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> *The essence of ultimate decision* remains impenetrable to the observer -- often, indeed, to the decider himself.... There will always be the dark and tangled stretches in the decision-making process -- mysterious even to those who may be most intimately involved.
>
> -*John Fitzgerald Kennedy*

1.0 Introduction

Said one professional environmental analyst working in New England, "Wise environmental decision making is the end to which impact assessment is the means" [80-104][1]. Since the National Environmental Policy Act (NEPA) was signed into existence in 1970, the process prescribed by Congress therein has become a "modus operandi whereby all relevant statutory requirements, executive orders, and regulations may be taken into account in a systematic and integrated manner" [Lynton Caldwell, 92-89]. Caldwell defines the purpose of NEPA as providing for a "full display of environmental alternatives and consequences for review by responsible agency decisionmakers" [92-74], through its requirement for the preparation of an environmental impact statement (EIS) for "legislation and other major Federal actions significantly affecting the quality of the human environment" [NEPA, §102(a)]. Caldwell goes on to describe the intent of Congress in developing the EIS requirement:

> The EIS was intended to set forth the environmental facts relative to proposed public action. It was conceived as a mandatory, action-forcing reorientation of planning and decisionmaking. But it was never intended to preempt the decisionmaking authority of responsible public officials. It was intended to influence the way in which this decisionmaking authority was exercised. [92-1]

So, then, the role of the EIA within the NEPA process is to delineate the range of possible alternatives, and present to decision makers the nature and relative magnitude of the consequences which would result from implementing each alternative. The EIA is not an end in itself, but rather a means to the end of an effective and thoughtful decision [92-6]. The role of the decision maker, then, is to apply his perceptions of the value system of his institution to weight each set of consequences to "look before leaping" by using the impact assessment to rank the alternatives, select one, and implement it [80-103]. The EIA also makes the premises of the decision explicit, often forcing decision makers to account publicly for their actions [81-285]. What is required to provide necessary information to the decision makers has been described by Caldwell as "an interactive process among science analysts and program planners that will draw from scientific investigations the range and details of evidence that will enable policymakers to arrive at decisions consistent with the mandates of the laws" [92-84].

The importance of successfully integrating the interdisciplinary inputs required by NEPA cannot be overemphasized. Judicial interpretations of EIS requirements have corroborated the necessity for interdisciplinary input [76-49], but successfully coordinating the diverse inputs from many specialized disciplines which must comprise the EIS is a complex task, made more difficult by the dynamic, uncertain, highly interconnected [93-13, 72-11], and often hazardous

[1] The format for references is [reference index-page number].

nature, as well as the close relationship with human well-being [93-10], of situations with environmental impacts [72-11, 97-46]. Yet, as one author put it, "Disparate scientific findings alone do not provide an adequate basis for planning and decisionmaking" [92-83].

Environmental decision making requires an "extraordinary range of inputs required to produce an informed decision" [72-11]. Yet the omission of any one relevant factor is likely to oversimplify the problem under consideration, and render the decision process incomplete and unrealistic [72-3]. Moreover, the more effectively environmental impacts are specified in the EIS, the more difficult the problem choosing among policy or project options becomes [90-11]. In fact, effective impact assessment should lead decision makers to consider tradeoffs they hadn't previously considered. The more tradeoffs that need to be considered, the more complex is the evaluation [90-11]. And if the tradeoffs are numerous, often small changes in the problem parameters can lead to drastic changes in the outcome of the decision [79-311].

It has been shown that the outcome of decisions is dependent to some degree on the decision process and the characteristics of the decision makers who engage in them [72-10]. Specifically, results may be based whether or not the decisions are made by individuals or as a group, the willingness of the decision makers to assume risks, and differences in perceptions which occur between every decision maker [72-10]. It is these differences in the decision making process and its participants which will be explored in the rest of this paper. First, the key players in environmental assessment and decision making, and the roles they play, will be presented. Then, the decision process models which may impact the choices prompted by environmental impact assessment will be explored. Finally, we will take a look at the attempts which have been made to improve environmental decision making, and present some guidelines and suggestions to facilitate the environmental assessment process to aid decision making.

2.0 Environmental Decision Making Players and Process

This section of the paper will discuss the players in environmental decision making, and the processes they typically follow to implement projects which benefit humanity but impact the environment of which he is a part. Key players in the evaluation, selection, and implementation processes are the public, the project proposers, the lead agency's decision makers, and the lead agency's planning and technical staff. Other parties which may be involved are reviewing agencies, the courts, specialty consultants, and non-partisan arbitrators. The process which is typically followed in environmental decision making is described in the section which follows the discussion of players below, followed by the criteria which are used to evaluate project and policy alternatives in the process.

2.1 Players in the Decision Making Process

The elements of a holistic relationship for environmental management as described by Beale include an integrated policy for the environment which apply to all levels of government, legislation and regulations which bind government agencies as well as the private sector and communities at large, and coordinated administration on the part of the government to guide the actions of federal agents, private industry, and all citizens [94-44]. This holistic approach to the management of the environment is reflected in the opportunities NEPA provides for participation in the environmental assessment process by any and all interested parties []. The process of scoping involves bringing together representatives from all interests and affected agencies early in the process. Scoping enables the full range of potentially relevant factors to be considered, and potential conflicts can thus be detected early. Thus, coordinative action can be taken, and inadvertent actions which might lead to conflict can be avoided [92-89].

2.1.1 The Role of the Public

The inclusion of the public in the environmental decision process is a fundamental provision of NEPA. One of the primary purposes of the EIS is to provide a chance for the public to review the information that will be used by decision makers to make a decision regarding the proposed action [78-96]. The fact that the EIS is prepared by the agency, who is in many cases the project's proponent, leads the public to assume that it is biased in favor of the proposed action, and consequently they don't depend on the EIS for scientific or critical assessment of the project [80-125]. Because many case studies have demonstrated that there exists a general public mistrust of government [82-11], environmental impact analysis is required by law to address comments and criticisms made by the public with written responses in the final EIS [80-107]. Other ways the public has to influence environmental policies include voting in public elections, participating in environmental interest and action groups, and litigation, as well as serving on citizen boards and participating directly in the environmental impact assessment process. Various ways to include the public in the environmental impact assessment process are discussed in section 5.5 of this paper.

