EPRI

Creating a New Distribution Asset Management & Infrastructure Planning Function at AEP

Project Report

Prepared For
American Electric Power
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EXECUTIVE SUMMARY

The purpose of this project is to develop and deliver a new distribution asset management and infrastructure planning capability at AEP. Business success depends in large part on making good investment decisions – decisions that result in an efficient delivery infrastructure. This project will deliver an infrastructure planning capability at AEP, including a process and analytical tools that will significantly improve future business performance.

The project consists of three phases. In the first phase, EPRI and AEP created a new distribution infrastructure planning process designed to meet the needs dictated by the changing nature of the electric power delivery business. The new process is based on the specific problems and needs that exist at AEP. It is a systematic approach to problem identification, analysis, and solution. The process will both require and facilitate changing the mind-set of individuals in the organization. The new infrastructure planning framework will motivate the planners and engineers to:

- focus on the economic value added of their actions
- recognize the importance of making business strategy decisions as well as technical decisions
- develop investment strategies that provide value to customers and return to shareholders

In the second phase, the analytical needs were assessed. Infrastructure investment choice is complicated by the long life and relatively large scale of the traditional choices (wires and transformers), the emergence of new investment alternatives including distributed generation, and the uncertainty associated with future customer loads, technology costs, and customer power quality needs.

These complications suggest that a good technical or engineering planning process is not sufficient to insure good investment decision-making. A good planning process helps insure that planners and engineers ask the right questions and identify the right problems. Nevertheless, further quantitative analysis is required to explore the economics and find superior solutions to the problems, considering both traditional and non-traditional alternatives.

In the second phase of the project, EPRI and AEP identified the specific quantitative tools that are needed to support the planning process at AEP,

and developed a plan to bring the tools in-house. The conclusion is that no off-the-shelf tools exist at this time. We decided to design and build our own tools. Both data-gathering and decision-making tools have been designed and prototypes have been tested.

In the third phase of the project, these tools will be built and brought in-house.

The report describes details of the first two phases with particular attention to the structure of the solution methodology, the design of the process, the design of the data-gathering process, and the principles underlying the methodology.

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Part I
PROJECT REVIEW

A Project Overview

A.1 Objective

The objective of this project is to create a new distribution asset management capability at AEP. This will involve designing and implementing an approach to systematic problem solving for distribution asset management and infrastructure planning. The problem solving framework will focus on identifying the underlying problems encountered in the distribution system and finding all potential alternatives and options that can be used to solve each problem. The capability will also include analytical methodology, software and training that will allow AEP's distribution planners to explore more fully the economics of the potential solutions.

This new planning capability will allow the company to develop transmission and distribution (T&D) and distributed resource (DR) investment strategies that meet customer needs, while taking into account the risks associated with future load uncertainty, costs, and industry restructuring. The methodology will help the company design risk-managed infrastructure investment and maintenance strategies.

A.2 Tasks

The objective, creating a new distribution asset management capability, is being achieved by carrying out a three-phase project. Phases 1 and 2 are complete. The first phase *tailored a systematic problem solving approach* to meet the needs of distribution asset management and infrastructure planning at AEP. The problem solving framework (planning process) was transferred to AEP through on-site training for about 20 people.

The second phase of the project was an *assessment of analytic needs.* This phase involved joint work among the EPRI project team and AEP staff to (1) identify the specific analytical tools needed to support distribution asset management and infrastructure planning, and (2) develop a plan (budget, man-hours, and project schedule) for obtaining the tools and training people to apply the methods.

The third phase will *implement the plan from phase 2 and transfer the analytical capability to AEP.* It is anticipated that the analytical tools will be transferred to AEP by carrying out at least one case study, and, in the process, training the distribution planners to use the methodology and software. Every effort will be made to use analytical methods available or under development from EPRI (such as the Area Investment Strategy Model, and the methodologies for asset replacement and reliability planning). However, if this effort identifies specific needs that cannot be met through EPRI products, the project team will review and suggest products from third party organizations, as well as identify opportunities for EPRI product development.

The tasks below describe the scope of the three phases of this project.

A.2.1 Phase One: Problem Solving Framework

Task 1: Develop the infrastructure planning process and associated training materials. The deliverable will be a new planning process tailored to the needs of AEP's distribution planning problems.

