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Teaching Notes for Course Modules

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Teaching Notes for Course Modules

Module 2

Day 1

"The Commons Game"

Saving the Commons:
A Behavioral Simulation for Experiencing the Role of Collaboration and Trust in Devising Workable Solutions to Environmental and Other Social Issues

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Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.

-- Garrett Hardin (1968)

Among the broad range of social issues of global concern, the impact of corporations on the natural environment is among the most important. This concern has been elevated both by the obvious deterioration of our planet in the face of accelerating development, but also by a better understanding of the human and economic costs of interrelated global and regional problems (e.g., overpopulation, global warming, ozone depletion, deforestation, air and water pollution and loss of biodiversity--Brown, 1993). Moving beyond the typical, extended debate over the merits of unilateral corporate action vs. mandated command and control policies, it is becoming clearer that dealing with these challenges will require a different set of values and premises.

Thus, it is critical for managers and policy makers alike to become sensitized to the importance of considering the extended consequences of their actions, to more broadly understand the benefits and costs associated with various options available for mitigating their environmental impact, and to more fully appreciate various stakeholder roles and responsibilities required to implement various solutions. It is essential that this effort be attended to now, as the concomitant problems of managing worldwide economic growth with environmental sustainability are expected to worsen in the next 50 years (Daly & Cobb, 1989; Commoner, 1990).

While developing successful solutions to environmental problems is a pressing task everywhere, it is worth noting that the fruits of such efforts may be even larger in some of the changing economies. In Eastern and Central Europe, for example, managers are facing extremely difficult tradeoffs between profits vs. the environment, often in a context of life threatening degradation caused by previous regimes. Similarly, in China rapid economic development appears to be accompanied by numerous environmental calamities in the making.

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Despite the clarity of this need, changing managers' and students' premises about corporate responsibility vis-a-vis the environment is no easy task (hereafter we will use the term "student" in the broadest sense to include practitioners). In spite of the magnitude of such problems both here and abroad, little is being done within the realm of traditional management education to address this crisis (Starik; 1995). While addressing such matters in textbooks or lectures may have some beneficial effect, such approaches are doomed to insufficiency because the learning objectives associated with environmental management require a more fundamental shift than can be accomplished through even mega-doses of facts.

The pedagogical issue here is that passive activities as reading, listening to lectures, or watching videos can efficiently convey a large amount of theoretical and factual information, but they are quite limited in their potential to have a lasting effect on students' premises or the manner in which they look at, or evaluate, a situation (Katz, 1974; Mintzberg, 1975; Serey & Verderber, 1991). From a broad business and society perspective, while such passive media may convey some sense of the plight of stakeholders affected by corporate activities, when moving on to consider solutions to those impacts, they are extremely limited. Furthermore, given the theoretical roots of capitalism on which our business system is based, arguments supporting "corporate responsibility" are too easily dismissed by students as simple "liberal sermonizing." Given this combination of limited traditional pedagogies and the seriousness of our global environmental problems, it is the responsibility management educators to devise new and more engaging methods to drive home a valid message about the nature of environmental problems and what must be done.

If we can get students to somehow experience, recognize and accept a relationship as valid, then is it possible for the educator to draw solutions from the students themselves. Thus, students become their own "authority" about the existence of the problem and more willingly take ownership of the solution. Such self-discovered solutions

can lead to better internalization of the learning (Aronson, 1980) and provide a better platform from which the student can move on to even higher levels of cognitive and ethical development. In Perry's (1970) scheme, the highest levels embrace commitment to a course of action--a praxis of internally derived theory and action. While the charismatic limitations of most academics suggests that no single pedagogical tool administered within a single training session can enlighten all students, our purpose here is to introduce a simulation which challenges most students enough to start them down the path toward new thinking about corporate responsibilities vis-a-vis the natural environment. The insights gleaned from this simulation create a platform from which to draw from the students themselves an understanding of the relative merits of different classes of solutions (e.g., governmental regulation, market incentives, industry self-regulation) and which permits them to see the benefits of proactive, collective solutions.

Before providing complete instructional materials required to conduct the simulation, some theoretical points will be made regarding a class of problems called"system-wide" which subsume many environmental issues. This literature review is intended to provide a theoretical basis for understanding the benefits of collaboration and mutual trust in developing collective solutions to many of the environmental problems faced by business today. Used in combination with the simulation, this theoretical overview also affords the opportunity to connect theory with application, which is too often lacking in business school curricular and pedagogical approaches (Porter & McKibbin, 1988). This section will be followed by the instructional materials and a discussion of general approaches to processing the simulation. The last section relates student experiences with the simulation, and concludes with a summary of the beneficial outcomes found from using this simulation in the classroom.

Theoretical Background

This particular simulation is designed to permit students, managers, and policy makers to experience Garrett Hardin's (1968) thesis regarding the "tragedy of the

commons." As the above quote clearly indicates, Hardin argues convincingly that whenever disassociated actors share a common resource, in the *presence* of "development" and in the *absence* of what Hardin referred to as "mutually coercive mechanisms," they are doomed to ruin it. This applies to any common resource (i.e., land, water, air or even space on the planet--in the case of population growth), many of which are already being stretched to their limits by an accelerating global economy We will hereafter refer to Hardin's thesis as "the commons problem."

Many of the social problems faced by business and society today are similar to the commons problem; that is, organizations acting independently in their own best interest often produce unintended consequences that are detrimental in the long-term for themselves and others. While the focus here is on environmental problems, it is worth noting that the dynamics of the commons problem extend into other domains as well. For example, in a recent interview with the authors, the CEO of an advertising agency in Eastern Europe was describing the problem of buying media time at a government run television network. The essence of the problem was that obtaining desirable "spots" for clients was requiring escalating levels of bribes and, acting independently, the agencies had to "outbid" each other or lose access. In this example, the television network was a common, finite resource they were collectively "ruining." The only way out, according to this CEO, was through collaboration among the agencies.

Aldrich (1976) labeled these class of organizational problems as "indivisible problems." Along similar lines, Ackoff (1974) more straightforwardly, mused about "organizational messes." Each in their own way was describing a class of problems that go beyond the ability of any one organization to resolve, primarily because they occur at the system-wide level (i.e., above the organization-level). One obvious characteristic of these indivisible, messy problems is that by cutting across traditional organizational boundaries workable solutions involve multiple stakeholders (Gray, 1985). Thus, with such problems from either utilitarian or universalistic philosophical perspectives, superior

solutions require concerned stakeholders to work together to find mutually agreeable social and/or institutional arrangements that satisfy various constituency needs and expectations. In this way, there are better opportunities for maximum benefit to accrue to the most people (i.e., the utilitarian evaluation of alternative courses of action) and moral principles of fairness and involvement will attend the process (i.e., likely universalistic criteria). Here the authors do not intend to denigrate the virtues of competition, which has been and will continue to be the engine for much development in our market-based economy, but we do which to recognize that greater levels of organizational interdependence and resource scarcity in today's global economy mandates an alternative approach which recognizes that success often derives as much from collaboration as it does competition.