2.1.2 The Project Proponents

The parties who initially devise the idea and intend to implement it are known as the project proponents. This role is usually played by private developers or agencies who wish to use federal funds to pay for all or part of the project, or who require an agency permit to implement it [98-18]. The project proponent may also be a federal agency wishing to implement new or revised rules, regulations, plans, policies, procedures, or legislative proposals [ibid]. The project proponent is usually required to prepare a proposal describing the project and anticipated impacts to submit to the lead agency who will prepare the EIS. In some cases, the proponent may actually prepare an initial version of the EIS, to be modified and distributed for review by the lead agency [98-15].

2.1.3 The Role of the Lead Agency

The lead agency is defined as the federal or state agency who has jurisdiction over the proposed project, which usually means the ability to approve the project or issue the necessary permits so that it can be implemented. One source describes the role of the lead agency as an "information retrieval system," whose job is to accurately relay information about the project's objective and impacts to the public, and to collect information from interested parties to be used in the decision process. After all the information exchange has taken place, the agency's job becomes to negotiate between involved parties to develop the most acceptable solution possible, and to make a decision based on the negotiated result [87-246].

The lead agency consists of two levels of actors, for the purposes of environmental decisions: the scientists, technical personnel and planners who prepare the EIS, and the administrators who make a decision on behalf of the agency regarding the project. The responsibilities of the first set of actors include scoping, preparation of a draft EIS, facilitating public review of the draft and responding to comments about it, conducting public hearings if necessary, and revising the draft EIS into the final version which gets presented to decision makers [80-107].

There is often a "culture gap" between the scientists and the administrators in the lead agency. While so-called "front line" and technical personnel who prepare the EIS often feel thwarted in their efforts to do a good "environmental job" by middle and upper level management decision makers [76-66], the administrators who must function in the world outside science are conscious of the political implications of issues and must satisfy their constituents [82-7, 90-12]. The contrast between these two contingencies, described by Beale, is focused on the kinds of information each requires to function:

> In making a decision a politician avoids getting mixed in detail, whereas an expert is heavily involved in detail. A politician seeks a wide range of opinions, where an expert concentrates on known specialist advice. Having made a decision, [the politician] tries to time his move to implement it in a way which will ensure that the governmental machinery can deliver a result which is acceptable. His survival depends on his success. [94-98]

In fact, despite the efforts of technical personnel to provide accurate and useful information for decision making, decision makers often complain that they cannot get "straightforward, unequivocal, relevant answers from scientists" and find it difficult to get help in estimating the risks their actions might entail [92-100]. The job of the administrative decision

maker is try to reconcile the tension between the expert assessments of impacts presented to him by his technical staff and the public's perception of the risks posed by the proposed action [66-195]. It is true that in most cases, "politics controls the outcome...even when the discussion is framed in economic or other terms" [68-121]. Suggestions for improving the relationship between these two contingencies can be found in the Guidelines section of this paper.

2.1.4 Other Players

Other players which may be involved in environmental impact assessment and decision making include reviewing agencies, the courts, specialty consultants, and non-partisan arbitrators. Reviewing agencies are other governmental organizations at the federal, state or local levels who have an interest in, but not jurisdiction over, the proposed action. These agencies participate in the scoping and review process, and contribute input and comments about potential conflicts, additional factors which must be considered, and other interests and impacts which may have been inadequately considered or represented by the lead agency and project proponent.

The courts participate in the environmental impact assessment process when the lead agency has failed to perform its required functions adequately. Although more efficient ways of resolving conflict may exist, litigation is the most popular response of parties who feel that their interests have not been adequately considered (and who have adequate resources to take this measure) [80-128]. The reader is referred to the existing body of case law for examples of litigation which has influenced the requirements for the preparation of impact statements. Additional discussion of the influence the courts on environmental impact assessments can be found in Berzok [81], and Ortolano, et al [80].

Third party players, including specialty consultants, academic organizations, and other non-governmental entities may be employed in various capacities in the impact assessment process [64-257]. These entities may be contracted by the lead agency to actually prepare the environmental assessment or EIS, or they may assist in EIS development by reviewing the draft EIS. Non-partisan third parties may also be employed or provided by the government to assist in negotiation and conducting public hearings.

2.2 Environmental Impact Assessment Process

Sources vary in describing the steps of the environmental impact assessment process. A typical process is delineated by Fabrick and O'Rourke [98-20]:

1. Environmental impact assessment
2. Scoping/Finding of No Significant Impact (FONSI)
3. Preparation of Draft EIS
4. Public review of Draft EIS
5. Preparation of Final EIS
6. Record of Agency Decision (ROD)
7. Preparation of Supplement EIS (if required)

Other sources emphasize the necessity of checking first to see if the project is listed as being "categorically excluded" [c.f.g. 78-90]. If the project is categorically excluded by the legislature or regulating agency, then no assessment of impacts is required. Moreover, if initial scoping and impact assessment yields a Finding of No Significant Impact, it is not necessary to continue the process into preparation of an EIS [78-92]. Requirements vary by location and agency as to the level of public review and involvement required. The planner is advised to consult state and federal agencies to determine the relevant requirements for each area. The contents of an EIS are required by NEPA §102(c) to include descriptions of:

- Environmental impacts of the proposed action
- Any adverse effects which cannot be avoided should the project be implemented
- Alternatives to the proposed action
- The relationship between local short-term uses of man's environment and the enhancement and maintenance of long-term productivity
- Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Typical problems which face agencies preparing environmental impact statements are time and money constraints, legal requirements and the potential for litigation, the potential for public conflict or especially significant impacts, and differing ideas of relevance held by the involved interest groups [92-83]. In conducting environmental impact assessment, NEPA requires federal agencies to "utilize interdisciplinary approaches, ensure an integration of natural and social sciences with environmental design arts, and ensure that unquantifiable environmental amenities and values get appropriate consideration along with technical and economic considerations" [76-23]. These criteria for evaluating proposed actions and their alternatives are described in the next section of this paper.

