"SHARED VISION" MODELING FOR ENVIRONMENTAL PROJECT PLANNING

Dr. Leonard Shabman
1901 Meadowview Circle
Blacksburg, VA 24060

PREPARED FOR PLANNING AND MANAGEMENT CONSULTANTS, LTD., CARBONDALE IL, Dr. Tim Feather (Project Manager), June 19, 1995

Introduction

> Restoration planning for the USACE still poses the traditional planning question: are the costs of an alternative warranted by the values received? In the USACE tradition this question was answered by relying on calculations made by planners for the budgetary authorities of the agency. The challenge of doing these calculations is now being replaced by the challenge of building agreements on what costs for achieving restoration planning objectives are "acceptable". Such planning for the USACE will demand identifying the "relevant" decision makers, determining what technical analysis is needed to support decision making and then communicating the finding of that analysis in a way that is useful for reaching agreements.
> *Shabman, in Feather et.al., 1994*

Shabman (Feather et.al, 1994) argues that elements of the traditional planning model are applicable to environmental project planning. However each of the elements, from defining desired outputs to judging the merits of changes in a watershed, will need to be attuned to the particular concerns of decision makers and to their understanding of the watershed[1]. Schkade (Feather et.al, 1994) argues that decision makers construct their preferences for environmental outcomes from the particular choice circumstances they face.

---

[1] "Decision makers" are individuals, agencies or groups who are able to take political or legal action to advance or thwart implementation of a water management alternative.

Together these two arguments imply that the environmental project planning process must not be wedded to "experts" definitions of environmental outputs, to particular measures of costs (e.g. forgone NED) or to standardized decision criteria for trading off between costs and outputs. Instead, the very process of making a decision yields its own measures of outputs and its own criteria for judging the acceptable costs for achieving different output levels. In the end acceptable tradeoffs can be described only after their has been an acceptance by stakeholders of a particular alternative.

A decision support approach for this choice making model has been developed and employed by the US Army Corps of Engineers, in its *National Study of Water Management During Drought*. The Corps has named the approach the "shared vision model"(SVM).[2]

Shared Vision Modeling

Implementation of a water resources management alternative requires agreement among multiple decision makers. Water resources modeling is expected to help in securing that agreement. However, as model building has become more complex and costly, models have become the domain of experts who are expected to develop models independent of decision makers and then transfer (translate) the model results to those decision makers.

It is also common in the literature to refer to these decision makers as "stakeholders". The terms are used here as synonyms.

[2] The Corps National Drought Study was conducted by the US Army Corps of Engineers, Institute for Water Resources. The IWR draft reports and extensive interviews with Mr. William Werick of IWR provide much of the basis for the following comments on the SVM approach. See: US Army Corps of Engineers, Institute for Water Resources, National Study of Water Management During Drought: The Report to Congress (DRAFT) IWR Report 94-NDS-12, September 1994;and,

Physical models are constructed to understand “in miniature” the hydrology of a watershed in order to design structurally adequate dams, channels and levees. Mathematical (computer based) simulation and optimization models can be developed for these same purposes. However, mathematical models are also required to understand matters that escape physical models, such as the effects of alternatives on fish and wildlife populations, on the general economy or on the income position of stakeholder groups.

Mathematical models are necessarily abstractions of the system being modeled and so approximations of some relationships are necessary in model building. The judgment of the modeler is important in deciding what these approximations will be. However, model results may be sensitive to model building judgments, or at least there is the prospect that this will be the case. Therefore, decision makers must have confidence in the model construction if they are to use model results as a guide to decision making. When there are multiple decision makers who must reach agreement on a choice of actions, there must be agreement on the analytical models. Agreement on the models is a forerunner to agreement on an alternative.

In environmental project planning there often is uncertainty about how ecological systems and their components will respond to an alternative. As a result, agreements are often negotiated over "technical" matters such as model design and data bases. These agreements must be established among stakeholders including natural resource agencies of the Federal government and the states, traditional water development interests and environmental groups. The challenge is to have models that best represent technical,

---

Werick, William and William Whipple, Jr. Managing Water for Drought, (DRAFT) ecological and cost conditions (perhaps by peer review), while also securing the confidence of decision makers.