Given these indivisible problems, competition (i.e., attempting to maximize individual gain in a win-lose payoff context) will lead to turmoil unless a third party intervenes to impose han arrangement, albeit one which may only be slightly better than turmoil (or ruination in the case of a commons). For example, in the absence of industries members working together to mitigate problems with pollution, there are now in excess of 15,000 pages of government enacted regulations. In this example, some level of effective collaboration among firms in an industry certainly could have mitigated this level of government intervention. Moreover, once the government became a major stakeholder collaboration with them would likely have resulted in more sensible regulation than many observers believe we have (sensible in terms of meeting industry needs while dealing with the problem). As a recent example of this, greater collaboration between industry and the EPA in the context of the stakeholder-driven ISO14000 development is supplanting the many of the ill-conceived "best available technology" mandates by the EPA with more flexibly administered environmental management systems. As a consequence, the current intention is that companies certified under ISO14000 standards will be given considerably more flexibility and internal motivation in reducing their levels of pollution.

The idea that organizations should mitigate the need for third party intervention by considering the expectations and needs of various stakeholder groups when making decisions is not new to the management literature. Indeed and in a broader sense, Barnard (1938) spoke quite forcefully about "systems of cooperation" and "moral responsibility." However, until very recently researchers and practitioners have taken the organization's perspective as the focal point among a given set of stakeholders. This focus served well to bring stakeholder views into account, but does not fully confront the system-wide problem described earlier. Freeman's (1984) stakeholder approach to management, for example, portrays the organization - stakeholder relationship as a hub and spoke system (i.e., where the organization is the focal point and various stakeholder groups extend out from the organization) Similarly, Ansoff (1965; 1984), resource-dependence theorists (Pfeffer & Salancik, 1978; Pfeffer, 1981) and transaction cost theorists (i e. Williamson, 1981) assume a similar stance

Such micro-perspectives, however, are becoming less applicable for developing effective solutions to system-wide problems faced by business in conjunction with the increased level of turbulence in organizational environments (Gray, 1985; 1989). Instead, effectively dealing with indivisible, messy problems--such as many environmental problems--requires a more macro-view of stakeholder relationships. Building on open systems theory (Blau & Scott, 1962), which suggests that the success of a firm is linked to its own ability to develop symbiotic relationships with other organizations, Ackoff (1974; 1981) proposed that solving system-wide, commons-type problems requires stakeholder participation. This model of stakeholder management emphasizes that firms should collaborate with other firms and stakeholders so to meet both firm specific goals and stakeholder needs. This system-wide perspective on stakeholder relations is explicitly adopted here in dealing with the commons problem.

Collaboration

Building on the system-wide model of stakeholder relations, a number of researchers have begun to investigate the benefits of collaborative problem solving among businesses, government, and other pertinent stakeholder groups in dealing with complex social issues (Austrom & Ladd, 1986; Gray, 1989; Logsdon, 1991a; Waddock, 1986; Waddock & Post, 1990).

Collaborative problem solving is defined as "a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible" (Gray, 1989: 5). Gray argues that increasing levels of environmental turbulence makes collaboration the only effective means for solving problems at the system-wide level. Environmental turbulence limits the ability of each stakeholder to understand more than a portion of a particular problem. Collaboration creates a greater mutual understanding of the problem through examination of divergent stakeholder perceptions. Once mutual understanding is reached, stakeholders can begin to negotiate a collective solution to the problem.

In contrast to the accepted norms of competitive behavior in business, collaboration requires that organizations understand that some form of collective action with other organizations and stakeholders is necessary for resolving commons-type problems. Once this understanding is in place, participants must develop and maintain a climate which is conducive to sustaining collaboration (Gray, 1989).

Understanding the need for collective action requires that participants recognize their interdependence and believe that positive outcomes will result from collaborative efforts (Logsdon, 1991b). In the absence of perceived interdependence, organizations may pursue individual responses, but there will not be the motivation for collective effort. Even when interdependence is recognized, organizations may not feel that collaborating is in their best interest, especially if past interactions to solve the problem have been

competitive. In such cases, a mandate from some external organization (e. g. government) may be necessary to induce stakeholders toward some form of collective action.

Despite understanding the need for collective action, or the use of third party intervention to induce collective action, developing successful solutions through collaboration requires constructive behaviors among participants (Gray, 1989). For example, successful collaborations require open communication and exchange of ideas, greater perceived influence by all participants, and a willingness to search for alternative courses of action among different solution sets. The importance of constructive behaviors cannot be overemphasized in sustaining effective collaborations. Even the best intentioned efforts toward collaboration can be undermined if dysfunctional behaviors interfere with the collaboration process or solution implementation. With this in mind, it is our position that developing and sustaining constructive behaviors is in large part dependent upon the level of mutual trust among participants. Nor are we alone in this assertion, many companies and industry associations have arrived at a similar solution (or at least the verbage is intended to convey such an impression). For example, in the chemical industry Robert Kennedy, CEO of Union Carbide admitted that a lack of trust created by irresponsible firms in the industry undermine many well intended initiatives. As a response this lack of trust key aspects of the Chemical Manufacturer's Association's "Responsible Care" program prescribe an ongoing process of communications on health, safety, and environmental matters with interested parties outside industry (this program is described in Case 12.5 in Schmidheiney, 1992:221-223).

Mutual Trust

As alluded to in the previous paragrapsh, a key to ensuring constructive dynamics among parties engaged in collaborations is the development of mutual trust (Golembiewski & McConkie, 1975). Mutual trust can be defined as "the willingness of individuals within a group to be vulnerable to the actions of others' in the group based upon the shared expectation that others' in the group will perform certain actions."

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Bound up in this definition of mutual trust are the concepts of risk taking and vulnerability (Luhmann, 1979; Barber, 1983). Relatedly, Zand (1972) argued that trust was the giving up of control, such that the trustor must rely on others actions with knowledge that the certainty of those actions cannot be known, a priori. Obviously trust can given either naively or prudently.