2.3 Criteria for Evaluating Alternatives

The criteria which are typically used to restrict consideration of project alternatives in the impact assessment are (not necessarily in order):

- Technological Feasibility
- Social and Political Acceptability
- Economic Feasibility

Alternatives which pass these "screening criteria" are narrowed to a representative set which get carried on for further scrutiny and analysis of their potential environmental impacts in the draft EIS. Technological feasibility is delimited by the presence, availability and reliability of technology to implement the alternative. In general, the closer an alternative is to the "cutting edge" of technological feasibility, the less likely it is to be economically feasible.

The second criterion, social and political acceptability, is operationally defined as the approval of an alternative by a majority, or at least the most powerful segments, of the constituent set of affected citizens. Social acceptability is based on how well the perceived effects of the alternative lie within the realm of acceptability of the public, while political acceptability relies on what politicians perceive to be the limits of social acceptability of their constituencies [82-9]. Social objectives should promote the well-being of people and the quality of life [94-156].

Finally, economic feasibility is defined by the real or perceived limitations on funds available to pay for the implementation of the alternative. When determining economic feasibility, it is important to consider not only the direct costs of implementing the project, but also the social costs to the community as a result of acting or not acting [94-156].

3.0 Conceptual Models of Organizational Decision Making

As mentioned in the first section of this paper, the outcome of a decision process is often sensitive to the parameters of the process itself and the characteristics of those who make the decisions. For this reason, it is helpful to consider some theoretical models of how decision making takes place in organizations. By looking at the context of the organization in which the decision will be made, project proponents and planners may get an idea of how to better structure the information they provide to decision makers, in order to facilitate the decision process and achieve the desired ends.

Since all decision making involves certain levels of risk, it is important to assess the potential impacts of the proposed action in terms of the risks they present, in order to effectively manage those risks. Some criteria for assessing environmental risks before making decisions as presented by Gute are:

- What is the magnitude of the potential problem?
- What is the level of hazard?
- How many people may be affected?
- What are the possible routes of exposure (e.g. respiration, skin contact, etc.)?
- What is the source of potential exposure?
- Is intervention feasible? [65-227]

It is also important to note that decisions are based on the following four components of the decision making system: a base of experiential knowledge, a prediction or forecasting system, a system of values, and a system for selecting an alternative [76-21].

Five primary theoretical models of organizational decision making are proposed by Meyer and Miller [62-87ff]. These models, along with their advantages and disadvantages in terms of the environmental decision context, are discussed in the following subsections.

3.1 The Rational Actor Approach

The Rational Actor Model is based on the assumption of rational behavior motivated by a conscious calculation of advantages, which are tabulated in terms of an explicit and internally consistent system of values [77-13]. In this model, rationality refers to "consistent, value-maximizing choice within specified constraints" [77-30]. This model, which was originally developed to describe individual decision making behavior [61], when applied in an organizational context assumes that the organization behaves as a single, monolithic entity. This entity attempts to make a single value-maximizing choice after considering all possible alternatives and all their possible consequences. The process consists of the following steps [96-30]:

1. Define the problem, and identify the desired outcome.
2. Identify the set of all possible solutions.
3. Identify and evaluate all possible consequences of each alternative.
4. Select that alternative which would probably have consequences that would be closest to the desired outcome.

Other analysts include in the process the step of implementing the selected alternative after it is chosen [e.g. 60, 72-5]. Analysis of behavior in terms of this model consists of determining what goal the actor was pursuing when it acted and how the action was a reasonable choice, given the actor's objectives and values [77-13]. While the Rational Actor Model provides a simple, logical means of analyzing behavior which is easy to accept and understand [77-19], in reality the complete knowledge of all available alternatives and all their possible consequences is impossible [96-30]. Moreover, analysis requires the assumption that the actor always acts rationally and requires knowledge of its goals, objectives and constraints [77].

Especially in environmental decision making, the consideration of the actions of others is important when choosing an action, to avoid the Tragedy of the Commons (described by Hardin in 1968). In this situation, a common resource is depleted by individual choices which, while perfectly rational to each individual, overwhelm the capacity of the common resource when undertaken by a significant number of individuals [71-16].

3.2 The Satisficing Approach

The Satisficing Approach is based on the classical Rational Actor Model, but differs in that it addresses the finite information processing capabilities of actors. The basic difference in the Satisficing Approach is that the actor considers a finite number of possible alternatives, evaluating the consequences of each alternative as he goes along, and selecting the first one he finds which is "good enough" [96-47], or which causes the least harm while providing some desired benefit [62-89]. A variation on this approach developed by Etzioni in 1968 is called Mixed Scanning, where the actor quickly scans the field of possible actions, identifying a preferred strategy on the basis of incomplete information. He then explores that strategy in more detail, occasionally returning to the general level to re-establish his overall direction [96-47].

The benefits of the Satisficing Approach are that it can significantly reduce the search time required to make a choice and that it more accurately acknowledges the information processing constraints of decision makers [62-94]. While still providing a goal-oriented decision process, the Satisficing Approach allows for a sequential search of the range of possible alternatives, which are evaluated rationally and in accordance with the actor's goals. However, this approach will probably not result in the choice of the "best" alternative, and may be severely limited if the actor sequentially searches the same set of alternatives every time.

3.3 The Incrementalist Approach

In the Incrementalist Approach, decision making is geared toward moving away from problems rather than moving toward objectives [62-94]. A relatively small set of possible choices is considered, namely those which differ incrementally from existing states. For each of these alternatives, only a restricted number of "important" consequences are evaluated. Since the problem confronting the decision maker is continually refined, Incrementalism allows for countless "means-ends and ends-means adjustments" which make problems more manageable [62-90]. Hence, there is no one "right" solution but rather a "never ending series of attacks" on the problem being addressed [ibid]. Incremental decision making has been described by Meyer

and Miller as "remedial, geared more toward alleviation of present, concrete, social imperfections than to the promotion of future goals" [ibid].

While the Incrementalist Approach provides a good model for understanding how environmental problems have traditionally been solved, its focus on reactive, remedial action goes against the spirit of NEPA, which advocates a proactive consideration of consequences *before* acting. Incrementalism tends to try to redefine problems such that they fit existing solutions [62-94], rather than creating new solutions to better address the problems as they are. As such, it is not the best approach to take when trying to define the most effective route to environmental quality.

