PROFESSIONAL PRACTICE

WHEN SCIENCE IS NOT ENOUGH: A CASE STUDY IN SOCIAL IMPACT MITIGATION

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Engineering managers quickly learn that a strictly technocratic approach to decision making will not suffice in the hurly-burly of corporate life. Little time exists for the thorough collection of data, the formulation of options, and the rational selection of an optimal solution. However, even when sufficient time and resources are available for reflection, the engineering manager is confounded by the apparent perverse behavior of humanity. Engineering training relies to a high degree on the ability to model physical variables whose behavior is highly predictable. Human beings, on the other hand, stubbornly refuse to be modeled—unlike billiard balls they have minds of their own. And they are often surprisingly different from engineers in their reactions to 'engineering' situations. The engineering manager may well be stumped by the need to lake into account alternative perspectives that appear to reject the core assumptions of the technocratic consciousness. Science and the scientific approach do not seem to provide the means to come to a decision that will span and satisfy multiple perspectives. The solution often chosen by the engineering manager is to denigrate world views other than the technocratic and to dismiss them from the situation by labeling them as irrational.

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This paper explores a decision-making situation involving severe social impacts where the engineering managers concerned had the courage to face the limitations of science and to seek solutions that would be inclusive of multiple value systems.

THE DECISION

On a headland overlooking a wealthy coastal suburb of Sydney stands a large sewage treatment plant. The sewage is collected from the northern suburbs, subjected to primary treatment, and expelled into the ocean through a deep outfall. About 90 wet tonnes of sludge were extracted per day, of which 60 wet tonnes were incinerated and the remainder either returned or subjected to a bio-recycling process that centrifuged and chemically stabilized the material.

The water board was under intense pressure from local community and environmental groups to cease incineration. Under the leadership of the local member of Parliament, these groups expressed concern that the incinerator gases had the potential to cause cancer and respiratory diseases, particularly asthma in children. In response to these concerns, the water board closed down the incinerator for a three-month trial period during which all the sludge was treated and trucked to a landfill on the other side of Sydney.

Before and during this trial period a series of scientific studies was undertaken. These included tests on the emission gases, a hazard assessment (not completed at that time), and a health survey to examine the incidents of childhood asthma and other respiratory diseases. Other less important studies on odors, noise, and traffic impacts were also undertaken, together with a general public perception survey. These studies were a comprehensive attempt to generate sufficient scientific data to enable the water board to decide whether or not to reactivate the incinerator. The incineration plant was a considerable investment and the water board engineers were clearly reluctant to abandon this technology without good, nonpolitical reasons.

None of the reports completed or in progress indicated any physical impact at a level that would mandate a permanent closing. No evidence was found of respiratory disease, little traffic congestion was predicted because of the trucking of dry sludge, little increase in noise or smell was experienced from trucking, and the predicted long-term carcinogenic effects were small. But

science was clearly not enough and the engineering managers of the water board wisely decided that the social issues must be confronted.

SOCIAL IMPACT STUDY

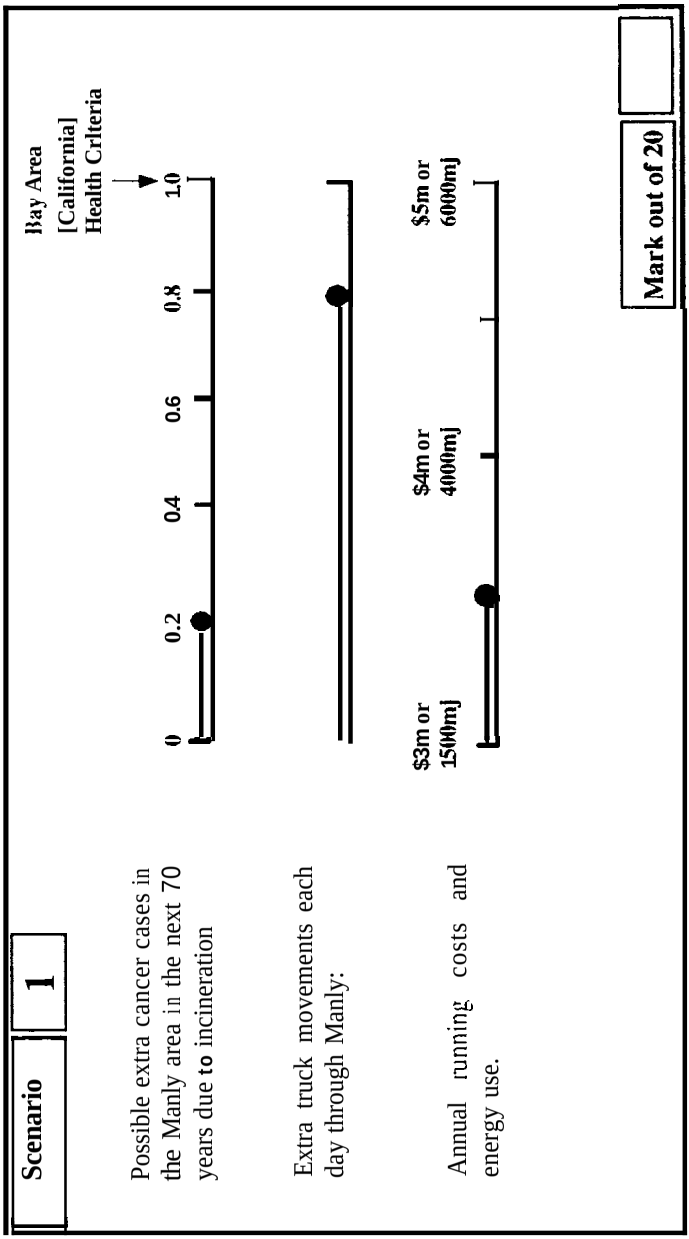
The author worked with a commercial consultant on an impact study that was designed to mobilize ways of thinking other than the technocratic. The technique used, however, was analytically rational and therefore capable of spanning the world views of both the public groups and the engineers. The method, ***case*** *judgment* (Parkin 1993), measured the values or preferences of individuals or groups over the important attributes of the problem and combined them with their associated public interest arguments to reveal the elements of a sociotechnical problem in such a manner that possible solutions could be deduced.