Specific deliverables will be a description of the process, overhead slides for training purposes, and references to appropriate literature covering systematic problem solving processes. Hypothetical case studies will be used as part of the training. On-site visits will be used to document (1) the planning situation at AEP, and (2) the nature of the planning problems that the company faces.

Task 2: Based on the materials developed in task 1.1, deliver a training class at AEP. This class will be for 20 to 30 people and be 2 to 3 days in length.

Phase 1 Schedule: All deliverables for task 1 were completed during 1998.

A.2.2 Phase Two: Analytical Needs Assessment

This phase will be carried out concurrently with phase 1. On-site visits will provide insights into the nature of the planning problems at AEP. The visits will be the key to identifying analytical needs.

Task 1: Based on field work at AEP, EPRI will identify specific analytical planning needs and will identify EPRI tools, both currently available and under development, that meet AEP's needs.. To the extent that specific needs exist and appropriate analytical methods are not available from EPRI, products from third-party organizations will be reviewed and suggested.

This investigation will include but not be limited to the following problem areas: (1) market research focused on understanding customer needs, (2) planning for infrastructure investments to meet new customer needs, (3) planning for replacement and repair of exiting aging assets. The analytical needs list will be driven by specific planning needs at AEP.

Task 2: Develop a plan for bringing the new analytical tools in-house, and creating an in-house capability to use the tools. This plan will include the budget, man-hours, and project schedule. Some EPRI distribution infrastructure planning products are still under development; e.g., the customer needs research and the asset replacement model.

As part of the plan for bringing new analytical tools in-house, the project team will identify:

- analytical products currently available,
- the delivery schedule for products under development,
- opportunities, costs, and manpower requirements associated with early adoption of methodologies under development (such as the asset replacement model).

Phase 2 Schedule: Deliverables for phase 2 were completed during 1998 and early 1999. One of the deliverables is this report summarizing the specific analytical needs at AEP, the alternatives for meeting these needs, and a plan for creating an in-house capability to use the tools.

A.2.3 Phase 3: Analytical Capability Development

Phase 3 be done in 1999 and 2000. Phase 3 will carry out the plan developed in phase 2. At the time of this report, we know that training will be required. We also know that one of the best ways to train people to use a new analytical approach is to identify a specific real-world problem and work with the people to apply the methodology and solve the problem.

The specific approach, deliverables, costs, and schedule were determined by the scope defined in phase 2.

A.3 Project Outcomes to Date

As of this writing, the project team has accomplished the following.

1. The distribution planning problem experienced at AEP has been well-defined. (See section I.B.3, below.)
2. The problem-solving framework has been developed.
3. The analytical needs assessment has been completed.
4. The value measurement methodology, tailored to AEP needs, has been designed. (See section I.E.1, below.)
5. The value assessment methodology has been tested and presented to AEP staff.
6. A working prototype of the project / portfolio analysis software has been designed, implemented in Excel, and successfully demonstrated.

Thus, phase 1 and phase 2 of the project are complete. These results will be discussed further in the report. We have also jointly determined that phase 3 should be implemented as a tailored collaboration between AEP and EPRI.

B Problem Statement

This section has two purposes. First, the general problem of distribution system planning is described with respect to business considerations and the associated analytic perspective. Second, the specific problem encountered at AEP is stated. This problem statement is the first of the project accomplishments listed above.

B.1 The Business Problem

Building and maintaining the distribution infrastructure accounts for over 40 percent of total electric utility investment. Distribution planning decisions are typically driven by technical issues and budget constraints.

The main objective is maximizing system utilization and reliability within a fixed budget. Distribution planning focuses on the near-term customer demand. The major decisions involve timing: when to add transformers and feeders. At present, little attention is given to alternative technical solutions, the scale of investments, or the long-term implications of resource commitments.

This planning approach was successful in a particular business environment. A series of changes have caused that environment to shift. These changes include the following.

- Industry restructuring, already under way, is bringing about the disaggregation of most vertically integrated electric utilities.
- For many companies, the funds allocated to the distribution side of the business have been reduced. Distribution engineers are required to build a business case around all significant projects.
- New customer needs, which vary by market segment, are beginning to emerge. An increasing number of customers are demanding higher reliability and improved power quality.
- Technology advances in information, communication, power electronics, materials, and distributed generation are providing new options, and potential pitfalls, for meeting customer needs.