3.4 The Organizational Process Approach

This model recognizes that decision making within organizations is likely to be influenced by the formal and informal structures of the organization, channels of communication, and standard operating procedures (SOPs) [62-91]. Since many prescribed standards for performing environmental impact assessment and making subsequent environmental decisions have been developed by government agencies, the Organizational Process Model provides a good context for understanding the decision making behavior of those organizations.

The premise of the theory is that decisions made by the leaders of organizations trigger standard organizational routines which have been developed to handle specific situations. In the cases where the actual situation closely matches the situation for which the SOP was developed, this approach to organizational decision making works quite well. Problems arise, however, when organizations are faced with situations for which no SOPs exist, or if the triggered SOP does not match well with the existing situation. In these cases, which often occur for projects falling between agencies' jurisdiction or which require interagency cooperation [77-93], projects rarely get implemented as planned, designed, or expected. New situations are handled by adapting old solutions to fit them [77-91]. If the project happens to go against the goals of the involved agency or agencies, resistance will be encountered. Finally, decision makers can expect the organization to "do its part in terms of what it knows how to do," and can expect distorted or incomplete information from each organization about its part of the problem, where more than one agency is involved [77-95].

The Organizational Process Model is good in that it provides a more accurate picture of typical organizational behavior than the Rational Actor approach, since it recognizes that organizational action is typically stimulated by specific problems, and focuses on finding a solution for each specific problem [77-76]. Consideration of this model by individuals acting within organizations can sometimes aid implementation of organizational change [77-96]. Such individuals should note that major organizational changes typically follow, rather than precede, major crises [77-113]. However, attempting to analyze organizational behavior using this model requires more thorough knowledge of the organization's structure and SOPs, since it must be tailored to each specific organization [77-96].

3.5 The Political Bargaining Approach

The Political Bargaining Approach, also known as the Governmental Process Model [c.f.g. 77], is based on the premise of action as a result of bargaining and compromise between competing actors [77-256]. The actions of each player in this "game" are based not necessarily on strategic objectives, but more likely on some combination of global, organizational and personal goals [77-144]. Success is based on the ability of a player to amass the support of his constituency and other players, which requires a certain degree of "fuzziness" in how the supporters perceive the objectives and actions of that player [77-177].

In the environmental arena, the rules of the game include regulations, legal precedents, and mandated procedures. The skill and experience of individual players can have a significant impact on the outcome of the process [77-169]. And each player is obligated to "fight for what he thinks is right" [77-144]. In political bargaining, alternatives are selected not by optimization, but by the interaction of interest groups. As one author put it, "Confrontation, negotiation, mediation, and compromise are the final arbiters" [90-32]. Compromise is possible because players are seldom interested only in one issue, and hence substitution of one concession for another is possible [96-29].

This model is especially meaningful in the context of governmental decision making, where those who ultimately make decisions are generally professional politicians whose actions presumably depend on their perceptions of the values of their constituency. Since environmental impact assessment as discussed in this paper falls within the context of governmental action, the Political Bargaining approach is likely to be a good way to understand and predict the behavior of decision makers. This is especially true since NEPA requires only *consideration of*, and not action based completely on, environmental consequences.

4.0 Recent Improvements to the Decision Making Process

This section of the paper will focus on several approaches being developed and implemented to improve the environmental decision making process in current research and practice. Included in the discussion are decision support systems and amalgamation, both of which address the heavy information processing requirements inherent in thoughtful environmental decision making. This section ends with a brief discussion of systems analysis, simulation and modeling, and private sector efforts to influence environmental quality.

4.1 Environmental Decision Support Systems

Humans have limited capacities in the tasks of symbol and information processing, which can lead to "a paralysis" in decision making resulting from information overload [97-14]. In response to this shortcoming, Decision Support Systems (DSSs) have been developed to help manage the vast amounts of information which must be considered and manipulated to make informed decisions about complex issues like environmental management. A DSS is typically an interactive computer-based system that helps decision makers to utilize data and models to solve complex or unstructured problems [97-17]. The primary purpose of a DSS is to support and improve the effectiveness of decisions about problems which are too poorly or insufficiently structured to be solved algorithmically, as is often the case in environmental situations [ibid].

The characteristics of DSSs include flexibility, user-friendliness, and support of personal decision making styles [97-20]. Some DSSs even have the capacity to learn new knowledge automatically as they are used, by incorporating artificial intelligence [97-9]. DSSs have been used for strategic planning according to organizational objectives, management control and planning, and operational control of processes [97-22]. Requirements for a DSS include accuracy, robustness, simplicity, and ease of use [97-43].

An environmental DSS should be able to support the process of structuring the environmental problem in question, help the user gain new insights about the problem, find examples of similar problems which have already been solved, and help produce and evaluate alternative solutions to the problem [97-7]. The complex nature of environmental problems, in addition to the huge number of parameters which describe each environmental situation, make DSSs especially useful in the endeavor of environmental decision making.

The Army Corps of Engineers has developed an Evaluation and Sensitivity Analysis Program (ESAP), which is an environmental DSS that is able to:

- identify important resources and environmental variables
- manage large amounts of diverse and complex data
- incorporate uncertainty into the data
- accommodate diverse viewpoints in supporting decisions. [86]

ESAP enables its users to systematically evaluate alternative solutions to environmental problems, identify resources which will be critical to their implementation, and determine the sensitivity of each evaluation with respect to its inputs. Based on a resource allocation tree, ESAP is an example of how decision support systems can be used to help decision makers manage information about environmental problems to come up with better solutions.

4.2 Amalgamation Techniques

Unaided human judgment is "notoriously unreliable" when used to combine disparate effects of alternatives into a conglomerate evaluation of their worth [79-302], and cannot generally be consistently reproduced. While amalgamation, defined as combining disparate impacts and attributes of alternatives so that they can be ranked [79-301], is not a new technique, it holds much potential for easing the information processing and knowledge demands currently placed on environmental decision makers.

