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EDITORIAL: ENERGY IN THE THIRD MILLENNIUM

A recent announcement by Princeton University energized the search for safe nuclear energy. Researchers at Princeton successfully tested a fuel with commercial promise and ready availability. The fuel was a mixture of equal parts of deuterium and tritium, which are isotopes of oxygen.

The nuclear fusion process is the safe alternative to the fission process. A fusion reaction is one in which two atomic nuclei merge to form a heavier nucleus and, in most cases, an accompanying product such as a free nucleon. This process, which has been energizing the stars for billions of years, has clear potential as a power source on earth.

The goal of nuclear fusion research is to create and contain the equivalent of a small star. The scientific community views this goal as the greatest technological challenge ever undertaken.

Nuclear fusion reactors require temperatures in the range of 100-250 million degrees, several times the temperature of the center of the sun. At these temperatures, matter can exist only in the plasma state, consisting of electrons, positive ions, and very few neutral atoms. Thermonuclear plasma is self-limiting because contact with the containment vessel walls causes extinction of the plasma within a few thousandths of a second.

In addition to an almost inexhaustible fuel supply, nuclear fusion is environmentally benign. The resulting ash is harmless helium and hydrogen and the heat in the fission reactors is much less than in a fission reactor and dissipates through larger thermal masses.

Nuclear fusion is not a chain reaction, and it cannot run out of control. Perturbations cause the plasma to extinguish itself. It would also be far more difficult to produce nuclear-weapons materials surreptitiously at a fusion plant than at a fission plant because fissionable material should not be present at fusion plants. It is a simple matter to detect characteristic gamma rays from such sources.

Here is some food for thought. Researchers at Princeton University, Argonne National Laboratory, and Massachusetts Institute of Technology now forecast the completion of a full-power nuclear fusion generator by the year 2035. Should nuclear fusion power become commonplace, what would be the impact on transportation as well as power generation? How would public utilities function and what would become of manufacturers of conventional power generating equipment?

Our lead article in this issue is by the U.S. Secretary of Energy, the Honorable Hazel R. O’Leary. Her statement on planning for strategic alignment in the U.S. Department of Energy presages the shape of things to come in government.

The U.S. Department of Energy is at the forefront of energy management. We would be wise to augment department’s work by concentrating on energy management from the VE viewpoint.

This is the theme of Bill Lenzer’s article on meters and models. This theme continues with Phil Thompson and Carl Starling’s article on VE in the advanced neutron source project and Sheridan Becht’s article on how one public utility is helping itself by helping its customers.

There are many contributions to be made in alternate energy sources. Cost competition with fossil fuels is always the issue. The article on renewable energy electrical equipment represents the current thinking of the U.S. Department of Commerce and is offered as background on potential areas for the practice of VE.

This issue’s book review candidate is Value Analysis in Design by Ted Fowler. The first of our two essays, S. S. Iyer’s article on what makes companies great illuminates some fundamental truths. Tom King’s thunder on first class travel reflects a lot of our own feelings.

The June 1995 Value World will be a special environmental issue. Until then,

Goodnight and 30.

Jack
PLANNING FOR STRATEGIC ALIGNMENT IN THE U.S. DEPARTMENT OF ENERGY

The Honorable Hazel R. O'Leary, Secretary of Energy

BACKGROUND

Responding to President Clinton's commitment to cut taxes for the middle class and make government more effective and efficient, Secretary of Energy Hazel R. O'Leary announced to employees on December 20, 1994 an effort to strategically align the Department of Energy. Planning for the effort began last summer following release of DOE's Strategic Plan, *Fueling a Competitive Economy*.

STATEMENT

The strategic alignment will be based on the recommendations of a team of about 35 employees that will analyze the department's functions and seek better ways to accomplish the missions in the Strategic Plan. The team will be supported by smaller employee teams helping with communications, staffing, administrative issues, and liaison with Congress.

The team members begin a review of the department's activities in January. By the end of April, they will recommend how the activities could be structured to better support the five business lines -- science and technology, national security, environmental quality, energy resources, and economic productivity -- and make the department leaner and more efficient. Their recommendations are due in four months because we can't afford to do it any slower.

While the realignment ultimately will reduce the workforce, it will not be driven by the need to reach a predetermined number of employees.

Instead, it will be driven by an analysis of the entire organization; how it currently functions; and how it should function in view of its new missions.

The focus here is on empowering our own employees to take a look at how we ought to be functioning in a very new world. In designing a new DOE, the employee teams will examine both DOE headquarters and field organizations, which employ about 20,000 federal and 140,000 contract employees.

The functions of all federal employees except those of the department's power administrations and the Federal Energy Regulatory Commission will be reviewed.

The strategic alignment, which will be led by Deputy Secretary Bill White, builds on the current contract reform and restructuring efforts that are already expected to save more than $5 billion over the next five years.

The realignment will help us meet our commitment to cut an additional $10.6 billion from our budget over the next five years. It will draw on private sector experience to eliminate low-priority work, reduce layers of management, and downsize the workforce.

I want to focus on how best to save money and get on with making this government much more responsive to citizens and aligning the work so it makes sense. I encourage you to take charge of the changes by having an employee-driven alignment and by being very open about what we know and exceedingly open about what we do not know.

WE ARE MORE THAN UP TO THIS CHALLENGE.
ENERGY VALUE MANAGEMENT
METERS AND MODELS

William F. Lenzer, PE, CVS, FSAVE

PREFACE

The value analysis (VA) methodology is applicable to any effort involving development and analysis of alternatives to improve a product, project, system, or procedure. Energy systems in residential, commercial, institutional, and industrial facilities represent a specific area to which the VA methodology can be applied.

The energy value management (EVM) approach can be used independent of any other study focus on a new project or existing facility. This article focuses on the use of meters and models in conducting EVM studies on existing facilities. Some suggestions are provided for new design.

INTRODUCTION

Meters are familiar to everyone. If you owned a home, you had an electric meter. Utilities use meters to determine how much energy you use. Meters are also used to measure and bill for other utility services such as water and natural gas. In commercial and industrial applications, meters are used to measure and bill (or sometimes "cost allocate") such services as steam, compressed air, chilled water, hot water and sewage. There are many types of meters that are used for many purposes.

Some measure simple events as the number of times a door opens. Others measure complex events as the intensity of radiation emitted by a distant galaxy. This article is limited to the use of meters to measure energy, namely electricity and natural gas.

The most common types of meters are those used by utilities on services to customers. The basic function of such meters is to "collect revenue."

Figure 1 shows a simplified FAST from a utility's viewpoint.

Figure 1 FAST diagram for utility metering.

The utility's meter and billing data provide the starting point in the information phase. The main reason for this is insufficient operating data to indicate how, where, or how much energy is used by specific facility functions and activities.

Particularly in commercial facilities, there may be little, if any information, other than what can be determined from utility billing data.

This lack of information enables sales agents to claim 20 or even 30 percent reduction in energy usage with their products. These agents produce letters avowing the benefits of the product.

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There is, however, little if any independent, objective verification of performance. We remember a person in the Midwest who claimed to have an aerosol spray that, when applied to the inside of electric panels, would reduce energy usage by 30 percent. There were testimonials galore.

A first step in conducting an EVM study is to examine the utility history of the facility. This includes a detailed analysis of the applied rate structure and the availability of alternate rates.

Utility rate structures are devised to "generate revenue" for the utility company and not to "reduce cost" for the customer. Many utility rate structures have become extremely complex. They often contain terms and other features, which are even difficult for a technical person to understand. There may also be several rate structures available to commercial customers.

Figure 2 graphically depicts how one utility company's rate structures, applicable to commercial customers, might vary. You will observe that the individual rate curves overlap at some point.

Overlaps are not always readily predictable and can result in the utility customer signing up for the wrong rate, which results in cost penalties. Other rates are extremely complex, and may involve multiple time of day windows. An example of such a rate is shown in Figure 3.

Utility rates are a special study area of their own. Understanding the rates, however, is critical in conducting an effective and accurate analysis. Once beyond the utility meters, the next step is to determine what energy functions are being performed and how much energy is required to perform those functions.

There are generally two approaches to acquire this information. These are:

- Modeling. Creating a model to simulate the energy flows.
- Metering. Installing metering devices to isolate and segregate energy flows.