Distribution asset management and infrastructure planning must respond to these changes. Today, and in the future, successful distribution planning requires making business strategy decisions in conjunction with technical engineering decisions. As a result, distribution infrastructure planning must evolve into a process that (1) considers capacity additions as investments, (2) forecasts customer needs, (3) develops new investment strategies and service offerings that provide value to customers and return to shareholders, and (4) assesses and manages the risks associated with the chosen planning policy.

B.2 The Analytic Problem

System engineering principles can create a sequence of actions that respond to a specific trajectory of conditions. However, the system engineering principles do not address uncertainty and the need to develop strategies that take into account the facts that (1) the future is unpredictable, and (2) conditions will change over time. These facts require plans conditioned on future changes.

EPRI is designing new approaches that allow utility planners to develop strategies that are responsive to uncertain future needs and market conditions. System engineering approaches are augmented with strategy development and analysis methodologies that are based on economic objectives and that explicitly consider the effects of uncertainty.

The new approaches lay out both the potential actions over time, as well as the spectrum of future needs and market conditions. Then, collections of feasible decisions are analyzed across all possible future needs and conditions. The analytic challenge is to make the analysis tractable. This has been accomplished by applying state-of-the-art mathematical modeling techniques implemented using efficient computer software. EPRI's Local Area Investment Strategy Model is an example of this new approach.

The optimal (least-cost) set of actions over time, given a specification of the potential future market conditions and uncertain evolution of system need, is found by such an approach. The optimal actions consist of a choice of what to do today, and a set of future decisions that are conditioned on how the critical uncertainties, such as load growth, infrastructure costs, and power prices, evolve.

One of the important features of the methodology is that it permits an extension of the idea of optimality to include criteria other than just a narrow definition of least cost. For example, it is possible to identify the portfolio of investment actions over time that provide the best quality or the greatest reliability or any combination of such criteria. This generalization is accomplished by incorporating a specific representation of the importance of such criteria, their relative weighting, and the contribution of alternative strategies to each of the criteria into the methodology. The basis of the representation is a model of the objectives, values, and attributes provided by each of the alternatives considered. These ideas are discussed further, below.

B.3 AEP Problem Statement

The problem addressed by this project is the following: *AEP does not currently evaluate and compare all distribution projects. The value of doing a particular project is not compared with the values of competing projects. For the projects that are evaluated, AEP is not satisfied with the current procedures.*

C Logical Representation of Solution Technique

The purpose of this section is to present a logical description of the solution to the problem stated above. The logical description reveals what the solution is supposed to do, rather than discussing how the problem will be solved. How the problem will be solved will be described below, in the design section.

We view the solution to this problem as a process that takes a collection of inputs and transforms them into the required outputs.

C.1 Inputs

The inputs to the process are the following:

- Corporate budgets specified over the planning period.
- Distribution Projects to be evaluated. The projects should include possible alternatives, with particular attention to the consequences of delaying a project.
- An objective or set of objectives that should be achieved by selecting various projects. Objectives might include minimizing capital costs, maximizing system reliability, maximizing power quality, or some combination of those and any other objectives of interest.
- A set of attributes provided by a project. Attributes are items that are readily observable or measurable that describe a project directly. Attributes might include the capital cost of a project, the number of outages per year that are expected to occur if the project is successfully completed, the thermal loading on equipment if the project is successfully completed, and other characteristics that describe or measure some (typically physical) condition that occurs because a project was successfully completed.
- A collection of values provided by a project. Values are measurements of the worth of an attribute or collection of attributes provided by a project or portfolio of projects. That is, an attribute provided by a project is transformed into a value by measuring the degree to which that attribute is important for achieving some goal. Goals might include improving service reliability, minimizing safety risk, controlling thermal loading, and achieving acceptable environmental impacts.

An integral part of the design of the methodology is the approach taken to determine attributes, assign values, and measure objectives. That is discussed further, below, in the design section.

C.2 Outputs

We have designed the methodology to provide the following requested outputs.