Also known as "multiattribute utility evaluation," amalgamation is performed by the analyst on behalf of the decision maker, and consists of the following steps:

1. Establish alternatives
2. Establish attributes which characterize the alternatives
3. Rate each alternative along each attribute
4. Normalize the ratings along each dimension
5. Determine relative weights of dimensions
6. Use a rating function to determine the multiattribute utility score [70-73].

In order to rate alternatives according to the attributes, a scaling system must be developed for each attribute. Scaling serves two purposes: it translates attributes into measures of values, and provides a measure of the decision maker's attitudes toward risk [79-305]. A weighting of the relative importance of each attribute must also be developed, based on direct ratings provided by the decision maker, inference from the tradeoffs he makes, or from correlation to previous decisions [ibid]. Decision rules are used to combine the weights and corresponding scalings for each alternative into a single index which represents the "worth" that alternative has to the decision maker, given his value system as reflected in the weighting system [79-306].

In order for amalgamation to provide an accurate representation of the true value of the alternatives to the decision maker, the attributes must completely describe the relevant impacts which characterize the alternatives, probability distributions for each attribute should be known, all relevant alternatives should be included in the analysis, and the decision makers must have a stable set of preferences which can be accurately represented by the analyst [79-303]. The primary benefit of amalgamation is that it makes data much more comprehensible by reducing the level of detail used to describe each alternative [90-16]. In this benefit also lies the potential for blind faith in the mathematical results of the amalgamation without regard to the data which was used to formulate it, or the sensitivity of the calculation to changes in the data [90-14]. The numerical precision of amalgamation results should never be mistaken for accuracy or consensus [79-315]!

The top-ranked alternative often depends on the method of amalgamation used [79-302]. For this reason, it is essential to carefully consider the requirements that the analysis is supposed to satisfy, including the purpose to be served, the usability of the results for the intended user, and the validity of the results, given the nature of the problem and potential biases, relative to other methods of amalgamation [79-301]. The purpose of the analysis, whether to provide a ranking, or to model the ranking process, should also be considered [79-303].

Amalgamation depends on the idea of significance, defined as the importance in human terms [78-96], as a common denominator for combining disparate results. Since significance to human beings is dependent upon value judgments which vary for different people, the results are not expected to be consistent if different decision makers are modeled [90-16]. Amalgamation can be quite difficult to perform, considering that decision makers often don't know what they want, different decision makers hold different values, and the choice of amalgamation method can affect the outcome of the process [79-315].

As one author wrote, "Difficult value judgments are inevitable required when amalgamating 'facts' (attributes of alternatives that, in principle, can be measured objectively) into an index or ranking of alternatives...Amalgamation is inherently subjective and value-laden..." [79-302]. While the selective use of amalgamation to highlight problem areas and tradeoffs among interest groups can be extremely helpful to the decision process, indiscriminate use of amalgamation serves only to obscure the problem and disguise tradeoffs [90-32].

The University of Southern California has developed a technique for matching facts from environmental impact assessment to relevant social values, to support informed decision making. The Simple Multi-Attribute Rating Technique (SMART) is intended to be an easy-to-use system for time- and resource-limited decision making. SMART is currently being tested, and so far has produced essentially the same results as more complex amalgamation techniques [88-83]. The use of systems such as SMART to quickly reduce complex descriptions of impacts

to usable rankings for many scenarios holds great potential for improving the efficiency and accuracy of environmental decision making.

4.3 Other Techniques to Aid Decision Making

Other techniques have also emerged in the literature as potential aids to environmental decision making. In addition to theoretically established tools such as systems analysis [98-11] and simulation and forecasting models [97-93], techniques such as comparative case- and system- studies are coming into consideration as solutions to managing complex environmental problems [92-114]. Innovative strategies being developed to aid in decision making for unstructured problems include the use of analogy, problem redefinition, intuition, formulation of new strategies from existing ones, and approximation [97-18].

The private sector has also contributed to solutions for environmental quality. As a result of factors such as liability, public scrutiny, pressures from the competition, and profitability due to changes in market demands [64-238], corporations have begun consider the environment in making decisions about use of resources, management of residuals, what products to produce, and how to incorporate environmental costs and benefits into their accounting systems [64-239]. Programs such as 3M's "Pollution Prevention Program" have resulted in payoffs including better environmental quality, conserved resources, improved technologies, and reduced costs [99-98]. The corporate world is finally realizing that "over the long run, the viability of business depends on the endurance of society and the natural environment in which it operates" [99-10].

5.0 Guidelines for Environmental Impact Assessment

In preparing an assessment of environmental impacts to aid decision making, it is important to consider the context in which the decision will be made. Some issues which should be borne in mind when developing environmental impact analyses of proposed actions are presented by Gardiner:

- Many alternative policies and programs will be competing for implementation
- Each program has a variety of social impacts, which may be direct and indirect, intended and unintended
- Many different viewpoints and value systems will be taken into account when evaluating these social impacts during the decision process [88-82].

It is important to proceed with the process of preparing an EIS with a clear idea of what decision makers and other readers will need to learn from it. The following subsections will discuss in more detail what information decision makers need to know to make informed decisions, what formats exist to help preparers of EISs, and what problems are commonly encountered in conducting EIA. Then, guidelines will be presented for conducting environmental impact assessment which can better facilitate and influence the decision process. This section of the paper will conclude with some ways to measure the success of the environmental impact assessment process, to enable planners and decision makers alike to judge the effectiveness of their efforts.

5.1 What Decision Makers Need to Know

A wise author (and admitted reader of many environmental impact statements) has said that "...information provides no utility by itself, but only as a way to improve decisions" [87-231]. Information can be viewed as a commodity, and since people have a limited ability to consume it and limited resources to expend on it, they tend toward not wanting to acquire information unless they need to use it [87-240]. Indeed, not only is overprovision of information wasteful on the part of the providers, it can also decrease the amount of information used by the informed parties [ibid]. It follows that the first step in determining what decision makers need to know is to try to estimate how much they are likely to be able to process. The idea of the marginal value of additional information proposed by O'Hare reinforces this concept by postulating that people generally expect any additional information they might acquire to support the position they've already selected [87-231].