The steps were as follows:

1. Records and discussions were examined to determine the dominant issues. This step revealed that three issues dominated all others: the carcinogenic potential of the emissions, the safety and amenity of trucking through the town, and the high cost and energy consumption associated with incineration.

2. Because the number of issues or attributes was low, the weights (preferences) placed on these factors by the public groups and the engineers were measured using *judgment analysis* (Parkin 1993; Cooksey 1995). Twenty cards were produced. Each card represented a scenario made up of different combinations of values for the three attributes. Each card contained three scales representing the potential values of the three attributes. These scales showed the highest and lowest values of likely extra cancer cases in the next 70 years, the extra truck movements each day if the use of the incinerator was scaled down, and the net cost/energy use associated with combinations of trucking and incineration. Values on each scale were randomly generated and culled for nonrepresentativeness to create 20 scenarios. **A** typical card can be seen in Figure 1.

Figure 1. Typical card



3. Representatives of a wide range of community groups, members of a community advisory group, the local member of Parliament, and the engineering managers assembled. Each was asked to consider their set of 20 cards and mark on each how well it represented their views of the public interest. They also were asked to write down their reasons for picking their five highest and lowest marked cards, expressed in terms of public interest rather than their particular interests. This proved to be particularly difficult for the representative of the townspeople objecting to the trucking as he also fervently supported closure of the incinerator.

4. Multiple regression analysis was used to determine the weights placed on each of the attributes by each person. These weights were then clustered into similar combinations of weights and associated public interest arguments were formulated. Thus, each cluster was represented by a set of weights and a set of public interest arguments supporting them. The weights and arguments can be seen in Tables 1 and 2.

An analysis of the public interest arguments revealed that all the clusters felt that incineration was undesirable but strong disagreement remained on the question of trucks. To find a solution, multiple regression equations for each cluster were again utilized. It was clear from the weights that only two possible *practical* scenarios produced similar judgment scores on the public interest scale when they were fed into the equations. The first involved low-level use of the incinerator and the use of only 12 trucks per day (out of a possible maximum of 30). Unfortunately, all clusters produced a score of only about 13 out of 20 on the public interest scale for this option, which implied that no group would be particularly happy with this solution. However, complete closure of the incinerator combined with only 12 trucks produced public interest scores between 14 and 19, with the anti-trucking group at 15.

On the basis of this analysis it was reconmended that the incinerator be decommissioned and the money saved used to halve the volume of sludge to be trucked. This could be achieved through the use of technologies such as drying and creating pellets. It was also agreed that other long-term solutions to eliminate trucking, such as barging, would be investigated. At least in the medium term, all parties seemed reasonably satisfied with this result.

Table 1. **Weights on the attributes**

CLUSTER	WEIGHTS		
	Cancer	Trucks	Cost and energy use
1	84	9	7
7	29	66	5
3	22	18	60
4	61	16	23

Table 2. **Public interest arguments**

Argument	Basis	Cluster	Summary
Against incineration	Health	1	Inefficient incineration will release dioxins and other unhealthy gases. Hazard analysis unreliable. Forecasting risk difficult. Be prudent
	Conservation of resources	3 & 4	Incineration uses more energy and costs more. Good fertilizer produced by sludge treatment.
Against trucking	Equity	2	Trucking concentrates risk in a narrow band, but the gases are more widely spread.
Against trucking and incineration	Risk	2	As both incineration and trucking put the public at risk, it is the duty of the water board to find a less risky alternative solution.

DISCUSSION

The continuing strong objection to the use of incineration by local residents, despite the lack of support from the scientific studies, should not be a surprise. Work on the psychology of risk indicates that gas emissions have the characteristics of hazards that are felt to be mysterious, unseen, unfamiliar, a risk of future generations, and uncontrollable—all of which produce fear in those affected (Krimsky and Golding 1992).

However, some of the people involved in the protests may not fear the emissions because of these psychological factors. In our case study, many

were quite knowledgeable about the scientific variables. Such people are often the most skeptical about the validity of technocratic methods such as hazard analysis. They also may share a profound distrust of the government agencies associated with the relevant technology.

What this case study demonstrated was it is possible for engineers to use analytically rational methods such as *case judgment* in order to include in the problem-solving process the power of communicative rationality. In situations involving social disputes, the use of science will never be enough. Non-technocrats must be given a voice—expressed, if possible, as well-structured public interest arguments. These groups will only accept a technical impact analysis method if they feel that equal weight has been given to their own well-thought-out arguments concerning the public good.

REFERENCES

Parkin, J.V. 1993. *Judging Plans and Projects: Analysis and Public Participation in the Evaluation Process*. Aldershot UK: Avebury.

Cooksey, R.W. 1995. *Judgment Analysis: Theory, Methods, and Applications*. San Diego: Academic Press.

Krimsky, S. and D. Golding. (eds.) 1992. *Social Theories of Risk*. Westport CT: Praeger.