Consider the example of modeling juvenile anadramous fish mortality as the fish pass down river from their spawning grounds. Mortality may be due to predation, to power houses at the hydro-electric dams or to extended residence time in the pools behind the power dams. How these mortality estimates are made, and how their relative magnitude is represented in a model, can affect the alternatives selected to meet the desired objective of increasing juvenile fish survival. In addition, the cost per fish saved will depend upon cost estimation models.

One way to help reach agreement on complex environmental issues that must be addressed through modeling is to integrate the stakeholders into the model building activity. The development of shared vision models is a way to achieve this result.

> "Shared vision models are *computer simulation models of water systems built, reviewed and tested collaboratively with all stakeholders*. The models represent not only the water infrastructure and operation, but also the most important effects of that system on society and the environment. Shared vision models take advantage of new, user friendly, graphical simulation software to bridge the gap between specialized water models and human decision making processes. Shared vision models (help) ... overcome differences in backgrounds, values and agency tradition." [emphasis added]

IWR Report 94-NDS-8, September 1994.

US Army Corps of Engineers, Institute for Water Resources, National Study of Water Management During Drought: The Report to Congress (DRAFT) IWR Report 94-NDS-12, September 1994, p.xvi)

Several aspects and contributions of SVM are evident in this description of shared vision models.[3]

Fi*rst*, shared vision modeling is not directed to an isolated part of the decision problem. Instead the SVM integrates many aspects of a problem that often are modeled separately. SVM models are built in pieces (modules), are built methodically for each piece and are built to be open to comment and understanding by all model users. Making the connections among model components is central to the SVM building process. An SVM model of juvenile fish might include modules where all stakeholders agree on the relationships describing predation mortality, mortality at the power generating facilities and losses in the pools behind the dams. Also, the SVM process would be used to describe financial costs as well as opportunity costs (such as forgone power) that would be incurred for any alternative that would reduce mortality by a given amount from any of the causes. The connections among the modules would be used to describe the cost and effectiveness of each alternative in reducing juvinelle mortality. By having stakeholders reach agreement on each module there is a basis for them to agree on the cost effectiveness estimates. Note however that the SVM must not be "garbage in and garbage out". The SVM needs to have expert participation in its development and must be peer reviewed and team reviewed.

[3] The Corps SVM employs a user friendly computer package called STELLA II [R.]

Second, SVM is expected to include the elements of a standard rational planning process. The purpose of modeling in traditional planning was to identify how well alternatives meet pre-defined objectives. There were protocols for measuring the "values" achieved by an alternative in terms of the objectives. Thus there might be reference to "NED value" or to "EQ value" of any alternative. The modeled effects of an alternative on these objectives were reported to a decision maker who was expected to choose an alternative. In this approach, objectives are stated in conceptual terms and weights among objectives are established without regard to the particular choice situation. The modeler justified measuring the effects of alternatives on the pre-determined objectives by assuming that tradeoffs would be made among objectives.

Some modelers used surveys to elicit decision makers weights on different objectives (and perhaps to even elicit the objectives). In these cases, the elicitation of weights (and objectives) is an intermediate data collection step that permitted the modeler to solve an optimization problem for a "decision maker", thus defining the best alternative among those available.

However, there is a fundamental difference in the SVM approach. Models and data are expected to help people in a decision making collectively *form* (construct) their preferences for different alternatives. SVM helps people discover objectives and the tradeoffs they are willing to make to reach agreement.[4] While there must be some initial definition of objectives and alternatives, these are subject to revision as new understanding is achieved. In creating the SVM, the objectives, the measurement metrics for the objectives and the weights among objectives emerge from the group as it works through the modeling process. For example an initial output objective of juvenile fish survival might shift to an objective adult fish returning to spawn some years later. In turn, this may demand a new module for the SVM model that represents fish growth and mortality once the leave the river where they spawned.

Third, SVM is built with the purpose of quickly answering "what if" questions for stakeholders. This capacity can assist in reaching agreements in two ways. One way is to test the sensitivity of the model solution to coefficients that might be in dispute. Given the scientific uncertainty and room for different views, the ability to accomplish rapid "what if" simulations of different technical and data assumptions will help participants to agree on the planning objectives, on the alternatives that might be formulated and on effects of the alternatives on planning objectives as well as on their particular social and economic interests. If, for example, there was disagreement on the number of fish that die at a power house, but there was agreement on other parts of the model then the sensitivity of the results to different coefficients for fish loss could be quickly assessed and the basis of selecting a compromise might be established. A second way that "what if" modeling can support agreement is to allow rapid assessment of tradeoffs by letting stakeholders "experiment" with different alternatives, immediately see the consequences and perhaps find bases for agreement. In this way tradeoff analysis can be rapidly accomplished. This is how modeling can be used in the consent/agreement building process.