For political decision making, well-structured information on a range of alternatives is needed [90-32]. This information should fully reveal the positive and negative impacts implementation of a decision could have on local interests and others, and should facilitate high-level consideration and comparison of entire programs, in terms of global objectives [74-129]. Information about environmental impacts should be summarized in terms of a basic evaluation, backed up by a narrative discussing relevant assumptions, characteristics of the evaluation technique, and highlighting key concerns [98-57]. The presentation should provide sufficient about the alternative choices and their impacts to allow the decision maker to reconcile "competing social goals" [90-12], and should present information about benefits, cost and tradeoffs, interactions between project components, the effects of varying alternatives on

solutions, and the ecological, sociological and economic effects of implementing each alternative [75-14].

Decision makers need to know what alternative courses of action are available to them, what circumstances of the problem are relevant but beyond their control, and what consequences and outcomes are associated with each potential choice [75-14]. Typical criteria which may be used by decision makers to evaluate alternatives include:

- Proposed location of the project and its current land use
- The differential assimilative capacity of various siting alternatives
- The degree of public controversy associated with each alternative
- Intangible benefits associated with each alternative
- Technology requirements for each alternative
- Significant "whole system" effects associated with each alternative
- Levels of risk associated with each alternative
- Degree of uncertainty associated with predicting the effects of each alternative [93-52].

The people who must manage environmentally significant projects and make decisions regarding them do not require "mass[es] of information on physical plans in technical jargon" [94-169]. Rather, what they need is a "brief," in simple but precise terms, incorporating "a comprehensive range of information [about each alternative], with advice on what the options entail" [ibid]. Environmental data must also be presented to decision makers with appropriate timing and depth of analysis [98-238]. In this way, they can make decisions promptly and consistently.

5.2 Recommended Format for the EIS

The Council on Environmental Quality (CEQ), created by NEPA to oversee its interests, has recommended the following format for an EIS (discussed in [98-24]):

1. Cover Sheet
2. Summary
3. Table of Contents
4. Purpose of and Need for Action
5. Alternatives, including the Proposed Action
6. Affected Environment
7. Environmental Consequences
8. List of Preparers
9. List of Agencies, Organizations and Individuals to Receive Copies of the EIS
10. Index
11. Appendices (if any)

For describing each alternative's anticipated impacts, the following descriptive criteria are recommended [76-78]:

- Probability of occurrence
- Anticipated magnitude

- Time frame
- Relevance of impact to each alternative
- Possibilities for mitigation (negative impacts) or enhancement (positive impacts)
- Supporting documentation.

A summarizing narrative should be used to integrate the various pieces of the document. The narrative should address the following topics [98-13]:

- Direct environmental effects and their significance
- Indirect environmental effects and their significance
- Possible conflicts between the proposed action and the objectives of existing plans, policies and controls
- Environmental effects of alternatives
- Energy requirements
- Natural or depletable resource requirements
- Urban quality, historical, and cultural resource effects
- Means to mitigate adverse environmental effects.

These guidelines provide a framework for preparing the draft and final EIS documents, and can serve as a checklist for preparers to ensure that no relevant or required information has been excluded or omitted [94-78].

5.3 Common Problems in EIA

Several common problems that impair the potential effectiveness of environmental impact assessment in influencing the decision process have been identified by Berzok [80-121]. First, sometimes EIA is not done early enough to have any potential to influence project design and definition. Too little public involvement is another common problem. The existence of biases on the part of the evaluators can sometimes interfere with their recommendations, as can the selective gathering of information to inequitably support the proponent's original design. Problems also occur when the lead agency perceives the EIA process as an obstacle to be overcome, rather than an opportunity to improve the proposed action. Finally, in many established processes for EIA, there is little carry-over from one learning experience to the next.

Two common but fundamental deficiencies in EISs have been noted by Gardiner [88-82]. First, some preparers succumb to the temptation to include as many facts as possible in the document. Gardiner emphasizes that having too many facts is as bad as having too few, especially without a good system for retrieving the information from the document. Secondly, little or no connection is provided between the presented facts and the public values which the decision makers are trying to accommodate.

Finally, some problems specific to the nature of environmental problem solving plague those who attempt to quantify environmental impacts [98-14]. These include the difficulties and expense associated with collecting "objective" data, the necessary layering of subjective analyses with that data to evaluate it, the need to "red flag" problem areas and data gaps to ensure their adequate consideration, and the extreme difficulty faced by the decision maker in trying to select an alternative by relating human values to abstract amalgamations of potential impacts.

5.4 Suggestions to Improve Usability

While traditionally agencies have thought that the EIS should be painstakingly complete and detailed, CEQ began to notice that sometimes the sheer volume of the EIS document obscured the data contained therein [76-31]. This agency attitude was shaped in part by the operational criterion imposed by the NEPA system for judging the adequacy of an EIS: that it be able to "withstand a court test of its completeness imposed by someone who is specifically looking for faults rather than trying to use it" [87-243].

One way to address the goal of usability while not compromising detail or completeness is to "tier" the presentation of information into several levels of depth and specificity, based on the amounts and types of information your audiences are likely to require [87-240]. The needs of decision makers and other readers, who are interested only in the results of the analysis, can be satisfied with an executive summary of the results, while people who need to investigate the methods or documentation of facts can explore the analysis in greater depth by reading the documentation and facts contained in the supporting appendices. A good system of cross-referencing or "road maps" should be provided to aid navigation through the document [87-242].

A second way to increase the usability of a detailed EIS is to consciously provide a system for retrieval of relevant facts, such as a particular organizing structure or an adequate indexing system [88-82]. The fact that voluminous sets of facts such as the Kinsey Studies, almanacs, and encyclopedias are considered useful by the majority of users attests to the potential of organization and indexing to increase usability. One possible organizing system is to package the data by potential user, rather than by subject [87-242]. This system enables the user to quickly identify what elements of the project and which associated impacts may affect him specifically.

