exactly how the affected public will react with respect to all the relevant elements.

Because of the specificity of each transmission line case, further research attempting to establish *general* principles regarding certain of the elements would seem to offer diminishing returns. Aesthetic concerns will vary with the particulars of terrain and land use, and the research to date suggests that there is no single or best aesthetic solution. Rather, the public wants to be involved in the aesthetic decisions for any given siting (Enk *et al.*, 1980). Likewise, the effects of symbolic meaning, economic benefits, and the dynamics of opposition and conflict vary considerably from case to case. While these elements are important, they may not be subject to generalizations that can be applied across multiple sitings nor used to predict the course of public attitudes to future sitings. They are probably best examined in the context of individual case studies.

There are, however, several of the attitudinal determinants we have discussed for which useful generalizations seem possible, and further research on these elements would seem fruitful. One is the effect of transmission lines on property values and public perception thereof. Property value effects are relatively easy to quantify and study empirically, and people's attitudes toward lines are influenced by how they think their pocketbooks are affected. We have outlined elsewhere a suggested research agenda in this area (Furby *et al.*, in press).

A second area is the perception of health and safety effects of transmission lines. In recent years, this issue has received increasing attention in public debate, and we suspect it will be a critical determinant of the acceptance or rejection of transmission lines in the future. A modest beginning has been made in research on this topic, but considerably more could be learned.

Most importantly, perhaps, we need to build upon research from other domains that point to the key role of process or procedural considerations in determining the nature and course of environmental conflicts (Daneke *et al.*, 1983). This is consistent with many classic studies in industrial psychology demonstrating that allowing workers to participate in problem solving and decision making produces greater acceptance and more efficient implementation of the resulting decisions (Vroom, 1969). A surprising number of those who have investigated the transmission line siting and property evaluation process state that more attention should be given to enlarging the scope and role of public participation. This was also acknowledged by representatives of the utilities and other public agencies with whom we spoke. It would appear that open discussion and increased public participation might avoid a polarization of forces, in which individual owners are pictured as selfish, greedy, and impeding social progress while utilities and public representatives are seen as high-handed and insensitive.

We recommend that future research focus on exploring the interactions among multiple elements of the conceptual framework as they relate to process issues. For example, a study that would have both theoretical and practical importance would examine the influence of process considerations on the interpretation of information about health effects. Recall that the study by Morgan *et al.* (1985) showed that information about health effects of transmission lines led to somewhat heightened risk perception and increased concern about health effects. Extrapolating from

research showing that lack of control is associated with high risk perception and low acceptance of risk (Renn and Swaton, 1984; Slovic *et al.*, 1984, 1985), we would predict that the increase in concern observed by Morgan *et al.* would be even greater if this information were presented within the context of a process that was not perceived as democratic and genuinely supportive of public participation. On the other hand, we would predict that the same information, presented within the context of a more participative process, would not lead to increased concern—in fact, concern might well decrease. These predictions could be tested rather directly by replicating the Morgan *et al.* study within the context of two (hypothetical) siting processes, one incorporating public participation, the other providing little opportunity for public input.

A related aspect is that many individuals may be opposed not just to the transmission line but to the power project itself: this is particularly likely if electricity is to be produced by a nuclear plant. If attitudes toward the transmission line could be effectively separated from those toward the project (or big government, or a specific utility), the tensions surrounding negotiations might be considerably eased. Significant changes with regard to public participation, whereby individuals could have additional input into the planning process prior to the selection of alternative corridors, might help considerably in this regard.

More generally, we need research aimed at describing how to create an acceptable siting process. Citizen participation in the planning and siting process can take many forms, and careful consideration should be given to the various effects of each. Innovations in citizen participation over the past decade are beginning to provide an evidentiary base from which we can draw in assessing the relative merits of different participatory arrangements, but the literature to date is sketchy and anecdotal (Ducsik, 1981), and a more organized empirical effort would clearly be desirable (e.g., Delli-Priscoli, 1983). At present, only rough guidelines are apparent. The process should involve all affected stakeholder groups genuinely and early enough so they can exert some influence over the alternatives that are being considered. Edwards and von Winterfeldt (1987) have developed a method for identifying relevant stakeholders and helping them articulate their values and concerns in a way that can be useful for policy makers. Implications of their technique for transmission line siting would be worth exploring. A good information and education program is essential to the process, but such a program must be a two-way affair, in which each party attends to and respects the views of the other parties.

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