Yet despite the potential for exploitation, trust has been exhalted as the "nurturant sun" which drives out latent fear and constricting behaviors (Golembiewski & McConkie, 1975). Thus, trust mitigates perceptions of both risk and vulnerability and engenders cooperative behavior (Deutsch, 1973). Zand (1972) confirmed this by finding that individuals who trusted one another engaged in a wide range of positive behaviors, including more open communication and exchange of ideas, greater perceived influence by all participants, and more extensive search for alternative courses of action. Specifically, with regard to collaboration, mutual trust enables the full exploration and integration of divergent perspectives which is necessary for arriving at a high quality collective solution; and, in its absence, collaborations deteriorate into competitive and political behaviors, secrecy, and poor information exchange and processing.

Once a collective solution has been reached, mutual trust also speaks to implementation issues and the proclivity for future collaborations. Successful implementation requires that each party accept personal responsibility for the decision and be resolute in their efforts. This will occur only under a strong assumption that no one engaged in self-serving behavior (Ouchi, 1980). In the absence of mutual trust, the willingness to make oneself vulnerable is replaced by defensive and competitive behaviors in an attempt to mitigate or avoid attacks (Gibb, 1961). Mutual trust also provides the foundation for building future collaborations. Throughout collaborations, mutual trust signals to those involved that future issues and problems can be dealt with in constructive manner.

Given the previous discussion, preparing students for effectively dealing with commons problems requires contriving a mechanism for them to come to a number of conclusions:

(1) That many problems faced by organizations can be classified as commons problems; (2) That their resolution transcends technical solutions; (3) That devising successful solutions is beyond the ability of any one organization and, thus, requires collective action; (4) That, in the long run, competitive behavior can be less profitable than collaboration; (5) That trust is the key factor in enabling collaboration; and, (6) That there are number of approaches for dealing with the commons problem, that some are better than others, and that some of the less desirable approaches will be imposed in the absence of more effective ones. We have found that the experiential simulation described on the following pages is beneficial in helping students reach these conclusions.

The Commons Simulation

Whereas commons-type simulations have been used previously in empirical, laboratory studies (Dawes, 1980; Edney, 1980; Powers & Boyle, 1983), there has been little effort to adapt them for classroom use. With this in mind, we have modified a simulation originally described by Powers and Boyle (1983). Our modifications had two primary intentions First, we sought to explore some additional aspects of Hardin's thesis. For example, we incorporated into the simulation a "plea to conscience" along with options for conferencing. Second, given the previous discussion on the benefits of collaboration in solving commons-type problems, we place much more emphasis on illuminating the benefits of collaborative problem-solving over regulation, and technical solutions. Finally, with the emphasis on collaboration, we attempt to create an understanding of the factors that lead to collaboration, especially mutual trust among participants.

PLAYERS MANUAL
COMMONS SIMULATION

RULES:

(1) YOU MAY TALK FREELY TO THE OTHER MANAGERS IN YOUR PLANT, BUT DO NOT TALK TO MANAGERS FROM OTHER PLANTS UNLESS GIVEN EXPLICIT PERMISSION!!!

(2) STAY ON THE SAME TRIAL AS EVERYONE ELSE!

(3) FILL IN ALL THE INFORMATION ON YOUR TALLY SHEET.

OBJECTIVE:

You (and your team members) comprise the top management team of a sizable manufacturing facility in Kivulini-- a country which is expected to experience rapid industrialization because of its low-wage structure and loose regulations. You and your team are somewhat troubled because you know that the financial performance of your plant has been discussed at headquarters and they have quite bluntly informed you that they expect higher returns on their invested capital. You are uncertain about whether the plant will be closed if your plant's profitability doesn't improve, but you are quite sure that your own compensation and career track in the company are related to the financial performance of the plant. Currently, your team has 100 pazoozas--the currency of Kivulini--in uncommitted funds.

Your plant, along with a number of other plants, is located on a large inland freshwater lake, Lacul Gunoi, upon which there are two cities (Porto Deano and Mji ya Ian) with a combined population of about 200,000 people. Importantly, all the plants (and the cities) desire a continuous, unpolluted source of water for their manufacturing processes (and quality of life as all of you live nearby the lake). Currently, while water quality has deteriorated noticeably in the last few years, the water is still acceptable. The lake has a restricted outlet and does replenish itself, but within limits.

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Unfortunately, while each plant needs a good source of water, each releases a number of toxic pollutants into the lake. Currently, neither the national nor local governments regulate either the amount of water taken from the lake or the amount of waste released into it Consequently, the condition of the lake is determined mainly by the plants themselves.

PROBLEM:

In sum, the problem facing you as a plant management team is, "How do we profitably operate our plant when our process is dependent on the lake as a public resource?"

PROCEDURE:

You will be confronted with a series of decision opportunities (trials) in which you must choose a course of action regarding your use of the lake water. Your management team may choose among five options prior to each trial (among three options initially):

(1) RED--you continue to use the lake water as you've always used it--releasing the toxic byproducts into the lake.

(2) BLACK--recognizing the deterioration of water quality, you limit pollution into the lake (e.g., by storing it, treating it, cutting back on production, or subcontracting its removal) Should the opportunity present itself to discuss this problem with other plant managers, choosing black implies compliance with any agreements or understandings to reduce levels of lake pollution.

(3) YELLOW --you take unilateral, technical measures to make your process less dependent on lake water and, as a result, less dependent on the actions of the other plants.

(4) BLUE (Available only after round 7)--you expend financial resources to enable a third party or agency to institute fines for polluters in the next trial (i.e., those choosing red).

(5) ORANGE (Available only after round 7)--you use financial resources to enable an association to reward the most cooperative team in the next trial (i.e., the team which has chosen black most often).

Note that only black, red and yellow choices are available during the first 7 trials.

Each choice has financial outcomes:

RED and BLACK: Financial outcomes associated with black and red choices depend on how many plants used those approaches. For example, if all plants on the lake limit their pollution (i.e., by choosing black), every plant will benefit by having cleaner water. However, if a single plant reduces pollution while all other continue to pollute (i.e., by choosing red), that single plant would incur the costs of reducing pollution with little benefit. Conversely, if all plants but one reduce their pollution by choosing black, the one rogue plant which continues to pollute by choosing red will accrue benefits from being a "free rider."

In addition to being dependent on the pattern of choices, payoffs are also dependent on the quality of the river. Of course, as the water quality deteriorates, all plants production processes will suffer. Conversely, as water quality improves, all benefit.