Additional guidelines provided by CEQ to improve the usability of EISs can be found in the documentation of its recommendations to agencies and have been discussed in some detail by Erickson [76]. First, preparers of EISs should try to keep their description of actual data and methods of analysis commensurate with the relative importance of the impact as determined by the analysis [76-31]. Second, highly technical and specialized analyses and data should not be included in the body of the draft EIS but rather included as supporting documentation in appendices or merely referenced [ibid]. Third, descriptions of the existing environment and proposed actions should be included in an EIS only to the extent that they are necessary for decision makers to understand the proposal, its reasonable alternatives, and their specific environmental impacts [ibid]. Finally, while the need to use the previous measures to improve the usability of EISs is real, it should not imply an opportunity to reduce the quality or specificity of environmental research. CEQ has stated that "environmental conclusions stated in an impact statement must still be logically supported by references to standard texts, scientific literature, appendices, special studies, or textual material within the statement..." [76-32].

5.5 Suggestions for Better Public Relations and Involvement

The inclusion of the public in the environmental assessment process is a specific provision of NEPA. Yet many agencies see the public as an obstacle to overcome in executing their project, the involvement of which reduces their control over the project, instead of the

ultimate beneficiary of the project who can help contribute to its success [80-128]. The public has the ability to act as an "informational resource" for the EIA process, and can contribute meaningful information based on its interests, values and familiarity with the situation and conditions surrounding the proposed project and the need which stimulated it [80-129].

Public participation can also contribute to the stability of the impact assessment process. As one author wrote, "When people are given a genuine role in the impact assessment process, they are more likely to perceive the process as legitimate" [ibid]. She goes on to note that in the vast majority of cases, members of the public have "commanded the respect and attention of the lead agency" when afforded the opportunity to make substantive comments about proposal [80-128]. Finally, she suggests that agencies may be more willing to "give the public a real role" when the process of public interaction is managed and facilitated by "in house" or third-party professionals [ibid].

The public has the ability to create real barriers to implementation of a project. And if the public is not convinced that the project is needed, detailed technical information presented by the agency to convince them otherwise is virtually useless [80-130]. In order to avoid being placed in the position of trying to defend their credibility to the public, agencies need to take a proactive stance toward the management of risks associated with the process [82-7]. And as long as environmental policy decision making is believed to lie solely within the domain of government experts, conflicts with the general public are inevitable [66-212].

Agencies are required by law to publicize the availability of the draft EIS, actively solicit comments from the public, and hold or sponsor public hearings or meetings [98-25]. In general, public workshops are good sources of information for both the public and the lead agency, and may prove to be much less "frustrating and intimidating" than public hearings [80-128]. Other techniques to integrate citizen perceptions into the decision process (and recruit them to the "cause" of the agency) include group discussions and negotiations, which foster community identity and trust [71-24].

Possible agency responses to public comments are modification of alternatives, development of other alternatives which were previously excluded from consideration, supplementing, improving or modifying the analysis, and making factual corrections; or, alternatively, providing justification of why no response is necessary [98-25]. Suggestions for most effectively influencing the attitudes and opinions of the public audience suggested by Swap [74-24] include the following:

- Dramatize any "clear and present dangers" which may exist
- Present information vividly, on a personal level
- Use visible and credible models
- Create opportunities for behavioral commitments.

Suggestions by other authors include providing for a dialogue with the public in the early planning stages of a project, acknowledging the presence of competing value systems, giving adequate consideration to nontechnical, qualitative issues which are important to the public [80-126], and even making provisions for interested parties to obtain or verify information to their own satisfaction, also known to this author as the Rule of "See For Yourself..." [87-245].

Maintaining credibility in the public eye is critical to the success of the planning and implementation processes. The rules for achieving and maintaining credibility as developed by Bidwell, et al [82-11] are:

1. Be honest and open in communications
2. State clearly how you plan to act
3. Act as promised
4. Give reasons for decisions that will appear reasonable to the majority
5. Treat the public as if you believe they're intelligent and mature.

Finally, O'Hare suggests that debate among interested parties shouldn't be arbitrarily limited to a given set of alternatives [87-246]. However, since finite resources prohibit consider consideration of too many alternatives, he suggests establishing deadlines in advance to limit the addition of new ideas or changes to existing ideas, as a legitimate way of avoiding excessive delay [87-247].

5.6 Suggestions for Structuring the EIA Team

For an EIS to be adequate, a full range of relevant sciences needs to be invoked [92-85]. Yet it is admittedly difficult to coordinate the work of diverse disciplinary specialists to produce the required coherent assessment of environmental implications for the set of action alternatives which is required in EIA [92-83]. In particular, technical specialists are usually trained to focus narrowly on specific phenomena that lie within their range of expertise, rather than to interact and make concessions to the "variant viewpoints of other disciplines" such as are required for participation in interdisciplinary planning and analysis [92-84, 92-7]. And scientists are often surprised to find that factors such as "misinformed consumerism" and political bargaining are more influential in policy making than scientific evidence [82-7].

Determination of the significance of environmental impacts and preparation of the EIS can most effectively accomplished by an experienced interdisciplinary team working with current modeling techniques to lay out and compare alternatives [78-92], under the leadership of a qualified professional who can encourage "integrated, interdisciplinary teamwork" rather than "multidisciplinary, disjointed results" [92-84]. Where possible, a permanent "core group" of agency discipline specialists should be established to perform impact assessment, working in conjunction with writers to create and review documents [78-94]. The benefits of using a permanent core group to conduct EIA include more uniform and coherent treatment of issues and writing style, built-in quality control, constant updating of the combined pool of experience, and easy interfacing with outside specialists [78-95]. In addition, new people brought into the EIA process can be quickly and effectively trained and brought up to speed by core group personnel.

The importance of open lines of communication between agency planners and decision makers is essential to ensure understanding of the constraints and most relevant issues of decision making on the part of the planners, and correct interpretation and understanding of the analytical results obtained in EIA on the part of the decision makers [76-69]. In addition, developing explicit interagency agreements about jurisdiction and domains can be helpful in avoiding duplication of effort and can facilitate the cooperation of agencies where joint efforts are required [76-29]. Finally, the use of "non-partisan conveners" to facilitate public workshops, serve as agency liaisons to interested citizen groups, document all processes, monitor and

enforce the provisions of the EIS, and support the transfer of knowledge and experience over the EIA process is highly recommended [80-131].