Either of these alternatives can be expensive and neither can be guaranteed to be 100 percent accurate. A model can usually be set up within a couple of months. Metering, however, takes longer. After meters are installed, the data they generate needs to be collected over a sustained period of several months to a year. The best and most valid
results are obtained when a combination of modeling and metering is used. This allows the model to challenge the meter and the meter to challenge the model. However, this is more expensive than either approach alone and requires that the opportunity for cost improvement be significant.

EVM must again be applied to determine the most cost-effective approach relative to the potential benefits.

**METERING MYTHOLOGY**

Many individuals think that meters are the most accurate method to determine energy use and whatever a meter indicates must be correct.

In the early 1980s, a commercial project began operating in the southern part of the country. The project had multiple utility meters that were billed collectively to the facility owner.

One metered system indicated a level of energy usage which the owner recognized as significantly low based on a combination of historical data and previous computer simulation for similar facilities.

The owner advised the utility within the first six months of operation that the meter was not registering properly. The utility company did nothing for more than five years, during which time billed usage was about 30 percent low.

Finally, the utility inspected the meter installation and found that it had not been installed properly and had been generating low readings. The owner was successful in not paying back-charges since the error had pointed out initially to the utility.

Utilities are probably the largest users of energy meters, and even they make mistakes. Utility meters, or for that matter, any meter will measure events that occur, providing that:

- They are installed correctly.
- They are periodically recalibrated for accuracy.

Meters, however, do not necessarily know what they are measuring or how much they should be measuring. Meters can be, and often are, improperly installed even by experts. Once installed, it is difficult, if not impossible, to detect the error unless there is a basis of comparison.

Meters are not 100 percent accurate even when installed properly. As with any manufactured device, meters have a tolerance range. Depending on the meter type and quality, the error can exceed one percent. With time and use, meter accuracy deteriorates. Utilities schedule meters to be rotated and recalibrated on a regular basis. This is generally required by the overseeing regulatory authority. On the commercial side, however, once a meter is installed by a non-regulated commercial entity, its calibration and accuracy are seldom checked.

A multi-tenant combination, retail, office, and hotel facility constructed in the mid 1980s purchased a computer metering system from a well known, reputable controls company. Computer metering was supposed to determine the amount of energy used to heat and cool each of over 150 tenant spaces. Based on metered results, the costs of operating the central heating and cooling plant were to be allocated to individual tenants.

After more than five years of operation, the computerized metering system was still not working to the degree necessary for adequate and equitable cost allocation. The owner identified two alternatives.

- Replace the existing computer system with a new system (and hope that works) at a cost of $1 million.
- Add conventional BTU meters at each tenant space at a cost of $375,000 plus manual reading and logging.

Because of the high cost of both options, the facility manager contacted the manager of a similar facility in a different part of the country to see how they handled this particular aspect of their property. The latter recommended a company that had developed a computer simulation model that could accurately allocate costs.

This company proposed to determine each tenant’s requirements by the use of a computer simulation program that had been developed for just such purposes. The total first year cost of this third alternative was under $75,000, including actual detailed field audits of each space.

In a test, the company simulated three tenant spaces where BTU meters were owner installed. After a short period of time, the simulated numbers were compared to the readings of the three meters. Two were dead on, but the simulated numbers were 30 percent high on the third. Further investigation revealed this tenant had a large opening onto the common area and found little need to turn on the
cooling and heating equipment. Instead, the tenant "sucked" off of the common area—a condition a meter could never detect. After the tenant began to operate the equipment properly, the simulated numbers and the meter agreed.

**READING METERS**

Look at the electric meter at home and try to read the dials. Chances are that if you've never tried this before and learned how to do it, you will not read it correctly. A typical electric meter contains a series of dials, each of which rotates in the opposite direction of the adjacent dials. The dials must be read backwards.

Figure 4 represents a typical dial setup on a residential meter.

![Figure 4: Typical meter register (kwh only).](image)

The following instructions were recently sent out as part of Texas Utilities' effort to teach their customers how to read their meters.

"To begin with, you read the dials backwards. In other words, from right to left.

"In the example, you start at the right dial, where the pointer is on "2." The next dial reads "9"—not "0"—because you always write down the number the pointer has just passed, not the one that it is moving towards.

"Reading all the dials in the example, the end result is "17592." You'll notice that, even though the meter is initially read backwards, it's written as the dials are lined up.

"This reading would represent the total kilowatt-hours registered on the meter. To determine usage, you would subtract the previous month's reading from this number."

Now, isn't that easy? And that's as simple as they come. There are meters that have demand registers to measure kilowatts, reactive kilovolt-amperes, kilovolt-amperes, or a combination of these. Some meters have adjustable multipliers, so that once you get the reading, you have to multiply it by a factor (ranging into the hundreds) to get the actual number. A multi-register meter might even have different multipliers for different registers.

Utility meters for gas and water are usually not as complicated as electric meters. Also, electronic meters are coming on the market. Most of these have digital displays and can be read remotely. While the direct digital readouts seem to solve most of the problems, there are still many hidden nuances that can create erroneous information.

For many years we attempted to obtain accurate meter readings from on-site building engineers or operations staff at several commercial facilities. Even with coaching and instruction, we encountered a high percentage of erroneous information. Our solution was to preprint a card that had a picture of the dials on a specific meter (see Figure 5) and let the field people draw in the register hands.

![Figure 5: Blank card for meter reading.](image)

This approach improved the quality of the information a little but not to the extent expected. The problem was solved and quality was greatly improved when we insisted that a straightedge (e.g., credit card or ruler) be used when drawing the position of the indicating hand.

**MODELS**

An energy model is a theoretical determination of the amount of energy that should be used within a specified time frame. The time frame could be short or long depending on the nature of the facility and its operations. Typically, annual energy is used as a basis since it covers a period of time that is reasonably cyclical for all normal operating parameters affecting the usage. Production output in process and manufacturing facilities that are energy sensitive, is also a factor that must be considered for those types of facilities.

There are many approaches to energy modeling,
ranging from the relatively simple to extremely complex. On the simple end of the spectrum would be a fixed energy element that operates continuously. An example of this would be an incandescent light that is on continuously. The amount of energy use is simply the power rating of the lamp times the hours it operates. A 100 watt lamp burning 24 hours per day, 365 days per year, uses 876,000 watt-hours per year. The more normal expression of usage is kilowatt-hour (kwh), which in this example, is 876 kwh per year.

Even in this simple example, the model of 876 kwh per year is inaccurate because no commonly available incandescent light source is rated to last 8,760 hours. The most typical lamps bought, especially for home use, are rated for less than 800 hours burning time. Therefore, in a year's time, the lamp must be changed around 10 times. Assuming that the lamp was changed prior to burnout and that the change took no more than a few minutes, then our model would be correct. But real life isn't that simple.

During the energy crisis of 1974, there was a significant movement toward creating computer programs that would simulate energy use. The idea was that this would increase the capability of an engineer or analyst to find better ways to design and build facilities that were more efficient than those previously built. It was also thought that these programs would help in the decision-making process on how to improve the efficiency of existing facilities. Indeed, programs have been developed and in some cases are very useful in predicting what is going to happen. However, there are so many variables involved that few programs have been thoroughly tested against reality.

Many product vendors have developed simulation programs to predict the performance and assist in the sales of their product. Thermal pane windows are a good example. I've seen many vendors show that this type of product saves energy, as it does almost everywhere and all the time, when you are considering a conditioned environment. But, how much does it really save?

Don't just believe the vendors or their computer printouts. Ask the right questions. Despite all of the improvements in energy modeling and simulation technology, people, even engineers, are still under the impression that thermal pane windows are always cost effective.

They are not! Many short-form energy modeling programs do not accurately consider all of the variables and often produce inaccurate results.

In warmer climates (most of California and the Southern States), tinted or reflective glass for vertical windows is much more cost effective than thermal pane. Why? Because, in these climates, the intensity of solar radiation has the greatest impact on the amount of energy required to condition interior space. Typically, commercial facilities in these climates require significantly more cooling than heating energy.

Models must have sufficient detail to recognize and accurately account for all of the significant variables. But, on the other hand, the more variables involved, the amount of input increases and input accuracy becomes more important. Accuracy of input depends on the individual who inputs.