Red choices will cause degradation of water quality. The facilitator will announce how many peg movements downward will attend each red choice (usually one or two, depending on the size and composition of the group). Black choices, on the other hand, neither degrade nor improve water quality. Water quality is only improved by natural processes; the lake water is flushed out by the annual, and often heavy, Spring rains.

The status of the lake will be shown by the location of a marker on a board, strip or blackboard. The marker will move up or down as the status of the lake changes. Every five trials, the peg will be moved up as a consequence of the natural restoration of the lake.

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These two influences (i.e., the number of plants polluting and water quality) are incorporated into different payoff matrices). The facilitator will display the correct payoff matrix corresponding the condition of the lake prior to each decision period (the simulation begins with the payoff matrix "0" (which represents water that is just "adequate" for your production processes. The payoff matrix will be changed as water quality either improves or deteriorates). For example, assume that water quality has deteriorated somewhat over a number of trials so that water quality is "-2." In this event, the "-2" matrix would be displayed for the next decision and would then be used to calculate the payoffs for those plants selecting either the red (pollute) or black (cooperate) options.

YELLOW. The yellow alternative (reduced dependence) costs a fixed amount of 20 pazoozas in the trial it is chosen. However, this choice adds 2 pazoozas onto whatever you earn or lose for the remainder of the simulation. This return takes effect three trials after the investment. The reasoning is that R&D used to develop a process which is less dependent on lake water will cost the company initially in the developmental phase, but have a future payoff after an implementation phase. Yellow may only be chosen once, however, after three implementation trials, the 2 pazooza payoff from choosing Yellow continues throughout the game. (While there is some inconsistency in playing red after choosing yellow, for simplicity--at least during the first few attempts at conducting this simulation--this bonus is best granted regardless of the option selected.)

BLUE & ORANGE: The blue alternative (fines) and orange (reward) alternative each cost 3 pazoozas (i.e., the resources expended by your plant to initiate a third party, agency, or association which enforces the fines and to gives rewards) in each trial it is chosen. The effect of the blue choice (i.e., the fine) is that it takes away all pazoozas that red choosing firms would have had if the fine had not been imposed and imposes a 5 pazooza fine. However, just as in the real world not all polluters

are caught. In this case polluters are caught about 25% of the time (actually a very high rate of enforcement effectiveness). Consequently, enforcement will be determined by double coin toss by the facilitator; with two consecutive heads required to catch the polluting factory. Those who are caught will have their identity made public by the facilitator (those not detected keep their anonymity). To keep things simple, in the event that two or more teams choose blue, we maintain the 25% catch rate arguing that the extra resources are used up in "administrative overhead."

The orange choice rewards the cleanest plant by adding 5 pazoozas onto the pazoozas already earned by the plant that has chosen black the most often at that point in the simulation. In addition, they will receive the "Green Award" which they can proudly display until the next time it is awarded. The facilitator will announce the winner of the award. Ties between two or more teams will be resolved by a coin toss, lottery, or by placing the resources in a pool for future use (in the event there are no "stand outs" as determined by the facilitator).
The effect of these choices is summarized below:

[Insert Exhibit 1 here]

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SPECIAL TRIALS

At round 5 an appeal to conscience is recommended. Such an appeal will consist of the government of Kivulini stating that they have become aware of a pollution problem on Lacul Gunoi and asking all plants on the lake to please reduce their pollution levels. It is important to point out that such an appeal implies no consequences or enforcement whatsoever.

Before round 8, a conference will be permitted among the plant representatives [NOTE: The form of these conferences may vary based on the preferences of the facilitator. It is also possible to double the payoffs, if desired, to place additional pressure on the groups to devise a solution. The facilitator will announce if any options are in effect.] Other conferencing trials are indicated on the instructor's log sheet.

INDICATING YOUR CHOICE

Your management team will indicate your choice when the facilitator or assistant comes by your plant (a color chip is stapled in your simulation folder--you may choose to point to the color of your choice). The simulation will continue until it is terminated by the facilitator.

RECORD KEEPING

Each plant's management team will be given a profit/loss statement for recording the payoff obtained for each trial and for keeping track of their cumulative gain (or loss). A copy of this profit/loss sheet is provided in Exhibit 2. At the beginning of the simulation, the cumulative score is set at 100 which reflects the amount of pazoozas you have available.

INSTRUCTOR'S MANUAL

COMMONS SIMULATION

The instructor should form plant management teams (between five and eight plant management teams are desirable). Each team is given a folder containing: the players manual; the profit/loss tally (Exhibit 2); and colored squares representing the five choices (these are glued or stapled inside the folder). It should take about 10-15 minutes to read the manual, depending on the language mixes of the participants.

Instructors will need: an administrators log sheet (Exhibit 3); some device for tracking the quality of the lake (shown in Exhibit 4 and described in more detail below); a set of payoff matrices on transparency film (Exhibit 5); a coin for flipping; and an overhead projector. The first three items are described in more detail below.

Administrators Log Sheet

A copy of this log sheet is given in Exhibit 3. After the teams have made their choices, the facilitator (or assistant) should visit each team and record their decision directly on this log. For example, if using 6 teams in the first trial (in which orange and blue options are unavailable) the assistant may have entered the pattern "B B R Y B R" on the first line. This would then be totaled as "3 2 1" under the headings "BK RD YL." It is this total that is then "tallied" on the board and is the pattern of decisions from which the payoffs are calculated. On return to the front of the classroom, the totals should be posted (on the board or flip chart) so that each team can calculate their payoff for that trial. Remember that payoffs for blue, orange, and yellow are fixed, but that payoffs for red or black choices depends on the correct payoff matrix. For example with water quality at level -2 (shown on the indicator in Exhbit 4), if two plants had chosen the black option and four plant had selected red, their payoffs would be -3 and +4, respectively (as determined in payoff matrix "-2" in Exhibit 5). It is critical to the success of the simulation that water quality is adjusted after each trial and the payoff matrix is changed accordingly.

After the first couple trials, the facilitator (or assistant) should ensure that each plant team is completing the form correctly. If a team has chosen blue (fines) and a team(s) has chosen red in the same trial, the double coin toss will be necessary to determine whether the polluting team is caught, identified, and the fine assessed. Also the selection of which team receives the "Green Prize" should be made based upon prior performance (i.e. the team which has played black most often). In the event of a tie, the decision may be settled with a coin toss (or other means). The nature of the Green Prize is left to the discretion of the facilitator Ideally, it should be something green and flashy, but with little intrinsic value. We use a green ribbon.

Water Quality Index

Some device must be created to track water quality. We use a board with holes drilled in it so that a peg, such as a golf tee, can indicate the current level of water quality. When traveling we use a velcro strip with a movable "dot" made of the "hooked" part of the material. Alternatively, it would be possible to simply draw something on the blackboard and track changes by erasing and moving a chalk mark.