[4] The emergence and revision of objectives as a part of planning is not a finding of the IWR reports on drought applications of the SVM approach.

Fourth, shared vision models can provide the basis for the discovery of mutual gains.[5] Of course interests among decision makers differ and different alternatives may have different effects on decision makers. If winners occur but losers are able to block action then the SVM model provides a way to search for alternatives, including side agreements, that are acceptable to those who can advance or block a choice. For example, the loss of power generating capacity in order to pass fish might be addressed by funding of special energy conservation programs or by developing ways to provide replacement power though the wholesale power market. These options could be addressed by developing a power module for the SVM and then through the SVM the possibility of mutual gains (or no losses) for all stakeholders might be assessed.

The idea of discovering mutual gain through modeling (called integrative bargaining in the negotiation literature) can be understood in terms of how preferences of decision makers for particular outcomes are constructed (Schkade, in Feather et.al., 1994) and not recalled by individuals and how such preferences are discovered in and emerge from group decision making settings (Shabman, in Feather et.al., 1994). In effect the decision making process is a value discovery process is an outcome of a decision making setting and is not an external input to that decision making setting.

Applying the SVM Approach

SVM, by creating a common exercise of model building, provides the focal point for assembling a team that crosses interest, organizational and geographic boundaries.

---

[5] One challenge will be to determine which stakeholders should be part of the

Once the team is assembled the shared vision model becomes a focal point of negotiation. In that sense the SVM becomes analogous to the single negotiating text approach to dispute resolution. However, SVM won't bring stakeholders to a negotiation if they were not willing to negotiate without a SVM. Stakeholders need to commit to a negotiation approach to conflict resolution (decision making) for the SVM to apply. As a related point, SVM won't solve problem of stakeholders trying to take advantage of a negotiation, by withholding information in an attempt to gain strategic advantage over others. In fact, stakeholders often act in a tactical manner, withholding data and information, and that same data and information may be needed for the building of the SVM.

Putting aside these difficulties and assuming that the stakeholders wish to bargain in good faith the construction of the SVM requires a user friendly, but powerful computer package.[6] STELLA II [R] is a brand name software package that was chosen by the Corps to assist in its SVM modeling for its drought management case studies. STELLA II [R] is a graphically oriented simulation modeling package that can be purchased off-the-shelf. The software is a visual spreadsheet for system analysis where the process being modeled is displayed as a "picture" rather than as a series of equations. While there is a need to employ a sound understanding of the system (often in terms of equations) when building a SVM, it is also possible for users to enter relationships in graphical as opposed to equation form and to see output in the same terms.

---

negotiation process.

[6] The building of a SVM contributes to building trust among stakeholders. Such trust building can contribute to achieving a negotiated agreement.

User friendliness does not mean that all decision makers (stakeholders) can be equally active or effective in building the SVM. Also the development of a SVM can be expensive in money and time and these costs will rise as the number of stakeholders increases. The stakeholders who are directly involved in the construction of the SVM must be technically competent, few in number but well connected to other stakeholders. In the end, all stakeholders must agree to be part of the SVM process and to abide by its outcome, if they are satisfied that the process has provided a technically strong and "fair" consideration of alternatives.

This need to manage stakeholder involvement in developing the SVM is why the Corps developed the concept of "circles of influence". The circle of influence allows stakeholders to have varied levels of responsibility and influence on the SVM consistent with their own interest and expertise. The basic idea is to have an inner most circle that includes technical agency personnel who have lead responsibility for building the operating SVM algorithm. Around this inner circle are representatives for each stakeholder class, such as environmental interests. This circle will review the model and reports. The next outer circle includes a representative of each specific stakeholder group for the issue. These people meet twice a year in workshop settings to use the model in a decision making setting. The last, and outermost circle, includes those with legal and budget authority to implement agreed upon alternatives.

Conclusion

Future planning for environmental projects will require involving multiple stakeholders in model development and in decision making. The shared vision modeling approach offers a computer assisted tool for facilitation negotiation and agreement.

However, the SVM is not a substitute for negotiation, but rather is an aid to negotiation. If stakeholders are unwilling to negotiate, or if a negotiation based decision process is not to be used, then the SVM approach is not warranted.