There are many commercially available computer simulation programs. Some are comprehensive and very good. Most can be proven accurate if the input data are correct, and if the program operator understands the meaning of the input and how that input is handled by the program. This takes experience. Too often, design engineers who have the opportunity to utilize these programs never have the opportunity to compare their projection to reality.

The quality and accuracy of input regarding how a facility is operated is a key ingredient. On existing facilities, the only accurate way to achieve this is by on-site audits performed by quality, well-educated, and experienced individuals. We've seen some agencies and clients contract for energy audit work where the only person who could do it cost effectively is someone working part time out of their home, has a good retirement, and just wants to keep busy. What kind of an audit on a mid-sized high school could you expect to get for $400? We've seen even worse scenarios.

EXAMPLES

Figure 6 shows a comparison of calculated versus metered energy usage in kwh of a large facility over a one-year period of time.
Figure 6 Calculated vs. metered energy usage.

This graphic display shows monthly variances between calculated and actual numbers. However, for the entire period the variance is about 5 percent. This may be considered exceptionally good because:

- The computer model used a composite weather year (i.e., 10-year average hourly data).
- The facility is a unique combination of retail stores (about 100) and a casino, for which there is no specific historical data available for comparison on a detail engineering basis.

The computer simulation method was developed for the specific purpose of generating accurate cost and charge allocation data without the extensive use of metering. The costs for doing this work are recovered by the landlord through the electric declining-block rate structure advantage and management fees. Tenants pay no more than they would have if they had installed their own systems, and the landlord can realize net revenue. The landlord receives a return on investment and still provides benefits to the tenants.

This type of system has been applied to over 100 million square feet of facilities in about 150 metropolitan areas throughout the USA. Through continued monitoring and using calculated data to challenge meter data and vice versa, many unusual situations have been uncovered which could not otherwise have been detected. Some of these include:

- A property manager was convinced by an energy consultant to close all of the outside air dampers on his air-handling units to reduce consumption. While this reduced energy usage, it violated all codes because no fresh air was being introduced. The condition was detected by the off-site owner, via a deviation in metered data from calculated data.
- A tenant was caught attempting to fool the meter system by propping open a back door and creating a draft that sucked conditioned air from common areas through his space. By this tactic, the tenant could keep his metered air-handling unit off, thus registering virtually no usage.
- A meter designed to measure all the electrical energy used by a central heating and cooling plant was consistently registering 10 percent more energy than indicated by the model. After more than five years of examining the model's premises and the physical installation, it was found that one of the meter's current transformers had been installed improperly, yielding high readings.

AN ASIDE

A representative of a natural gas utility conducted a study of a central heating system for a large apartment complex. The utility representative recommended to the owner that the existing electric boilers be replaced with gas-fired boilers. The calculated savings indicated a three-year return-on-investment through a yearly $50,000 reduction in utility costs. The owner made the change.

Eighteen months after the change, the owner only saw about a $10,000 annual reduction in utility costs. It seems that the electric rate structure contained ratchets, which increased the owner's average unit cost of electricity with a reduction in usage. In other words, the electric cost did not reduce in direct proportion to the reduction in electric energy use. The bottom line was that the owner's return-on-investment was poor and the change should have never been made. This is not unusual.
CONCLUSION

Trust neither meters nor models alone. If you are an owner trying to reduce your operating cost by reducing energy usage, consider your potential benefit before proceeding with an EVM study. A 10 to 20 percent reduction in energy usage on older facilities should be attainable and provide a reasonable ROI (five years or less). Don't trust vendors. They are only there to sell their products. Most vendors are so singularly focused on their product that they might overlook the obvious. An independent consultant should be considered as an asset to in-house technical staff. A completely independent team of professionals might also be warranted.

Using EVM to examine energy issues and concerns can prove extremely beneficial. A large synthetic materials manufacturing facility employed EVM with a "show-me" attitude, knowing full well that their in-house staff could routinely uncover five percent savings. The use of EVM, combining in-house experts with outside specialists, resulted in 13 percent savings.

William F. Lenzer, PE, CVS, FSAVE, is President of VEI, Incorporated in Dallas, Texas.

VALUE BRIEF

U.S. Net Imports of Energy Rose in 1992 to Highest Level Since 1979

U.S. Energy Exports and Net Imports (Quadrillion BTU)

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*Includes coal coke and small amounts of electricity transmitted across U.S.borders with Canada and Mexico.

APPLICATION OF VALUE ENGINEERING TO THE ADVANCED NEUTRON SOURCE PROJECT

Philip B. Thompson and Carl D. Starling, CVS

INTRODUCTION

This paper discusses the application of value engineering (VE) methodology to a large, complex research facility that is being proposed for Oak Ridge National Laboratory (ORNL). ORNL is managed by Martin Marietta Energy Systems, Inc. (MMES), under contract with the Oak Ridge Operations Office of the U.S. Department of Energy (DOE). DOE, as an agency of the federal government, encourages the application of value engineering to its projects (by issuance of DOE Order 4010.1). This is in accordance with the Office of Management and Budget Circular A-131, which is aimed at eliminating unnecessary cost and achieving the best results for the taxpayers. The Advanced Neutron Source (ANS) Project's management has also supported the concept of VE studies as an integral part of the project's work, with specific plans incorporated into the conceptual design documentation. It was with that in mind that the application of VE to the project was initiated during the conceptual design. That effort was also supported by Gilbert/Commonwealth, Inc. (G/C), the architect-engineer under contract with MMES to furnish conceptual design services.

PROJECT HIGHLIGHTS

The mission of the ANS Project is to lead the world as a research facility for analyzing materials by neutron scattering, to replace the High Flux Isotope Reactor (HFIR) at the ORNL as the world's only source of transuranium isotopes outside of Russia, and to function as a user facility, allowing more than 1000 industrial, academic, and government researchers to perform experiments each year.

The ANS is based on a heavy-water-cooled, reflected, and moderated reactor providing a source of neutrons to extensive experiment and user support facilities. It is being designed as a 330 megawatt (MW) research reactor with a neutron flux greater than $5 \times 10^8$ neutrons per square meter per second. When completed and in operation, it will be DOE's principal new neutron research facility for science and technology.

The primary purpose of the ANS is to provide world-class facilities for neutron scattering research, for isotope production, and for materials irradiation in the United States. The neutrons provided by the reactor cover a broad range of energy spectra to produce sources of hot, thermal, cold, very cold, and ultra-cold neutrons usable at the experiment stations. Beams of cold neutrons will be directed into a large guide hall using neutron guide technology, greatly enhancing the number of research stations possible. Fundamental and nuclear physics, materials analysis, and other research programs will share the neutron beam facilities.

As shown in Figure 1, the ANS facility will be a new laboratory for neutron research comprising an array of buildings and support facilities arranged on a 30-hectare (i.e., 73-acre) site and include the following major elements.

1. A guide hall and research support area contains most of the neutron beam experiments and support facilities. A reactor containment building houses the neutron source (i.e, 330 MW reactor) and additional scientific research facilities, with a reactor support building housing the majority of the plant systems. An operations support building provides offices, shops, and training facilities, while an office and interface complex provides access control, offices, and administrative support facilities.

2. Other facilities that include electrical substations, a detritiation plant, a reactor mock-up building, a diesel generator building, and user housing. Sufficient laboratory and office space will be provided to create an effective user-oriented environment.
ESTIMATED COST

The breakdown of project cost in Table 1 illustrates the size of the project and identifies areas where VE would most likely have the highest impact. The plant systems represent the highest cost element. A further breakdown of the plant systems cost in Table 2, indicates that the electrical power, the water systems, the instrumentation and control systems, and the detritiation plant are the cost drivers within the plant systems category.