As previously mentioned, the simulation begins with the marker at the "0" level and as teams choose red (i.e., to continue polluting the lake water) the marker is moved down one or two units for each red chosen. The choice of how many units to move the marker down for each red choice depends on the number of plants and the type of participants. With six or fewer plants we use two units per red and with environmentally-oriented groups or international groups we may increase it even more. In typical play, the marker will initially move quickly downward into the -3, -4, and lower regions. As each new region is reached, a new payoff matrix is shown prior to the next trial.

Factories don't make the water any cleaner by choosing options other than red, they merely prevent its further deterioration. The lake improves through natural processes which serve to flush out the pollutants periodically. Consequently, every five rounds the water quality index is moved upward 10 units with a large number of plants or five units

with a small number of plants. This decision is also an opportunity for the facilitator to "fine tune" the simulation to his or her audience. We will move it up less with less competitive groups. So as to make the participants think you aren't controlling the outcome, however, this decision should be made up front and announced. The administrator's log sheet should be consulted each time to insure that actions are taken at the proper times.

Payoff Matrices

The payoff matrices for determining payoffs from red and black choices are presented in Exhibit 5. As previously described, these payoff matrices correspond to zones in the water quality indicator and attempt to capture payoffs associated with the pattern of decisions among all the plants on the lake. While these payoffs could be included in the participants materials, it is preferable that the students experience the consequences of their actions one matrix at a time and deduce the pattern underlying the payoff matrices as the simulation progresses. Although these are presented in reduced form here for the efficient use of space, these will obviously need to be enlarged.

Materials and Equipment

An overhead projector and transparency masters are desirable for running the simulation. However, in the event that these are unavailable or the cost of transparency film is high, the materials could be copied or drawn on the board, as necessary.

Experiences From Using The Simulation

Even though everything is described for students in the player's manual, it is useful to review Exhibit 1 (included in the players' manual) and to briefly answer any questions prior to beginning the simulation. Beyond that, the first few trials will likely go slowly, but the learning curve is quite steep. The facilitator should allow the simulation to progress through 10-12 trials at a minimum, depending on class time and the capabilities of the students. During conference trials, the facilitator should also allow ample time for representatives from each plant to confer with each other out in the hall or in a separate classroom. The point of these conference trials is to afford students the opportunity to explore different means for managing the commons, and to afford the opportunity for some plants to betray collective decisions in the interest of short-term gain.

Processing the Simulation

We usually begin processing this simulation by defining some basic terms. It is important to define the term "commons." The students need to understand that a commons is a finite resource with free access by a population. In a sense it is a resource that is theoretically owned by everyone, but practically owned by noone. In the simulation, the lake is such a commons resource. It is also important to identify other type of "commons" in order to generalize the problem later on. Air, water, ground water, other rivers, national parks, free range land, rain forests, and the diversity of species on the planet are but a few.

The next stage is to have them freely discuss what happened in the simulation. In leading this discussion we try to follow the model where the student provide "data" which are their observations. We call this the "publishing" phase. These data are then discussed to highlight relationships-the "processing" phase. Finally, it is important to place the problem into the managerial content--the "generalizing" phase.

Experiencing the Tragedy of the Commons

In our experience, the pattern of results obtained invariably show that when the various plants operate independently (and under strong pressures for profitability), the water quality will deteriorate--often quite rapidly. Thus, the marker will plunge through enough regions on the water quality indicator that the students will see the pattern in the payoff matrices which confirms that all the plants become worse off and, if taken far enough, no plant will obtain profits. Indeed, the quality of the water should become a serious concern for all plant managers by the time they are allowed to conference prior to the eighth trial.

It is important to explore why--according to Hardin (1968)--this has to happen. In his often cited article he uses the metaphor of the "village commons." Here is a situation where a herdsman, along with many others, has access to a common and finite resource to graze his sheep. From the individual herdsman's point of view, the economic benefit of grazing one more sheep is substantial--he or she gets all of the benefit when taking a fattened animal to market. However, the costs are both trivial and, importantly, shared. Thus, it is clear that a rational, independent herdsman will add the additional sheep to those already grazing on the commons. The costs only become evident when a serious problem of overgrazing is evident and, even then, the benefits exceed the costs because the benefits accrue individually while the costs are shared, social costs. According to Hardin this calculus will rule up the point that the commons is ruined as long as the actors are dissociated or some public interest doesn't intervene. It is useful to have the students add other examples as a way of illustrating the prevalence of commons-type problems. for example, one of the authors had a problems with putting reading on reserve in the library (i.e., a type of commons). Too often, some individuals would take the materials for personal use making them unavailable for others (and making it impossible to test the class on). The consequence was that now all students must purchase the materials (and,

ironically, the students who took the material presumably read it, but couldn't be tested on it!) .

This idea can be easily transferred to the simulation as each plant accrues the short-term economic benefits of releasing the waste into the lake while the costs (in terms of deteriorating water quality) were shared. It is interesting to consider the effect of development on this process as in a condition of resource abundance the social costs are quite small. Inquire of the class which team had the best profit during the period of play. It will almost always be a team that exploited the commons.

It is also useful to explore the relationship of development to the morality of exploiting the commons. In the Caribbean basin 100 years ago, there was little problem when the locals would cut wood to make charcoal--the islands were covered with forests. However, as in modern day Haiti such an action has caused widespread erosion of scarce topsoil. As a result, the island is irreversibly damaged--a commons has been ruined. Thus, it might be argued that the morality of an action actually changes with the scarcity of a resource. This is one reason why simple, all-purpose rules for resource use don't serve us very well. Moreover, such prohibitions are usually stated in the negative and rarely make a case for proaction.

Pleas to Conscience

This simulation also affords the opportunity to observe the reaction of students' to the government's plea for self-restraint (about trial #5 or 6). As Hardin (1968) persuasively asserted, such pleas are often counter-productive. The typical pattern is that those individuals (or organizations) that comply often end up witnessing widespread abuse and begin feeling like they've been fools more than good citizens. Each then vows not to be the fool the next time. Explore whether the plea had such an effect. Even if it fell on deaf ears, this is a point worth discussing. A number of educators and managers will recall the pleas by the Nixon administration for everyone to set their thermostats at 65 degrees

during the 1970's oil crisis. Are any pleas for voluntary restraint are currently being made? Do any involve a common resource?