- Project rankings, such that all projects are placed in priority sequence, will be identified.
- The optimal portfolio of projects over the planning period will be specified.
- The optimal timing of projects will be determined. This will include specifying when to start, how much to delay, and when to complete, each project.
- A measurement of the value of additional budget, which will specify which additional projects can be done if the budget were to increase, and which would be delayed or dropped. (Note that additional budget could change the optimal portfolio and the optimal timing of projects that were selected initially.) The contribution to the objective of additional budget will be specified.
- The risks associated with the optimal strategy will be measured.
- The costs of the optimal strategy, both capital and operating, will be measured.
- The profits provided by the optimal strategy will be measured.

C.3 Transformation Processes

The transformation processes are designed to create the outputs from the inputs. There are four logically necessary transformation processes. The first takes the attributes, values, and objectives and transforms that data into benefits, typically measured in dollars. The purpose of the second transformation is to map the collection of possible projects and alternatives into budget requirements. In the third transformation, benefits and budget requirements are traded off to determine the project portfolio, a collection of projects and their timings. The fourth transformation converts a change in budget to the corresponding change in the project portfolio. These transformations are implemented in the programs and routines of the methodology.

D Design of Proposed System

The design of the methodology is presented in the flowchart of Figure 1. The user inputs are noted in the rectangles at the left of the diagram. These include, as noted above, the specification of projects and alternatives, the attribute levels provided by the alternatives, the values associated with the attributes, and the objective to be achieved by the optimal portfolio. The budget specification is an input on the right hand side of the diagram.

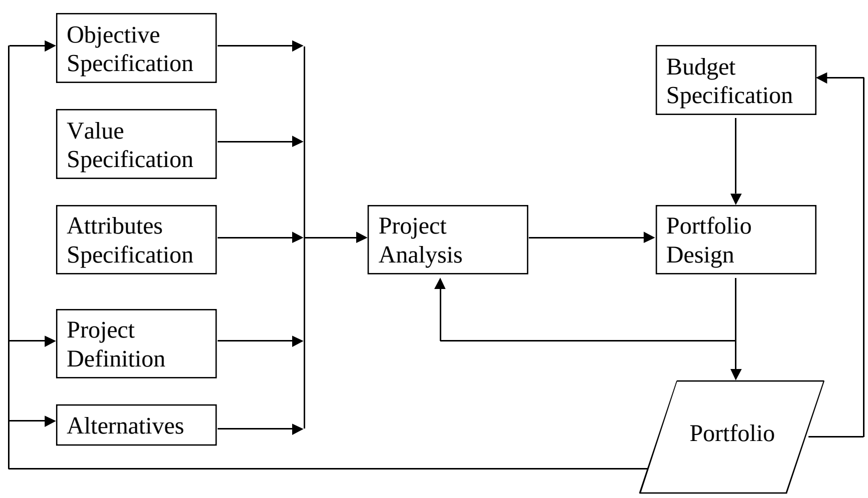

Figure 1: System Design

At the heart of the design are the two analytic modules, Project Analysis and Portfolio Design. These two modules result from the fact that the methodology performs its analysis on two levels.

At the individual project or local level, the Project Analysis module determines the optimal timing of a project with respect to local budget constraints. The optimality is based on the values of the attributes provided by the project. At the system policy or global level, the Portfolio Design module combines the optimal timing of projects and the overall budget constraints into a portfolio of projects that satisfy the constraints and are optimal with respect to the objectives.

The design indicates two feedback loops. There is an internal feedback loop between the Portfolio Design and Project Analysis modules which adjusts the optimal timing of each local project in the Project Analysis module in order to satisfy the optimality and feasibility conditions required by the Portfolio Design module. The feedback loop is actuated by budget signals and rationing with respect to satisfaction of the objective. The external feedback loop is based on user modifications to the budget specifications or the projects and alternatives under consideration, or the objective function. The purpose of this feedback loop is to permit the user to analyze the changes that would result in the optimal portfolio if budgets were changed, projects were added or dropped, or the objective were changed. This last loop responds to requests for specific capabilities by AEP.

E What Remains To Be Done

There are three items that remain to be done, all part of the third phase of this project. The data-gathering process must be designed, the portfolio selection software must be implemented, and the outputs and output reports must be specified.