Table 1. Design and Construction Project Cost

<table>
<thead>
<tr>
<th>Item</th>
<th>$ Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant systems</td>
<td>879.5</td>
</tr>
<tr>
<td>Site and buildings</td>
<td>511.1</td>
</tr>
<tr>
<td>Experiment systems</td>
<td>302.8</td>
</tr>
<tr>
<td>Project support</td>
<td>259.8</td>
</tr>
<tr>
<td>Reactor systems</td>
<td>178.1</td>
</tr>
<tr>
<td>Research and development</td>
<td>53.7</td>
</tr>
<tr>
<td>Operations</td>
<td>16.2</td>
</tr>
<tr>
<td>DOE subcontractor support</td>
<td>11.0</td>
</tr>
<tr>
<td>Total</td>
<td>2,252.2</td>
</tr>
</tbody>
</table>

STATUS AND SCHEDULE

The conceptual design report was issued at the end of June 1992 and comprised 12,000 single spaced pages plus 390 engineering drawings. That report has been reviewed and approved by the scientific community and by DOE and provides a detailed basis for continued advanced conceptual design and planning for start of the detailed design and construction phase in DOE's fiscal year 1995. A summary of the conceptual design has also been prepared that provides a comprehensive overview of all project elements. (1)

The ANS Project is expected to take about nine years for the design and construction phase, with initial operations currently planned for late in the year 2003.

VALUE ENGINEERING PLANNING

A project of the size, complexity, and cost of the ANS offers significant potential for application of the VE methodology. As an integral part of the project's planning base, a VE plan was prepared that identified approximately 20 VE studies to be
performed at various stages of the project, with most being done early in the detailed design phase.

The VE plan describes a disciplined approach using the five-phase VE job plan that is sanctioned by the Society of American Value Engineers. The plan indicates the approach to be applied to selected project elements, including the element to be studied and the specific study method to be employed. The plan also addresses a range of methods for applying the methodology, ranging from preliminary evaluation by project staff with relatively informal documentation to formal value engineering studies led by a certified value specialist and documented accordingly. (2)

VE STUDY

A key early consideration for the ANS Project was the possibility of applying VE in the conceptual design phase (i.e., prior to start of detailed design). The project's management expected that, at the completion of the conceptual design, costs would be perceived as too high. Several questions were asked. Was it appropriate to conduct any VE studies at this time? Were sufficient information and resources available to conduct credible and effective studies? Would the results be timely and contribute to real reductions in costs or increases in value? The answer to all of these questions was “yes”.

Management direction was provided to conduct a formal VE study. It was believed that such a study would validate the VE plan or show what changes were needed (viz., additional studies). The study would validate any cost reductions previously identified and could result in additional project improvements and cost reductions.

Plans included the U.S. Army Corps of Engineers Office of the Chief of Engineers Value Engineering Study Team (OVEST) as part of the overall study team. The study team consisted of six OVEST members, six MMES people, and four G/C people, all of whom were familiar with the ANS Project. The team was supplemented, as needed, with personnel having special expertise.

This might be perceived as too many team members, but this level of participation was necessary in order to cover the three classical VE people areas: Those who are bothered by, or own, the problem; those who are charged with resolving the problem; and those who are affected by the solution to the problem. (3)

The complexity and breadth of the study required more time than the conventional 40-hour workshop. The study started on October 26, 1992, and was completed on December 16, 1992, when a briefing was conducted for the senior managers of the ANS Project.

However, work did not proceed continuously as there were breaks between meetings. Meetings lasted from a single day up to five days and totaled twelve full work days. Some of these work sessions took place at MMES's offices in Oak Ridge, Tennessee, and others took place in G/C's offices in Reading, Pennsylvania.

THE JOB PLAN

The study followed the normal five-phase job plan sanctioned by SAVE. The job plan's phases are: Information; Speculation; Analysis and Judgment; Development and Presentation; and Reporting and Implementation.

The Information Phase involved the most effort and the most people to gather all of the pertinent information, to plan the approach, to identify the functions, to identify the targets of opportunity, and to create the function diagram. About five days were spent on this phase.

The Speculation Phase used an initial cost reduction study as a starting place for ideas and proceeded with a brainstorming session that lasted approximately one-half day. This resulted in the generation of 119 ideas.

The Analysis and Judgment Phase after completion of the brainstorming, resulted in the selection of 32 proposals for further development. The impact, if all proposals were implemented, would approach $100 million in cost reductions. Assignments were made to various individuals to lead development efforts for these proposals, and this concluded the analysis phase.

At the conclusion of the Development Phase, a
significant subset of the proposals was sufficiently
developed to be accepted by the project
management for implementation into the project.
The project's cost estimates were revised in a
detailed new bottom-up evaluation that incorporated
these savings. The total exceeded $63 million. Table 3 provides a listing of these savings.

Table 3 Cost savings

<table>
<thead>
<tr>
<th>Land Improvements</th>
<th>$ Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redesign Main road intersection</td>
<td>2.9</td>
</tr>
<tr>
<td>Remove security fence and move detritiation facility</td>
<td>0.8</td>
</tr>
<tr>
<td>Delete storm water retention basin</td>
<td>2.6</td>
</tr>
<tr>
<td>Modify site grading</td>
<td>1.4</td>
</tr>
<tr>
<td>Subtotal</td>
<td>7.7</td>
</tr>
<tr>
<td>Reactor Building</td>
<td>8.2</td>
</tr>
<tr>
<td>Reactor Support Building</td>
<td>2.7</td>
</tr>
<tr>
<td>Optimize Operations Support Building</td>
<td>6.0</td>
</tr>
<tr>
<td>Resize Reactor Support Building</td>
<td>8.7</td>
</tr>
<tr>
<td>Subtotal</td>
<td>8.7</td>
</tr>
<tr>
<td>Guide Hall</td>
<td></td>
</tr>
<tr>
<td>Relocate visitor viewing gallery</td>
<td>1.3</td>
</tr>
<tr>
<td>Eliminate clerestory windows</td>
<td>0.8</td>
</tr>
<tr>
<td>Eliminate lead shielding around guide tubes</td>
<td>19.5</td>
</tr>
<tr>
<td>Subtotal</td>
<td>21.6</td>
</tr>
<tr>
<td>Office Building</td>
<td></td>
</tr>
<tr>
<td>Reduce building height</td>
<td>3.0</td>
</tr>
<tr>
<td>Reduce miscellaneous expenses</td>
<td>1.1</td>
</tr>
<tr>
<td>Upgrade building after using for temporary Construction offices</td>
<td>(1.8)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2.3</td>
</tr>
<tr>
<td>Construction Support</td>
<td>8.9</td>
</tr>
<tr>
<td>Eliminate temporary construction administration building</td>
<td></td>
</tr>
<tr>
<td>Use fabric structures for enclosed storage and fabrication shops</td>
<td>5.8</td>
</tr>
<tr>
<td>Subtotal</td>
<td>14.7</td>
</tr>
<tr>
<td>Total</td>
<td>63.2</td>
</tr>
</tbody>
</table>

The Reporting and Implementation Phase is the most important and usually the most difficult element of a VE study. In this case, however, the phase was not difficult because many of the people responsible for implementing the VE proposals were among those who developed the proposals. As a result, a project change order was prepared that incorporated the changes listed above into the technical requirements of the project and that reflected the reduction of $63.2 million in the project's total estimated cost.

Additional cost savings are likely to result from this work as the project progresses into the detailed design stage. In addition to the improvement in the cost picture, the design was improved as a result of this effort.

**VE STUDY OF ANS REACTOR SYSTEM**

Encouraged by the results arising from the balance-of-plant VE study discussed above, the ANS Project management considered the possibility of conducting a study in an area that generally is not considered to be amenable to VE implementation. That area is the reactor control system subassemblies, which are extremely complex and critical to safety performance.

The mechanical design of the control rod drive system must meet severe physical and operational constraints such as:

- Fast response time, scram in milliseconds.
- Tight physical boundaries inside the center hole in the reactor core.
- Rigid regulatory requirements-quality, safety, and nuclear.
- Severe radiation environment, operation, replacement, and design life.

An evaluation was made to define what might be achieved from application of VE to this very complex and constrained subsystem. As a result, a team was selected to conduct a VE study that would evaluate performance objectives, design criteria, constraints, and design solutions to assure (1) that the present conceptual design basis offered the simplest design solution; (2) that it was cost effective with respect to initial fabrication processes and final operation, including replacement and maintenance aspects; and (3) that it would meet performance and safety requirements with adequate margins.