A Framework of Choices

Next, it is good to focus on the different types of behaviors represented by the decision options and, by having selected them, the environmental postures of each plant. We usually focus initially on the dimensions along which they differ. [As an aside at this point, an earlier version of the game logically equated the color green with collaboration. After some experimentation with the simulation, it was found that the color green had excessive emotional appeal. It seemed that--especially in an environmental management class--everyone wanted to be "green" and, as a result, there was insufficient thought given to precisely what choosing green meant.]

Clearly, one dimension is a positive or negative orientation toward other plants. Competition (red) and punishment (blue) are distributive and coercive, respectively . On the other hand, collaboration (black) and rewarding (orange) are much more positive in their orientation. The technical, withdrawal option (yellow) is intermediate.

Another dimension is how interactive each option is. One the one hand, punishment (blue) or reward (orange) relies on third parties to monitor the activities of other plants and deal with them accordingly. Collaboration (black) is obviously interactive, however, so is competition in the sense that plants are clearly and directly reacting to each other. On the other hand, the technical, withdrawal option seeks independence over interaction. For convenience, we place it in an intermediate position on this dimension and then array the options in a 2X2 matrix as depicted in Exhibit 6. We then query the students about the merits of each approach.

Students are generally quick to point out that competition is bad in this context as it would ultimately ruin the commons (i.e., lead to Hardin's "tragedy of the commons"). On the other hand collaboration is good, if it can be created. Not only does it lead to improvements in the commons, but it is also the approach which is consistent with long-

term survival and profitability. This is especially true if, in the absence of collaboration, ineffective regulations are enacted (the "big government is bad government" conservative position) . Relatedly, students should also point out that both rewards and punishments have serious limitations. They often rely on outsiders (i.e., government or some association with its own agenda) to determine criteria, and adequate enforcement is often a problem as each reaches only a fraction of the plants. Thus, the consequences are uncertain.

The Limits of Technical Solutions

This simulation is less realistic and convincing in demonstrating the limitations of technical options. Nevertheless, the inclusion of that approach is a reminder to discuss this matter. The EPA, for example, has required businesses to adopt "best available technologies" (BAT) in their factories. Clearly such solutions are often not the best from the company's point of view, and when selected by bureaucrats leave plenty of room for nonsense. Students will normally have little trouble accepting this observation. However, Hardin's (1968) pessimism toward technical solutions was much broader and was born more out of his sense of the need for more fundamental behavioral change. For example, although the technologies exist to clean up litter along roadsides, it would be so much better if the public simply developed stronger aesthetic values or were educated about the resultant waste and cleanup costs. Hardin's plea was geared mainly at the population problem (which is the driver of development) and it is clear, as the recent population summit in Cairo demonstrated, that with this particular issue technical solutions are limited.

A Model of Collaboration

It is useful to explore why collaborative solutions are superior among these various options. First, collaborative solutions allow the essential needs of all the parties to be raised. If some level of consensus attends the solution then the solution would at least minimally satisfy each of the parties expectations. Moreover, it might be pointed out that

in a litigious society such as ours, the costs of not meeting stakeholder needs are elevated. Miles (1980:375) proposed a definition along these lines for organizational effectiveness which he interestingly labeled "the ecology model" in which organizational effectiveness is "minimally satisfying the expectation of its strategic constituencies." At the system-wide level such a definition would certainly be a strong candidate for decision effectiveness. Second, at the system-wide level such a decision is more likely to be implemented and at lower cost because the enforcement costs would be much lower than in the event of a third party solution. Thirdly, collaborative solutions can be more creative. For example, conferences often result in creative solutions for rotating the task of playing "blue" (punish) or for more openness in the declaration of choices. Finally, such a solution can be flexibly allowed to evolve over time and, possibly, to be administered on a case by case basis considering mitigating factors and special circumstances.

Having led the students to an appreciation of collaboration in dealing with the commons problem, the discussion should turn to an identification of the process variables that can lead to collaboration. At this point we usually let the students develop their own model of collaboration based on their experiences in the simulation. To begin this effort, we put the word "collaboration" on the board and let the students identify the antecedents. As each is identified, we add it and draw an arrow to the dependent variable and to any others than seem appropriate. The model can quickly become rather complex, but that makes a good point in its own right. (While there may be some legitimate questions about whether this is a linear model, for pedagogical purposes it is clearly a more straightforward and digestible approach.) Some of the following elements of the model emerge fairly quickly.

1) The purpose of the exercise evolves with each trial. Initially, students were told to seek profits, but it becomes quite evident that the condition of the water is clearly linked to this goal. Thus, as a group of plants, the creation of a superordinate goal to improve water quality becomes an obvious rallying point when they are allowed to meet

face to face. (We add the word superordinate goal to the model and draw an arrow to collaboration). The realization of interdependence and a common fate is also related to this coming together to identify common goals. Indeed, the worse the water quality becomes, the more this interdependence and common fate become obvious to the participants. (We then add interdependence and draw a line to superordinate goal. In this way the model is elaborated.)

2) You might raise the question of where the superordinate goals came from. After some discussion, a student will usually point out that some individual championed the idea in the early conferencing. This allow you to add leadership to the model and to discuss the role of leadership in this process. Ask the students what qualities such a leader might possess. Such qualities as credibility, a track record for success, and communication skills usually emerge. These are then added as antecedent of leadership.

3) It is also clear that the opportunity for communication is centreal to collaboration. Indeed, one of the conditions for the tragedy of the commons is that of disassociated actors seeking individual gain. The creation of communication links (especially face to face links) means that they are no longer independent and can interact to make this point known and discuss the deterioration of the commons and its implications.

4) The realization that communication is important, can turn the discussion to the process of communication. This can turn the students attention to the central role of trust in making collaboration possible. This affords an opportunity to discuss what trust is and what behaviors on the part of the other plant managers engender trust. For example, the willingness to be vulnerable to the actions of the other plants (i.e., to make one's factory's profitability dependent on the actions of others) is dependent on the integrity of the other plant managers (see leadership above). We usually make sure trust is usually entered in the center of the model and the concept of leadership and communication are clearly linked to it. It is useful at this point to try to obtain from the students the factors that promote trust.

5) Openness (or secrecy in the reverse) engenders trust as it is a signal of the integrity of the parties. The plant managers who were the most open about making their choices known where more credible. Certainly, those plant teams that went out of their way to conceal their choices were deemed untrustworthy.

6) Past behavior has a large effect on the ability to trust. Certainly, opportunistic teams (i.e., those who promise to choose black, but play red) find that their promises quickly lose credibility. This affords a good opportunity to point out that trust is fragile. That is it takes some effort to create and it is very easily lost. Once lost, it is very difficult to regain. Conversely, proven evidence of trust (e.g., all team choose black and then follow through) reinforces trust.