E.1 Design of Data-Gathering Process

E.1.1 Attribute Specification

As part of Phases 1 and 2, a set of attributes have been specified. These will be refined in Phase 3. A schematic diagram of the attributes and their interrelationships is presented in Figures 2, 3, and 4 below. Figure 2 presents the top level of the attribute specification. Improving Portfolio Importance, the top value, can be thought of as an objective. This value is a function of three lower-level values, avoiding adverse regulatory impacts, improving distribution system performance, and improving financial performance. The diagram indicates that if the bottom three are known, then the top value is known. The lower values are combined based on their relative importance in achieving overall portfolio objectives.

The next two figures, Figure 3, and Figure 4, describe in more detail the at-

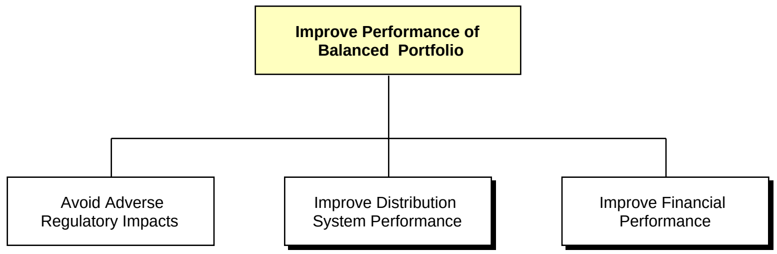

Figure 2: Attribute Specifications: Top Level

tribute structure that supports the measurement of Distribution System Performance and Financial Performance. Figure 3 indicates that Distribution System Performance (as currently defined) is dependent on five attributes: Service Reliability, Safety Risk, Service Quality, Thermal Loading, and Environmental Impacts. If the values of each of these were known, then the Distribution System Performance would be known. Also shown in Figure 3 is the decomposition of each of the five attributes that determine Distribution System Performance. These lower-level attributes are fundamental descriptors of performance that can be directly measured. Also present is a customer importance index which permits the users to distinguish the contribution of identical attributes based on the customers served, either their number or their importance.

Figure 4 is similar to Figure 3. The Financial Performance (as currently defined) is a function of costs, revenues, and lawsuit risks. Costs are a function of capital, operating and maintenance costs, salvage value of retired equipment, and removal costs. Revenue is based on changes in customers served. Lawsuit risks can be assessed directly and need not be further decomposed.

This preliminary attribute specification was presented to AEP in December, 1998. We agreed that the specification would be subject to further study and possible modification, as appropriate. The remaining design work includes refining attribute selection, design and testing of measurement scales for each of the attributes and design and testing of the applicability of the structure to projects and alternatives. Further attribute-specification work can be done while solving an actual problem using real projects.

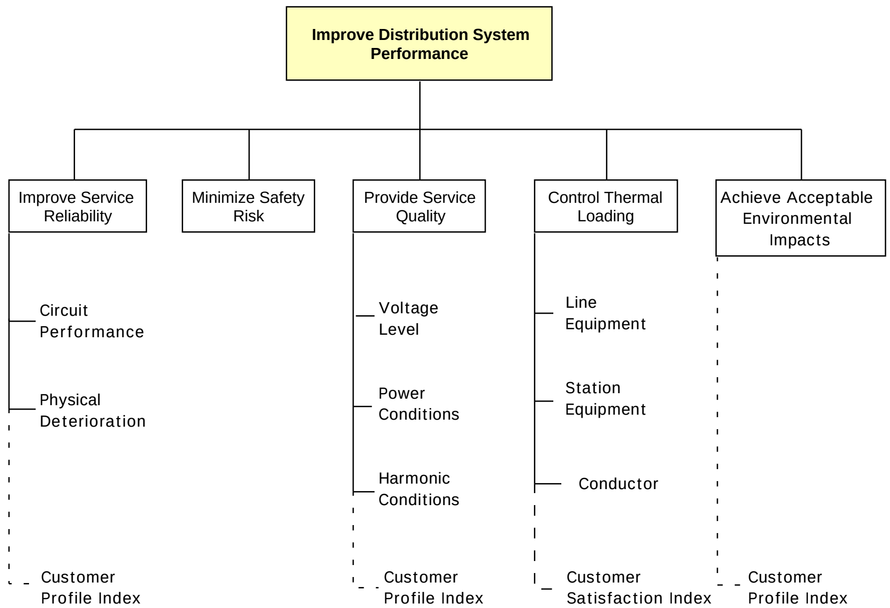

Figure 3: Distribution System Performance Attribute Structure

E.1.2 Design and Testing of Measurement Scales

The scales on which the attributes are measured have to be designed and tested. The principles that support the design of the measurement scales are described below. The design and testing is a task for Phase 3.