The team was composed of project personnel, a reactor control expert from Canada, reactor operations personnel from Oak Ridge, a tube manufacturing consultant from Florida, and a
consultant who was a certified value specialist with experience in nuclear reactor components. The team followed the five-phase job plan described earlier over a five-day period, with good results. The team identified 14 targets of opportunity and listed 78 ideas during brainstorming sessions.

After analyzing the list of ideas, the team found that the requirements were complex but well defined. They represented stringent, but necessary, conditions challenging the designer. They required careful consideration of the elements related to diversity, redundancy, and maintainability. They were appropriately keyed to performance reaction times, environmental conditions, and reliability constraints. They also found that the design was defined to a level of detail beyond normal conceptual design expectations (this system is an essential safety system and warranted special design attention) and that it was driven by several key issues (e.g., materials, scram time, vibration, radiation, reliability, component life spans, and remote replacement).

A significant finding is that there is potential for alternatives even within a severely constrained subsystem such as the reactor control rod drives and that a high possibility exists that options defined by the VE study team could improve performance against the key parameters. An equally significant element is that cost reduction is not a goal, but simplicity and confidence in a design that will meet all of the primary requirements is the real value desired.

The results from the study were that new insights into the requirements, the issues, and the possible solutions were developed and included confirmation of functions and associated requirements. A very nice piece of work was done to document these: identification of several alternative approaches to the design of selected subsystems and components and development of a keen team appreciation for the VE methodology as applied to a unique mechanical system; and a fully documented study that will contribute to the content and conduct of future reviews; and the design evolution of this critical system.

**SUMMARY**

The ANS Project considers VE an integral component of the project's planning base and has incorporated the preparation of a specific VE plan as part of the conceptual design activity.

Significant VE has already been accomplished with over $63 million in cost reductions incorporated into a revised conceptual design and a VE study conducted on a specialized mechanical design with extremely productive results.

**ACKNOWLEDGMENT**

This work was done by Martin Marietta Energy Systems, Inc. at Oak Ridge National Laboratory in Oak Ridge, Tennessee, under Contract DE-AC05-84OR21400 with the U.S. Department of Energy.

**REFERENCES**


BUSINESSES SEE ENERGY SAVINGS IN A NEW LIGHT

Sheridan Becht

BACKGROUND

In Orlando Florida, smart local businesses searching for ways to reduce operating cost are joining in a partnership with their local electric company. Using a value engineering (VE) approach, the Orlando Utilities Commission (OUC) is helping commercial customers uncover and reduce energy waste.

As is often common with VE, participants find an answer that was literally glaring at them from the beginning. The brilliant solution? Redesign overhead lighting!

EFFICIENT LIGHTING PROGRAM

For years, utilities throughout Florida have enjoyed an ever increasing demand for electricity as new customers moved into their service area. Traditionally, this growing demand would eventually begin to stretch capacity and costly new generation would be built. Now OUC has an alternative. By working with customers to lower their existing electric load, the utility effectively increases the power available for new or growing customers. In effect OUC "buys back" those kilowatts for only a fraction of what it would cost to build a new generator to produce it.

Consequently, new generating units can be smaller and construction can be delayed longer, keeping costs down for all customers.

After space conditioning, lighting is the second or third highest energy user in today's workplace. Thanks to OUC's commercial efficient lighting program, businesses are finding that they can significantly reduce energy consumption by modernizing or "retrofitting" existing lighting fixtures with high efficiency reflectors or lamps.

Not only is less electricity needed to provide the same light levels, but modern fixtures often provide a higher quality of light and that can have a positive effect on productivity. The utility/customer partnership produces a true win-win situation. Customers get lower monthly power bills while the utility reduces its existing demand for electricity.

While it's often easy to see the benefits of improving building lighting, the cost of such a project may leave the idea on the back burner. To help business get over the sticker shock, OUC pays a $100.00 rebate for each kilowatt of electric lighting that is permanently removed.

The process begins with a commercial energy survey and that's where the VE comes into play. Note the adherence to the VE job plan in the six steps that follow:

Step 1: Information

An OUC energy specialist and building engineers conduct a walk through audit of the facility. A survey is taken of the numbers and types of lighting fixtures. Existing light levels are measured, and corresponding energy use data are calculated.

Especially important, building occupants are surveyed to learn the particular needs of the task at hand, the hours of operation, and other characteristics. In particular, surveyors look for areas that may be over lighted.

Step 2: Creativity

The data is reviewed by the OUC energy efficiency specialist and building engineers. Various lighting changes and retrofit options are explored. Possibilities include replacing standard core and coil ballast with electronic ballast; converting to lower watt, high efficiency fluorescent tubes; converting standard four tube fixtures to two tube reflector fixtures or two high output fluorescent tubes; replacing incandescent lamps with compact
fluorescent; replacing existing interior mercury vapor fixtures with high pressure sodium or metal halide fixtures. The team pays particular attention to areas that have adequate lighting but could get by with less.

**Step 3: Evaluation**

Each of the various options is evaluated for cost, feasibility, ease of replacement, bulb life, and reliability. Light levels are compared to IES standards. Based on reduced energy costs, the changes should have a payback period of two years or less without a rebate. After a rebate a 12 to 16 month payback period is expected.

**Step 4: Development**

In this step the proposed changes are compared to existing design; advantages and disadvantages are outlined. The energy specialist can help in the solicitation for bids from reputable vendors.

**Step 5: Presentation**

Once a vendor is selected, a proposal is presented to the building owner/operator outlining changes and cost. The energy specialist remains available to provide technical support to building engineers.

**Step 6: Implementation**

Once work is completed and verified, OUC presents the rebate check for $100 for every kilowatt (1,000 watts) of lighting that is permanently removed. And, that's only the beginning. Over the life of the new lights, customers save many times their original investment through lower energy costs. Additional savings may also flow from a reduction in the cooling load on the building formerly generated by the light's waste heat.

The program exceeded expectations in its first year. More than 1,891 kilowatts of electric demand has been reduced since the lighting retrofit and rebate program began in 1993. At $100 per 1,000 kilowatts, OUC has paid out over $187,000.00 in rebates to commercial customers.

Large and small businesses have taken advantage of the program. Martin Marietta Corporation, OUC's largest customer, realized significant energy savings at their South Orlando office tower. By replacing sets of four standard fluorescent lamps with a pair of higher output lamps they reduced electric consumption by an estimated $3,500.00 per month.

American Broadcasting Company's television affiliate in Orlando, WFTV, Channel 9, was also among the first to take advantage of the rebate program. Although WFTV's building was less than three years old, it was found that installing reflectors could reduce the need for 30 kilowatts of power. OUC sent WFTV a check for $3,040.00.

Even businesses with multiple facilities have participated. The 7-11 convenience store chain and a large grocery chain have taken advantage of the program. While only commercial customers are eligible to participate, the program is good news for everyone. Using less electricity also means less impact on the environment. And the capacity once used to supply electricity for the inefficient lighting is now available to serve new customers.

**CONCLUSION**

OUC energy specialists point out that building owners don't have to wait until a project is completed to take advantage of the savings from more efficient lighting. A VE review of proposed lighting during the design phase of a new facility can provide even greater opportunities to improve lighting performance, save on initial capital cost, and result in lower monthly energy costs.

OUC intends to investigate the role of VE in other phases of operation.

Sheridan Becht is an Information Specialist with the Orlando Utilities Commission in Orlando, Florida.
When Unit 2 comes on line in June 1996, the coal-fired Curtis H. Stanton Energy Center will provide 880 megawatts of reliable, low-cost, and environmentally responsive power to customers of the Orlando Utilities Commission.

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**Value Brief**

**Crude Oil**

One U.S. barrel contains 42 U.S. gallons. One barrel of crude oil equals the amount of energy in 5.6 thousand cubic feet of natural gas, 520 pounds of coal, and 6,500 kilowatt-hours of electricity.

According to the U.S. Energy Information Administration, the known world-wide reserve of crude oil is about 911.6 billion barrels distributed as follows: Middle East 586.0 billion barrels; North America 85.3 barrels; South America 68.9 billion barrels; Former Soviet Union 57.9 billion barrels; Africa 53.0 billion barrels; Asia 42.7 billion barrels; Western Europe 14.8 billion barrels; and Australia and Pacific 3.0 billion barrels.
RENEWABLE ENERGY ELECTRICAL EQUIPMENT

U.S. Industrial Outlook 1994

BACKGROUND

Each year, the U.S. Department of Commerce attempts to project future business outlooks for a wide range of industrial sectors. This article, adapted from the U.S. Industrial Outlook 1994, addresses the outlook for the renewable energy electrical equipment industry over the rest of the decade.