7) Related to this the contrivance of workable safeguards. If some mechanisms can be found to identify those who cheat and obtain compensation contractually, sue for performance, or enact fines through a criminal process, then it is somewhat easier to trust that parties will follow through. It is possible that the plant teams devised some system of safeguards among themselves. For example, we've had teams designate an "auditor" or "inspection team" who attends the facilitator in tallying the choices. To some extent our legal system affords such assurances, parties can also seek these through contractual, criminal or civil law. We need to recognize, however, that recourse to laws can be extremely inefficient and time consuming. They are most effective when they constrain behavior so well that legal recourse is rare.

8) It is also interesting to explore cultural assumptions embedded in our society about the nature of business Our experience is that many young male business students are most prone to exhibit competitive behavior. This is possibly due to the level of competition taught in athletic competition where the ethic, "winning is everything" seems to predominate. Other groups can show a much greater propensity toward cooperative behavior. Many international students, females, and liberal arts students are much more inclined toward collaborative behavior. The facilitator needs to be sensitive to the

composition of the class and adapt the game accordingly. For example, when used in a "managing natural resources" seminar comprised of international policy makers, it was necessary to stress the profit goals imposed on the plants and to place extra weight on competition in denigrating the quality of the lake.

9) Related to all this is the issue of diversity. As global solutions to environmental problems become increasingly necessary and as corporations are becoming increasingly global, it is likely the solutions to environmental issues will encounter more diversity. Although, in some ways special interest groups within North America can be extremely diverse in terms of their value sets. Creating trust in the presence of marked diversity requires more effort, patience, and give-and-take.

Saving the Commons--Developing Solutions

We usually conclude the simulation with a discussion of all the approaches that can be taken to save the commons. While the virtues of collaboration are evident, it is useful to undertake a general review of all options.

Privatization. One approach to the commons problem can simply be to take the common resource out of the commons--to privatize it. In this sense, we could sell the lake to a private party. Obviously, this is often not possible and the success of the option depends solely on the character and intentions of the private party. However, there are recent examples of nature conservancies buying land and setting it aside.

Subsidization. In the case of the lake, the public could decide to subsidize the water treatment. This may be an expensive solution in that the public bears the social costs of the plants actions directly through treatment (rather than directly through pollution). This would require a system for collection and treatment which would have to be developed and financed. Moreover, the generally accepted idea of the "polluter pays" is violated. Nevertheless, some communities do subsidize waste disposal in some industrial parks in order to attract employers to an area.

Administrative Solutions. One approach is to have regulations enacted. This limits the freedom of access to the commons and should be based on some clear decision rule (e.g., wealth, lottery, queues, rationing). Regulations can be enacted by statutory a legislature or administrative law (an agency of the government like the E.P.A.). Of the two choices, administrative law implies somewhat greater technical familiarity, yet each require costly enforcement mechanisms if the law is to have much effect. There is an additional problem with regulation and that is the problem of if the regulators are watchdogs (whose going to watch the regulators?). Thus, we could pass laws which limit how many plants can use lake water, how much water they can use, technologies they must employ and so on. The problem with this approach is that the regulators often do not know the parties, their expectations, or the manufacturing process. Moreover, regulations often take on a tenacious rigidity so that they are inflexibly applied and are difficult to change.

Market Interventions. This approach attempt to incorporate the social cost into the individual decision about resource use. Often this is through taxation, but a more popular approach is through marketable permits. Thus, for example, once the permits are issued for the release of so many tons of sulfur dioxide the Tennessee Valley Authority could buy a permit from Wisconsin Power who didn't need it because it had adopted cleaner technologies (this very transaction was made during the Bush administration).

Technical Solutions. Another approach would be to develop a technological solution which would inexpensively treat the toxic discharge into the lake (the so-called "end of pipe solution"). A superior approach would be to find a new production technology which would emit fewer discharges. For example, in the paper industry, much of the water used after removing the lignin from the pulp is reused. Similarly, oxygen bleaching avoids the release of organochlorines into the water such as dioxin. It is important to note that, while the point is likely to be debated, Hardin's (1968) position is that for most commons problems technical solutions can't provide a workable, lasting solution.

Behavioral Solutions. If somehow people's behaviors were changed to be more environmentally sensitive, then much good could be accomplished toward saving the commons. In part, this could be by understanding the need for restraint in certain ways (attempting to car pool to work), but it can also be accomplished through education. This is the approach that's being attempted by anti-smoking campaigns, for example. While behavioral solutions may eventually afford long-term solutions to the commons problems, as the persistent smoking problem would suggest, it can be difficult to raise the awareness about behaviors that have relatively immediate social costs.

Institution Building. A final approach can be the creation of infrastructure to facilitate collaboration (i.e., industry associations, chambers of commerce, various types of task forces). Relatedly, this can involve the empowerment of stakeholder groups, so as to gain a place at the decision table. While such institutions can create modest institutional sanctions against violators, they most effectively run on mutual trust. This is the best approach in most situations.

Conclusion

The well known expression, "seeing is believing," applies here. This is especially true in the business education/training context where self selection ensures a concentration of goal-oriented, competitive students. This circumscribed ethic is inculcated and reinforced in many courses (finance courses, for example, most explicitly embrace the unitary goal of "maximizing shareholder wealth"). No amount of lecturing or readings appear to sway most of these students away from the Friedmanian dogma that the "invisible hand" ensures that profit seeking behavior within the law is the only realistic approach to environmental issues. However, while this simulation is geared mainly to the disbelieving business student, it also has worked well in other contexts--with policy makers from developing countries and even with the already converted (those "greens" who seek to balance economic growth with environmental sustainability). These later

groups find this simulation to be quite valuable in illuminating the nature of the problem and the various approaches that are used to deal with it.

In sum, the simulation intends to let students experience the realities of the commons problem as a prelude to contriving new solutions and for understanding the various approaches to the problem. Particular emphasis is placed on the desirability of collaborative solutions and to the processes that lead to such solutions. As a result of this simulation many students have modified their belief that business is only about competition to, in our opinion, a more sophisticated view that recognizes that in many instances organizational survival and profitability hinges on collaboration. While this new position has clear implications for dealing with the commons problem, many of the central points highlighted in this simulation are transferable to other settings where collaboration is becoming increasingly important. For example, international strategic alliances require similar processes. Most importantly, this simulation leads students to these conclusions rather than dictating them. Thus, we find the learning in this simulation to be long lasting. Some evidence of this is provided by the fact that this simulation is conducted on the first class period of our environmental management class; yet when polled at the end of the course, students repeatedly indicate that this was their most useful session. Along the same lines, when used in Eastern and Central Europe, students indicate that this simulation was particularly enlightening in conveying a more sophisticated and enlightened image of capitalism.