5.7 Suggestions for "Tightening Up the Process"

The addition of feedback loops to support the transfer of knowledge and experience from one EIA to the next is a significant way to improve the EIA process [78-96]. These loops can be used to assess the effectiveness of mitigation measures and weigh their effectiveness against corresponding costs and benefits [ibid]. Other suggestions to improve the EIA process include incorporation of the probabilistic nature of potential impacts, the use of statistics to provide measures like sensitivity of the results to changes in the data, allowing for midcourse corrections in the direction the project is taking, and the use of economic criteria to guide data collection [89-185].

The objectivity of decision making can be enhanced by making explicit the data and procedures upon which the decision is based [97-9]. The most important step of the EIA process is the initial assessment of *significant* effects during scoping [78-90]. If the impacts of the project are found to be not significant, then the additional effort of preparing an EIS is not necessary. If significant impacts are found, then the "lens" used to focus the rest of the process, from analysis to writing, should be the *significance of impacts in terms of human values* [78-96].

Another way to reduce the effort required in EIA is to make use of existing data whenever possible [98-14]. One way to do this is to get a complete proposal, including all relevant information, from the project proponent before entering the EIA process [78-90]. This effort can be facilitated by providing all applicants with complete, explicit, and specific guidelines for preparing the description of the proposed action [78-92]. A second technique for using existing data is to modify the applicant's proposal when possible, rather than starting over, when it is necessary to make changes in the action as it is proposed [78-89]. If mitigation can be applied to the original proposal to eliminate significant impacts, the requirement to prepare an EIS can be eliminated [78-92]. An unanticipated side effect of this loophole is that mitigation of environmental impacts is now commonly incorporated into the original project design process [92-132].

Many federal and state agencies have already developed very specific guidelines for EIS preparation. Taking advantage of these guidelines can help to ensure that all necessary information is provided, and can save significant effort in preparing and organizing the document [76-26]. When considering whether or not to proceed with EIA for a particular project, it is essential to check first whether the project is subject to any categorical or legislative exclusions [78-93], since if the project is excluded by type, no EIA will be required.

Finally, it is essential to recognize at all stages of the process that different objectives and analysis methods will produce differing results. If it is impossible to agree on goals, objectives, and constraints, the results of EIA will prove to be relatively meaningless [67-170]. Moreover, the rather tenuous efforts to quantify in terms of human values and significance what is essentially only qualifiable data may lead to false perceptions of accuracy or consensus, as noted earlier in this paper. Thus, although the ultimate desire of political decision making is to seek consensus, strict documentation of objectives, values, assumptions, and procedures is essential to even attempting to reach a decision which is satisfactory to all involved groups [90-33].

5.8 Suggestions for Decision Makers

Various advice is advocated in the literature for reducing the liability and complexity inherent in the task of making environmental decisions. Some strategies listed by Bidwell, et al, for coping with risk include reducing the actual risk whenever possible, encouraging acceptance by the affected parties of some degree of perceived risk through education or offers of compensation or insurance [82-12]. Other ways of dealing with risk include placing emphasis on the benefits of potential outcomes, taking a proactive stance on mitigation, building legitimacy and credibility, and seeking consensus wherever possible [82-10].

When attempting to assess the opinions of constituents, it is essential to have a clear understanding of the problem and associated objectives, use simple and nontechnical language whenever possible, and listen to the audience and know their concerns [82-13]. Decision makers need to recognize that it is especially difficult for people who have expressed commitments to certain ideas or beliefs in the public spotlight to change their orientation without losing face [87-243]. Therefore, all efforts to inform or influence other people need to be directed by diplomacy. Moreover, if programs are presented in "take-it-or-leave-it" terms, people may decide that the status quo is preferable to the program as presented, and may require "overwhelming evidence contradicting what he knows before he will rationally invest in more information" [87-243]. For this reason, it is important to keep the possibility of persuasion alive by keeping participants uncommitted until the last possible minute. If everyone agrees that a certain solution is "pretty good," then no one feels like a loser. The best way to attain this outcome is by providing many possible alternatives, each described by as many parameters as possible, so that the final choice can be "tweaked" over a wide range of values [ibid].

5.9 Measures of Success

While various criteria exist for evaluating the success of environmental assessment efforts, the practical test of the effectiveness of EIA is the extent to which decision makers revise their plans to account for environmental impacts as a result of the EIA [81-285, 92-87]. Other components of EIA effectiveness are defined by Ortolano, et al as follows:

- Compliance with the rules, regulations, and other procedural requirements of a formal EIA program
- Preparation of adequate EIA documents
- Utilization of "proper methods" in assessing impacts
- Influence of environmental information on various aspects of formal planning, including
  - formulation of alternatives,
  - selection of a proposed plan, and
  - mitigation of anticipated adverse impacts
- Placement of "appropriate" weight on environmental impacts relative to economic, social, and technical factors [81-285].

Using these measures of effectiveness, the reader of this paper may evaluate the degree to which changes in the EIA process of which he is a part represent improvements in the journey toward the goal of environmental quality.

6.0 Conclusions

Some conclusions drawn by Berzok about NEPA and the EIA process echo the points emphasized in this paper:

- Environmental Impact Assessment could be better used to shape the process of project definition.
- Adequate technical procedures currently exist to enable planners to accurately forecast and evaluate potential environmental impacts.
- In general, the public wants a meaningful role in the EIA process.
- EIA could be significantly improved by adding feedback and learning mechanisms to the process [80-108].

The benefits of improving the environmental planning and decision making mechanisms are clear: better environmental quality, reduction in liability and future costs, lower life-cycle costs, and reduced delays in project implementation [98-104]. The development of all programs carries an inherent responsibility to maximize environmental quality, together with other goals [98-33]. Over time, the net result of redirecting the nation's productive capacity and consumer demand will lead to preference of durability over planned obsolescence, to stimulate proper stewardship of limited resources through recycling and development of new technologies, and to stimulate interest in sources of satisfaction which reduce environmental distress [93-5]. Given the impacts of NEPA and a good process for evaluation of environmental impacts, we may rest assured that while decision makers can still choose to disregard the scientific evidence of the environmental impacts their decisions may have, they can no longer claim ignorance as a defense for those choices [92-37].

7.0 References

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