Renewable energy electrical equipment produces electricity from resources that are replenished or regenerated by natural forces, such as sunlight, wind, cellulose and organic wastes, VATER currents, and the earth's subsurface heat. The U.S. renewable energy electric equipment sector is composed of a number of separate industries, including solar photovoltaic, wind energy, biomass energy, geothermal energy, and small hydro energy. Although they share certain market characteristics, each industry is based on technologies that respond differently to market dynamics and applications.

All renewable energy equipment can generate larger-scale, utility-interconnected power. The wind energy, biomass, geothermal, and small hydro industries are active in private and independent power production, selling power to utilities under the Public Utilities Regulatory Policies Act of 1978 and the National Energy Policy Act of 1992. The Energy Policy Act also provides a strong stimulus to producers of renewable energy in the form of incentive payments of 1.5 cents and various tax credits for each kilowatt-hour energy produced.

Definitions

**Solar photovoltaic.** Solar photovoltaic systems convert sunlight to electrical energy through the flow of electrons caused by the absorption of light protons by a semiconductor device known as a solar cell. This creates direct-current electricity that can be transmitted, stored, or used in various applications.

**Wind.** Wind energy systems generate power through the circulation of blades rotating on either a horizontal or vertical axis that drive an electric power generator shaft. Wind turbines can generate 12 to 24 volt, direct-current stand-alone power, or 110 to 240 volt, alternating current, utility-scale power. Wind turbines consecutively configured on so-called wind farms can generate multi-megawatt electricity when connected to utility transmission lines.

**Biomass.** Biomass systems derive energy from organic materials, including trees, vegetation, and forest residues; grains and other crops; and animal, agricultural, and commercial wastes. Biomass is converted into energy or fuels through either thermochemical or biochemical processes.

**Hydro.** Small hydroelectric systems are designed to produce power through the diversion, regulation, and use of small river or stream flow to drive generator turbines. These water flows are characterized by slow or variable rates of flow, low head (the angle of the bed slope to a vertical line at any fixed point), and small, seasonally-available volume.

**Geothermal.** Geothermal energy systems utilize the then-energy from the earth's molten interior stored in accessible portions of below-surface rock formation. Geothermal power projects utilize the then-energy extracted from a mixture of hot water and steam in the wellheads. The steam or heat is then used to generate electricity from standard turbine generators.

Several factors can determine demand for renewable energy-generating equipment. These include cost and availability of renewable resources; cost and availability of alternative resources, especially hydrocarbon fuels; commercial and residential electricity demand; disposable consumer income; the availability of financing, and government energy and environmental policies.

Assuming U.S. economic growth of 2 to 3 percent, global growth of 3 to 3.4 percent, and no new tax or other incentives, sales of various types of renewable energy, 1995. Exports electrical equipment are expected to grow 5 to 70 percent during 1994 and 1995.

If Congress funds the production incentives authorized under the Energy Policy Act for the fiscal year that began in October 1994, then expanded development of domestic power projects could double the anticipated sales growth of renewable energy equipment in 1995 and beyond.
SOLAR PHOTOVOLTAIC ENERGY

The U.S. solar photovoltaic (PV) industry experienced rapid growth during the middle and late 1980's. Exports of PV cells, modules, and panels reached $80 million in 1994. With the introduction of new thin-film and double-triple junction PV technologies, and resulting increases in efficiency, the average cost per peak watt in large orders is projected to dip from $4.32 in 1991 to approximately $4 by 1995. Continued or accelerated double-digit annual increases in U.S. domestic and export sales are projected between 1995 and 1999, based on increased rural electrification in developing countries, and plans by major U.S. utilities to use solar photovoltaic in peak power, demandside management and distributive offset projects. Total annual world PV trade may approach 300 megawatts by the end of the 1990's, with the U.S. share ranging from one-third to two-fifths of the total. Annual U.S. sales may exceed $600 million per year by the end of the 1990's, assuming PV prices decline to between $3 and $3.50 per peak watt.

WIND ENERGY

The U.S. wind industry consists of five distinct but interrelated sub-groups: wind measurement and turbine performance instrument manufacturers; wind energy consultants; firms that produce small-scale wind turbines (with capacity of between 50 watts and 10 kilowatts) for stand-alone power; firms that produce large wind turbines for use by utilities (typically with generating capacities of 25 to 600 kilowatts); and companies that develop, finance, and manage utility-scale wind power projects.

The growing success of wind power has convinced the U.S. wind industry of the importance of vertically integrated markets. New manufacturing firms are following the example of the largest existing wind-turbine manufacturer by developing and owning their own power projects. Wind-power project developers and operators have indicated they plan to manufacture and install their own turbines, as well as wind measurement and turbine performance instruments.

U.S. firms have currently planned, or have under first-stage development, more than 330 megawatts of wind-power projects in the Pacific Northwest, Texas, Colorado, Minnesota, Iowa, New York, Massachusetts, Maine and Vermont. In addition, plans to expand existing wind-power projects in California and Hawaii could add another 400 megawatts to installed wind-power capacity in the United States by 1998.

If Congress funds renewable energy incentive payments for the fiscal year that begins October 1994, the forecast for additional intermediate-scale, utility-interconnected, wind power capacity installed annually in the United States from 1995 to 1999 would jump to 300 megawatts, an estimated 80 percent of which would be U.S. produced. Foreign-based projects may add another 160 megawatts of installed capacity per year. With the World Bank and other multilateral lenders encouraging the use of small-scale turbines in the Asia-Pacific region, U.S. producers are expected to double their sales every three years through 1999.

BIOMASS ENERGY

The industry is composed of companies that produce equipment to harvest, transport, shred, or pelletize biomass feedstock; firms specializing in the manufacture or sale of combustion, gasification, or decomposition equipment that utilizes biomass feedstock; and project engineering and developing companies that design, develop, finance, and operate biomass power projects. The three types of commercial projects are waste-to-energy plants (also called municipal solid waste plants); wood and agricultural waste-fired plants; and landfill plants.

The United States has installed more biomass power capacity than any other country in the world. As a result, U.S. firms retain a competitive edge in all aspects of biomass project development, including design, planning, environmental impact analysis, operation, and management.

Despite these advantages, the U.S. industry has relied on European licenses for development of most of the commercial waste-to-energy combustion technologies used in U.S. projects. U.S. research and development, and operational advances have focused on biogasification facets of biomass combustion. Steam and gas turbine and power transmission technology used in many U.S.-based biomass power projects reflect the technical and price competition between Japanese and U.S. firms. By contrast, the export market will be undergoing significant growth. Exports of biomass power equipment and services are expected to double in 1993 and 1994 from the previous two years, then increase 20 to 40 percent per year during the remainder of the 1990's. U.S. industry is expected to install an estimated 30 megawatts of biomass
power in developing countries during 1993 and 1994. At an average cost between $1,000 and $1,200 per kilowatt installed, the total value of biomass power projects built during 1993 and 1994 would range from $200 million to $240 million per year.

Additional biomass power capacity built by U.S. industry is forecast to increase by 15 to 25 percent annually between 1995 and 1999, with growing portions of that increase attributable to exports to developing countries. Annual growth in additional biomass power capacity installed in the United States during the middle and late 1990's could be significantly higher than forecasted under three conditions: if Congress changes the tax credit to include non-dedicated biomass wastes; if Congress funds the renewable energy incentives; and if renewable energy power purchase set-asides become more widely adopted by utilities. In the event these three conditions are met, additional capacity installed could average 400 to 500 megawatts per year during the second half of the 1990's.

SMALL HYDRO ENERGY

The economic history of the small hydroelectric power industry parallels that of other renewable energy industries. Commercial development during the past two decades is the direct result of high fossil fuel prices; and policy and tax incentives to encourage renewable energy development, diversify sources of electric power, and expand utility-scale power supply.