E.1.3 Specification of Projects and Alternatives

Projects and their alternatives must be described with respect to the attributes. After the measurement scales are designed and tested, training in assessing the data describing projects can proceed. At that time, it is natural to expect that the scales may change somewhat. Nevertheless, learning how to describe projects is a separate task. We anticipate that a significant portion of Phase 3 work will be devoted to this task, particularly since the consequences of delaying a project are essential to understand. Analyzing the consequences of delay is one of the underlying principles of this methodology, since a critical decision variable is project timing.

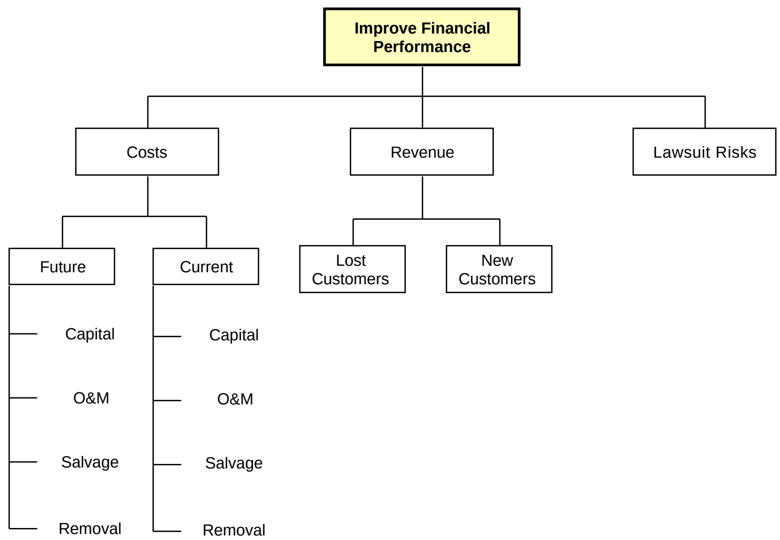

Figure 4: Financial Performance Attribute Structure

E.2 Implementation of Portfolio Selection Software

The remaining issues with respect to the algorithms applied to the portfolio selection problem are implementation issues rather than design decisions, although the implementation issues are usually formidable for large-scale problems. Moreover, past experience suggests that implementation may be expected to require some design changes. At the time of this writing, we have a mathematical programming formulation in place for the global analysis and a dynamic programming formulation in place for the local analysis. Both these formulations have prototype implementations currently.

E.3 Output Definition and Reports

It is premature to consider these issues at this time. Indeed, it is best to design output formats informed by experience using the methodology in an actual situation. Phase 3 will have as one of its results the complete specification of the outputs and reports of the methodology.

Part II

SYSTEM OBJECTIVES

The purpose of this section of the report is to describe further characteristics of the methodology. These further characteristics can be classified with respect to scope and treatment. The scope of the methodology includes such considerations as how many projects it can handle and the phenomena it addresses. The treatment of the methodology refers to how it responds to business considerations and issues. The section ends with a discussion of what is required in order to apply the methodology successfully.

A Scope

A.1 Large Number of Projects

The number of projects that the methodology can handle is limited by the computational ability of the software/hardware implementation. There is no *a priori* limitation with respect to number of projects. Given the current state-of-art of applied mathematics and computer technology, the system, when complete, should be able to handle hundreds to a few thousand projects

A.2 Multiple Performance Measures

The methodology is designed to handle an arbitrary number of performance measures. The attribute structure should suggest the breadth of possibilities. It would be natural to design portfolios that are least cost or that are most reliable or that provide the greatest power quality or that provide some weighted combination of these measures. Any of these performance measures, or objectives, can be addressed in the methodology.

A.3 Analysis of Uncertainty

A fundamental aspect of the methodology is that it treats uncertainty directly. Many approaches to analysis of uncertainty begin with a deterministic methodology and modify it ex post. These approaches are generally misleading. We have modeled uncertainty directly in the data gathering process.