Since the beginning of the twentieth century, utilities and government agencies have favored hydroelectric power development as the source of baseload power. Hydroelectric resources in the United States are relatively abundant, and have the highest, potential, energy-conversion efficiency (98 percent) of any energy source. Depending on rainfall, hydroelectric plants provide 10 to 12 percent of the United States' annual electric needs.

Growth in development of small hydroelectric projects is expected to resume in the 1990's, the result of progress in the permitting, licensing, and environmental-assessment process. Industry officials estimate that approximately one-fifth of this planned capacity will have been installed by the end of 1993, with another 130 megawatts planned for installation in 1994. The remaining 390 megawatts is expected to come on line between 1995 and 1997. These planned projects would double installation of additional capacity in the United States to an average of 130 megawatts per year from the slump in 1991 and 1992. Additional capacity installed in the United States may reach an average of 200 to 300 megawatts per year by the late 1990's.

Optimistic assessments for development of small hydroelectric power projects in Latin America, Asia, Eastern Europe, and several republics of the former Soviet Union indicate that U.S. firms may install an additional 100 megawatts of power per year by the middle and late 1990's. This export-driven growth could expand industry economic activity by 33-to-50 percent per year.

GEOTHERMAL ENERGY

In contrast with other renewable energy technologies, the utility industry played a major role in the commercial development of geothermal energy. In fact, three utility entities at Geysers, California own and operate 1,625 megawatts of power, which represents more than 52 percent of the nation's geothermal power capacity.

The economic history of the geothermal industry is relatively recent and generally parallels that of other renewable energy power producers. Commercial exploitation of geothermal resources dates to the late 1950's. The first geothermal power plant went on-line in 1960. The rapid expansion of the geothermal industry occurred during the 1970's and early 1980's because of high fossil-fuel prices, and Federal policies and tax incentives to encourage renewable energy development, diversify national sources of electricity, and expand utility-scale power supply.

The reversal of these conditions in the late 1980's resulted in the curtailment of new project development. The industry installed only 405 megawatts of geothermal power capacity between 1989 and 1992 to reach a cumulative total of 3,019 megawatts. Industry officials expect that only an additional 85 megawatts of geothermal power capacity will be installed in 1993, pushing cumulative installed capacity to 3,104 megawatts.

Data of actual generation of geothermal power indicates there was little change between 1990 and 1991 (about 15.8 billion kilowatt hours), despite an increase of more than 200 megawatts of installed capacity. The reason is that several geothermal power plants were taken out of operation for part of
1990 and 1991, and thus were not generating electricity.

The United States leads all other countries in developing its geothermal energy resources. By 1990, almost half of the world's geothermal power capacity was installed in the United States. Despite the rapid growth of the domestic market, the U.S. geothermal industry has long been interested in export markets.

U.S. firms developed geothermal projects in the Philippines and Mexico in the late 1970's and early 1980's. As a result, by 1990, these two countries represented 40 percent of the world's installed geothermal power capacity.

More than 300,000 megawatts of potential geothermal power capacity has been identified for development outside the United States. Emerging markets exist in Central and Southeast Asia, Latin America, East Africa, Eastern Europe, and countries of the former Soviet Union. More than 3,000 megawatts of geothermal power is expected to be developed under "build-own-operate" or "build-own-transfer" contracts with government enterprises in the Philippines and Indonesia through 1998.

Geothermal power capacity installed by U.S. firms outside the United States declined steadily between 1985 and 1991 because of falling oil prices, the lead time required for geothermal project development, and the loss by U.S. firms of several multilateral bank-funded projects open to competitive bid. However, in 1992 and 1993, U.S. firms improved their international competitive position by winning contracts in Indonesia and the Philippines for the development of more than 600 megawatts of geothermal private power projects.

The United States is competitive in the production of certain types of equipment used in geothermal development, most notably resources-assessment instruments, drilling equipment and geothermal-extraction equipment and thermal-energy conversion equipment. U.S. industry additionally has a significant qualitative and quantitative edge in certain geothermal processes, including double flash and binary cycle, and in all aspects of development. U.S. firms are also more experienced and knowledgeable in developing and operating geothermal projects than firms in other countries.

Competition for geothermal markets in most developing countries is expected to be intense among U.S., Japanese, European and Mexican firms. U.S. geothermal industry officials have expressed their concern to the U.S. Government that the industry's competitive edge in the international marketplace is being undermined by Japanese and European companies using their governments' foreign aid and trade finance programs to win contracts that are competitively bid.

Both the near and longer-term outlook for the U.S. geothermal industry point to an acceleration in the rate of growth of additional capacity. Most, if not all, of this U.S. growth will be driven by independent development. As a result, the division of geothermal power ownership in the United States will be reversed by the end of the 1990's, with almost 60 percent of capacity located in independently-owned plants, and 40 percent in utility-owned plants.

Favorable trends affecting the industry's commercial outlook include a one-third decline in geothermal energy costs because of technological advances and production efficiencies; higher natural gas prices that push up competitors' costs; utilities increasing purchases of renewable energy; rising demand in the western states where U.S. geothermal resources are located; access to utility transmission lines; extension of Federal tax credits; and rapid expansion of export markets.

Counter to these favorable trends is the depletion of steam reserves for power production at the Geysers, California site that could cut the industry's capacity by 50 to 100 megawatts by 1998. Partially offsetting the depletion is a planned project to inject water transported by pipeline from California's central valley into Geysers' geothermal wellheads.
BOOK REVIEW

Value Analysis in Design

Theodore C. Fowler
Van Nostrand Reinhold, 1990

The subtitle of the book, Competitive Manufacturing, is very fitting. The theme of the book is how to design and manage advanced technology projects so that you can gain the most competitive advantage with the least expenditure of resources.

The book offers comprehensive guidelines on planning, budgeting, organizing, scheduling, and staffing. It includes such details as how to manage quality assurance, build project teams, manage time, measure performance, and integrate projects into an overall framework.

The book consists of a foreword written by Tom Snodgrass, a preface wherein the author makes a clear statement of his goal, 13 chapters, an epilogue, three appendixes, references, and index. The references are meager, but the index is quite substantial.

The first two chapters address the origin of value analysis and what value and value analysis are. The author speaks from the perspective of the user as well as the supplier in defining the meaning of value.

Chapter 3 introduces the concept of the value analysis job plan as an organized approach with the purpose of gaining the most competitive advantage with the least expenditure of resources. The author offers compelling reasons to believe that the value analysis (VA) process has proven effective in an unlimited variety of applications and that it can work for you in problems involving function and cost, given you remain open-minded.

The remainder of the text is organized along the lines of the job plan phases, which is useful to extant and would-be practitioners of the art. Chapter 3 addresses the Preparation Phase, illuminating team structures and data requirements for successful VA studies.

The author digresses in Chapter 4 for a very important reason. This is the logical place to underscore the need for user inputs as the focus for VA studies. The differentiation between customer and user is important, and the techniques for measuring their acceptance are useful to know.

Chapter 5 returns to the logical flow of the VA job plan with the Information Phase. The author gets right to the point with the discussion of team mindset and the elements needed to achieve it. The job plan flow continues through Chapters 6 through 12.

Chapter 13, the pièce de résistance of the book, contains details on 36 VA case studies that reveal the power and ubiquity of the VA process. The case studies cover a broad spectrum of applications occupying 85 of the 295 text pages. They are well documented and well illustrated. There is much to learn from these case studies. It is fitting that Appendix C (seven more pages) summarizes the lessons learned and key points of the case studies.

Another highlight of the book is the epilogue on establishing a value analysis system. One of the most frequent questions asked of practitioners is “How do we get started in VA?” The author stresses the importance of management support and provides a number of principles that you should observe in attempting to get started. We mention just two of these principles.

Patience: Cost reduction can pay off in weeks; VA takes months.
Low key: You are asking professionals to change the way they solve problems. Such a behavioral change must be based on favorable experience. Build your system slowly.

For VA to succeed, people must know that management wants it to succeed. Appendix A offers a statement of policy and procedure as a role model for a corporate directive. Appendix B provides a collection of forms and checklist that you need in this business.

Value Analysis in Design displays the considerable breadth and depth of the knowledge and experience of the author and the colleagues he cites. We give the book five thumbs-up.