A.4 Respond to Budget Signals

The outer feedback loop in the design (see Figure 1, above) permits the portfolio selection to be determined by the budget and to respond to changes in budget. The local analysis is designed to modify the optimal timing of projects as a function of budget signals. The basis of the analysis is that the optimal portfolio is constrained to be within the budget.

B Treatment of Business Issues

B.1 Level playing field for all projects

The project selection process should be such that all projects compete fairly. The only reason for a project to be selected is that it contributes to the objectives of the project portfolio. No other characteristics should be able to force the choice. All projects are ranked on the same scales and everyone should be able to agree on the measurement of the attributes provided by each project.

B.2 Resolve differences of opinion rationally

The methodology provides a system for resolving differences of opinion as well as determining which differences matter. The analysis of project choice will focus on attributes, objectives, and portfolio structure.

B.3 Defensible logic for peer review

It will be possible to explain in detail why a particular project or portfolio was selected. Reviews, like differences of opinion, will be based on attributes, objectives, and portfolio structure.

B.4 Transparent analysis

Not only will the inputs be clear, but the analysis and selection criteria will also be readily apparent. It will be possible to explain why a selection was made. It will also be possible to observe how changing the inputs results in different portfolios. The methodology attempts to eliminate all ambiguity regarding project and portfolio selection

B.5 Completeness with respect to performance measures

The methodology is designed to address multiple performance measures for multiple objectives. It will be possible to compare solutions with respect to different or competing objectives. It is also straightforward to add objectives at some future time by modifying, as necessary, the attribute structure or the value assessment.

B.6 Bias- and error-free

The methodology is designed to minimize the effect of individual biases and to eliminate, as far as possible, any cognitive errors. It is difficult to eliminate deliberate miss-reporting or miss-assessments, but the transparency of the data and the analysis should tend to prevent such deliberate misstatements from going undetected.

B.7 Practically applicable with respect to cost and time

If the methodology is cumbersome and time-consuming, it will not be used. The initial data-gathering process will require significant efforts, but subsequent analyses should be relatively simple and timely.

B.8 Compatible with existing business practices

Since the structure of the attributes is based on AEP inputs, and since the objectives are completely flexible and user-specified, this criterion is virtually guaranteed.

C Requirements

These are self-evident and are listed for completeness.

- Commitment to collect information
- Expertise in using system
- Expertise in analysis of candidate projects
- Access to policy makers
- Time and resources made available
- Commitment to use results

Part III

DATA REQUIREMENTS & ASSESSMENT PRINCIPLES

The purpose of this section of the report is to discuss the requirements and principles that will guide the data-gathering in Phase 3 of the project as well as any subsequent modifications and additions to the data base. This section may serve both as a reference for the discussion of the attributes presented above as well as a guide for part of Phase 3 of the project.

A Data Requirements

There are several aspects of the data-gathering that are important to highlight. These aspects define what is sought in the data-gathering. The following section, on assessment principles, discusses how the data-gathering will proceed.

A.1 Specification of actual consequences of alternatives

Each project or alternative is designed to change some aspect of current performance, presumably with respect to the three high-level attributes in Figure 2, above. The consequences of performing or delaying each project or alternative should be clearly understood with respect to those attributes. These are the actual consequences of selecting or rejecting a project. If important consequences are left out, then the collection of attributes must be expanded until all consequences are measured. The essential idea is that projects have consequences.

A.2 Specification of attributes that describe alternatives

The consequences of selecting an alternative can be described by the collection of attributes. The set of attributes must be those that both describe alternatives, at the lowest level, and that describe consequences, at the highest level. The essential ideas are that projects have both characteristics and consequences, both are expressed as changed attribute levels, and the characteristics provide the consequences. For example, with reference to Figure 3, a project attribute is the voltage level provided by a reinforcement project, and a consequence of such a reinforcement project are changed values of both Service Quality and Distribution System Performance, higher level attributes.

A.3 Specification of objectives

The objectives of the portfolio must be specified as a function of attribute levels. It is natural to express the objectives of the portfolio as maximizing or minimizing some important, measurable aspect of performance. We have identified objectives such as minimizing cost, maximizing power quality, and other objectives described in Figures 2, 3, and 4. Continuing the example in section A.2, above, the objectives are to Provide Service Quality and Improve Distribution System Performance.

A.4 Analysis of tradeoffs among competing objectives

Since not all objectives can be met by all alternatives, and since not all objectives are equally important, it is natural to capture the relative importance of competing objectives. The analysis of such tradeoffs is expressed in a set of attribute weights that express the higher-level attribute as a weighted sum of the lower-level attributes. For example, in Figure 3, Distribution System Performance is a weighted sum of the values for Service Reliability, Safety Risk, Service Quality, Thermal Loading, and Environmental Impacts. In Figure 2, Portfolio Performance is a weighted sum of Adverse Regulatory Impacts, Distribution System Performance, and Financial Performance. As the weights vary, the optimal portfolio varies. Thus, the analyst may use the methodology to investigate the consequences of various tradeoffs.

A.5 Role of individual assessor

The performance of the individual assessor is critical to the performance of the methodology. The data-gathering process must promote accurate judgment and clear reporting. Ideally, all will agree on the values of the attributes describing a project. Differences should be resolved reasonably. The weighting of the higher-level attributes and the budget specification are properly the province of management. This separation of assessment responsibilities may be a useful way to improve the quality of the output of the methodology.

B Assessment Principles

The following five principles specify how the data will be gathered. They are included in this report for reference.

B.1 Principle of Measured Observations

For each attribute, the principle states that one must assess the consequences of any possible outcome, so that the range of outcomes must span the space. The principle requires each attribute to be exhaustive. An example is the scale for outage duration, ranging from 0 to several days.

B.2 Natural Units Principle (Constructed Scale)

For each attribute, the performance measurement is a constructed scale based on natural units. Natural units are readily observable and measurable. The principle has two parts. Part one states that the natural units are applied to define stops on a scale, such as single pounds on a weight scale. Part two states that the values of a constructed scale may span differently sized natural units intervals. An example is the scale for outage duration. The natural units of the scale might have eight intervals, 0, 0-1 hour, 1-2 hours, 2-8 hours, 8-12 hours, 12-24 hours, 1-3 days, more than 3 days. The constructed scale could have corresponding values 0 through 7, indicating that the value of each interval increases linearly, even though the natural units do not increase linearly. Thus, the principle requires construction of a value scale using the natural units scale.

B.3 Risk Assessment Principle

The principle requires that when lives are at stake, risks should be encoded directly, using either lotteries or expected values. For example, when assessing the risk to the public one should use a probability distribution on deaths and injuries, as opposed to stating any results with certainty.

B.4 Comparison Principle

If an attribute proves difficult to assess, it may be possible to identify a proxy, so that the actual consequences of the attribute can be related to known consequences of another attribute. A typical example is the socioeconomic impact of a project. The proxy for the attribute can be taken as the intrusiveness of living in certain conditions, such as a crowded, noisy neighborhood, or next to a 3-shift factory, or next to a city dump. The intrusiveness can be measured naturally by the number of complaints received per week. The constructed scale can then be based on the number of complaints received per week. Thus, the principle recommends the use of a proxy.

B.5 Principle of Relative Importance

The principle defines the way that weights can be specified. There are two parts to the principle. Part one requires assessment of the relative importance of moving from the worst to the best outcome for any two attributes. This means that we determine which attribute one would prefer to improve over its full span. Part two identifies the indifference point between the full span of the relatively less valuable attribute and a partial span of the more important attribute.

Part IV

CONCLUSIONS

The objective of this project is to create a new asset management and infrastructure planning capability at AEP. The project is comprised of three phases, the first two of which have been completed. To date, we have accomplished several objectives, including having successfully developed a new problem solving framework for use at AEP. The problem solving framework consists of a design and working prototype of a project selection methodology and a design for gathering data on the attributes of projects. This data will drive the selection methodology and permit AEP to analyze alternate choices for project portfolios. The methodology and data-gathering are designed to move the planning processes at AEP in the direction of greater clarity, further objectivity, and improved performance. In particular, the consequences of making certain assumptions and tradeoffs will be more clearly understood.

The project is not yet complete, since Phase 3 has not begun. The purpose of Phase 3 is to make the designs operational.