VALUE WORLD, Volume XVIII Number 1, February 1995
Every once in a while, the question is asked, "What truly makes companies great?" There follows a spate of research, reviews, studies, and surveys to unravel the secrets behind the success of the leaders. This decade was no exception.

For the book Built to Last: Successful Habits of Visionary Companies, Collins, Porras and their Stanford University research team dug deeply into 36 leading companies, of which 18 were considered visionary and the other 18, comparable competitor companies. Peters and Waterman had earlier profiled 43 best run American companies in the book In Search of Excellence.

The Boston based Consultants, Bain and Co., Inc., collected information from 500 line, divisional and corporate managers on 25 favorite management tools and techniques to identify if there is any one magic tool or technique for success. Industry Week survey of 1993 best plants in USA describes ten organizations that had crafted dynamic achievements, the tools, techniques, technologies and resources that they applied, and the ideas used to motivate the human spirit. The Manufacturing 2000 Research Project at the International Institute of Management Development, in Lausanne, Switzerland, has been, for the past five years, on a quest to find ways companies can change and transform themselves to meet the challenges ahead.

What they garnered is a treasure trove of invaluable information on multi-faceted pursuit of excellence. Ups and downs are natural in corporate life, but the key is resilience to bounce back from adversity. Then, they become extraordinary long-term performers.

Having a basic set of core values and a sense of enduring purpose preserves the core ideology and a well-defined value system by which the organization processes and procedures function. Simultaneously, the value system seeks change, improvement, innovation, and renewal as Motorola has demonstrated. Business success follows trying a lot of things and keeping what works, as 3M's history reveals. Putting people and products before profits was magical at Ford.

Making a paradigm shift, combining academic thinking and industrial experience, selecting and using some tools and techniques, striving to achieve a new level of operation rather than concentrating on fire-fighting and latest crisis, defining value of the products and services in customers' eyes are some of the vitally important choices they had and exploited to best advantage.

The Industry Week survey concludes that the common characteristics of the winners were that all 25 of them put major emphasis on employee empowerment, use of multi-functional work teams and continuous improvement programs. In addition, 96 percent of them relied heavily on total quality management, just-in-time continuous flow, manufacturing-supplier partnerships, customer satisfaction programs, employee training, inventory reduction strategies, and efforts to ensure delivery dependability.

Ninety-two percent of these companies cited cycle-time reduction and concurrent engineering as major initiatives. On an average, these companies boosted overall productivity by 64.5 percent in five years, while reducing manufacturing costs by 30.4 percent.

Evidence enough, and more, to show that successful companies use almost every ideology, systems, tools, techniques, concepts, and technology to stay on the top of relentless waves of changes over time. Interestingly, they really are bits and pieces of value analysis (VA) and value engineering (VE), without calling them by those names except at Johnson & Johnson's Aircraft operations and Belfab. These companies specifically mention value analysis teams and value-added chain.

VA/VE provide a powerful methodology for solving
problems and reducing costs while maintaining or improving performance and quality.

They are organized, systematic, creative, and common-sense approaches for continuous and continual improvement of product and services. Its core is the value concept: that an item is intended for a purpose called "function". The customer buys a product or service for that purpose, and it is of value to the customer if it accomplishes that purpose efficiently and effectively at the lowest overall total cost.

It is a common belief and conviction that there is always a better way to do anything. The mission of VA/VE, therefore, is finding that way. The aim of VA/VE is the greatest value return for the money spent. VA/VE ensures this by supervising for value at all stages of development and production - concept, design, specification, manufacturing, purchasing, packaging, transportation, sales, distribution, maintenance, and service.

VA/VE, a team approach, uses all internal expertise and specialization; all available tools and techniques - both old and new; and complement of external consultation, as appropriate and relevant. In short, VA/VE is change, purposefully directed and managed for betterment.

If the bits and pieces contribute to making companies enduringly great and help the best to grow even better, imagine what the totality of these bits and pieces, that is VA/VE, can and will endow. Will the wise, remembering the past, clearly perceiving the present, learning from experience, settle for anything less than the totality to meet the challenge ahead!

For a decade, performance was the criterion that gave products and services the edge over competition. Then came quality, the basis for improving dependability and reliability.

More recently, the focus has shifted to speed: getting the products and services to the market fast, without compromising cost, performance or quality. Today, you must harness the five forces of change: techniques, tools, talents, tasks, and time. Besides, it is the age of customization. In the past, an adequate quality and an affordable price were good enough to attract and keep customers. Not so any more. Customers seek a customized product or service that is unique and tailored exactly for what each wants it to be.

The increasing awareness of the relationship between quality and price has led customers to research all attributes, rate them, and shop strategically for the most value-added items. They look for not only satisfaction, but more importantly, delight with the acquisition: that is, not only that their needs have to be satisfied, but also that you are delighting them as their supplier and selling them on the basis of value. With globalization of markets, their choices are becoming unlimited; whilst, the challenges to the companies are multiplying exponentially, to lead on all of these aspects, severally and collectively, and to maintain that lead continuously and continually. Which is what VA/VE were created for: to make and deliver, with speed, a better designed, more efficient product and service, with improved performance and safety, quality, reliability, and dependability, at the least possible cost, at any point of time; thus ensuring greatest customer satisfaction and delight.

The future will be in making it happen. And, for making the future happen, every industry, including the super achievers, would certainly find VA/VE the most promising and rewarding of all tools and techniques.

How I used to envy those travelers who occupied the plush seats of first class airline travel. Lucky stiffs!

Vicarously, I joined them beyond the curtain sipping Bailey's Irish Cream and meeting people of wisdom and influence, relishing in the luxury of private toilets, linens, and Rogers Brothers silverware.

But the cost differential between economy and first class fares previously kept me from joining the favored elite. That is, until I became a frequent flyer; a man of means now granted a free upgrade on numerous occasions.

My new found pleasure permits me to belly up to the gate boarding at my leisure, competing only with those traveling with small children, and others less fortunate.

Throughout these first class experiences, I have made two distinct observations about my fellow travelers:

- People often change their demeanor and style while occupying the elite forward section. They aren't the same people as when they trudge to the back. They act differently and they are different, if only until touch down.
- As for stimulating conversation, forget it in the first class section. There isn't any. The most interesting conversation occurs in the economy cabin. First class is often loaded with frightful bores, whom I think have captured me.

Just some little things I noticed in first class, such as the man who apparently is contracting St. Vitus Dance while impatiently awaiting a flight attendant to tend his sport jacket. He was roughly eighteen inches away from the closet and would not have become overheated from hanging the jacket himself.

Then there are the contrasts. One traveler nonchalantly declines refreshments, seemingly as a sign of, "Who really needs it; I even drive a Volkswagen.

While others are in an unannounced Olympic drinking or snacking contest, becoming red-eyed and bloated, the best that I can hope for is that they don't spill tomato juice all over me.

Saying all this, I would want you to know that I am unaffected by being placed in the forward cabin.

Incidentally, do you have any frequent flyer upgrades you aren't using?

Thomas R. King, CVS, FSAVE, is a SAVE Past President and with Joy Technologies, Inc. in Franklin, Pennsylvania
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Value Engineering as a Budgeting Tool, Harvey C. Childs, AIA, Errata, October 1994.

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Fuerstenberg, Gary, EIT, Comparison of VE and TQM, October 1994.
Management Review Staff, After All the Tests have Been Graded, Will TQM Get an A+ or and F?, May 1994.
McEnnue, John F. With Jill Woller, CVS, VE Helps Resuscitate Underfunded Hospital Clinic, October 1994.
A number of readers have telephoned us about the linear programming problem in the previous two issues of *Value World*. Several realized that we gave you a trick question.

We gave you three constraint equations, but there are only two unknowns: the number of cubic yards from Pit A and the number of cubic yards from Pit B. You only need two equations to solve for two unknowns. Which two of the three equations given do you use?

Use the two equations with the largest constants.

\[0.20X + 0.30Y = 20,000 \text{ cubic yards for coarse gravel and}\]
\[0.25X + 0.20Y = 20,000 \text{ cubic yards for sand.}\]

Solve these two equations simultaneously. You will get the exact amount needed of coarse gravel and sand with too much of fine gravel, but it will be the least-cost solution.

Try solving the problem. We will give you the solution in the next issue of *Value World*. 
VE-THE WAY TO
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