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Exhibit 1

"Commons" Game

Costs & Earnings Schedule

Color	Earnings/Costs for Team	Consequences for Other Plants	Lasting Effects
Red	See Payoff Matrix	-----	----
Black	See Payoff Matrix	-----	----
Yellow	-20 Pz	——	+2 to Team starting 3 trials after investment
Blue	-3 Pz	"Red" Plants -5 Pz fine & loss of payoff*	----
Orange	-3 Pz	Most Exemplary Plant +2	----

*If caught (determined by double coin toss).

Exhibit 2

PARTICIPANT'S P/L ACCOUNT

TRIAL	CHOICE	SCORE	ADJ.	TOTAL FOR TRIAL	CUMULATIVE SCORE
ONLY BLACK, RED, OR YELLOW CHOICES IN FIRST 7 ROUNDS*					100pz
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
ALL CHOICES AVAILABLE					
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	_____	_____	_____	_____	_____
11	_____	_____	_____	_____	_____
12	_____	_____	_____	_____	_____
13	_____	_____	_____	_____	_____
14	_____	_____	_____	_____	_____
15	_____	_____	_____	_____	_____
16	_____	_____	_____	_____	_____
17	_____	_____	_____	_____	_____
18	_____	_____	_____	_____	_____
19	_____	_____	_____	_____	_____
20	_____	_____	_____	_____	_____

Note: Cumulative score can go negative up to -50 pazoozas. Plants with cumulative balances less than -50 will be closed down pending a review of their financial viability.

* Once the yellow option is used, it cannot be selected again, +2 points should can be added to all following trails under "adjustments."

Exhibit 3

ADMINISTRATOR'S SCORE SHEET

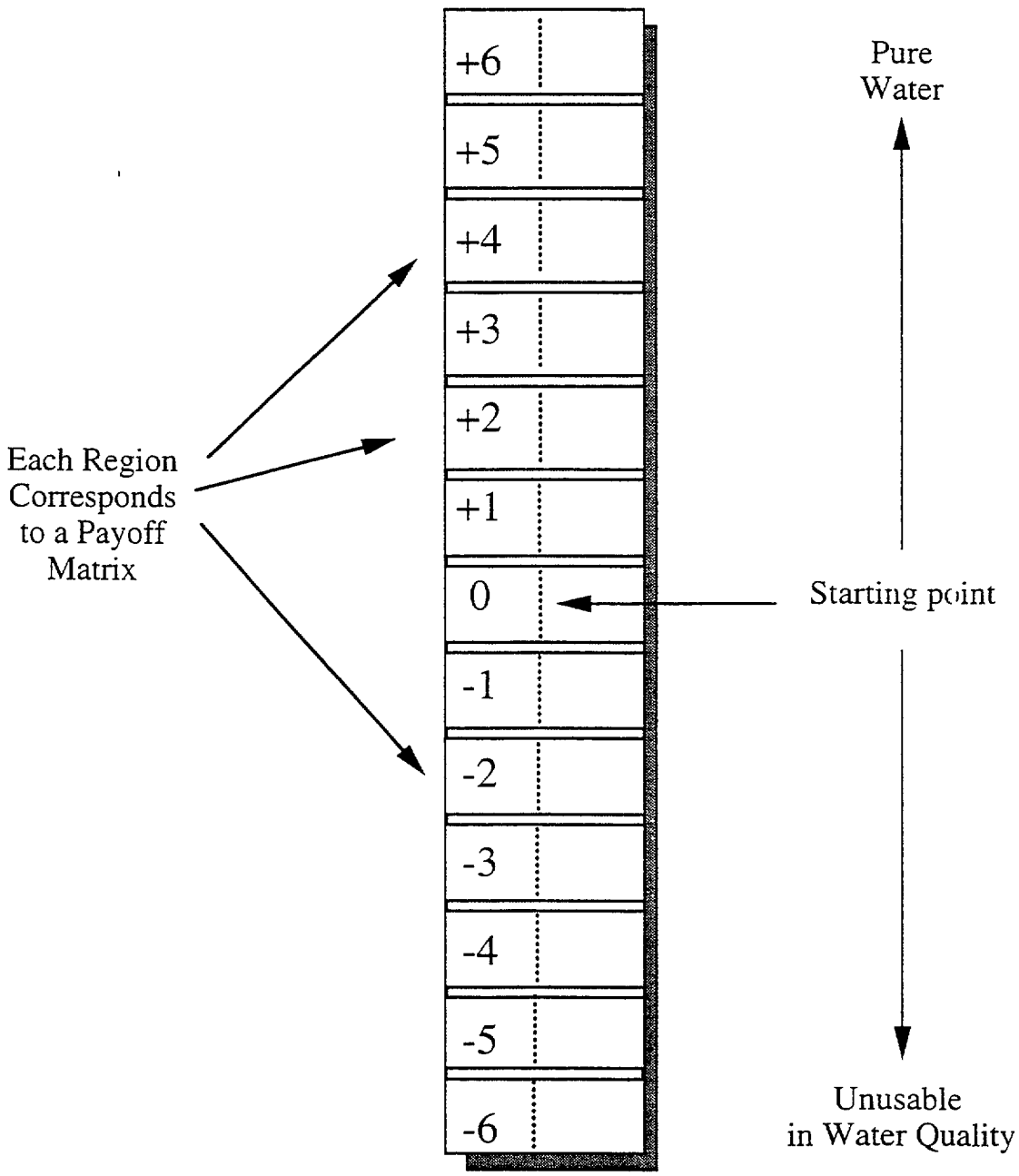
	PLANT #								TOTALS				
TRIAL	1	2	3	4	5	6	7	8	BK	RD	YL	BL	OR
1 (BK,R,Y)	____	____	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____	____	____
5(*,&,^)	____	____	____	____	____	____	____	____	____	____	____	____	____
6	____	____	____	____	____	____	____	____	____	____	____	____	____
7	____	____	____	____	____	____	____	____	____	____	____	____	____
8(#,all)	____	____	____	____	____	____	____	____	____	____	____	____	____
9	____	____	____	____	____	____	____	____	____	____	____	____	____
10(*,&)	____	____	____	____	____	____	____	____	____	____	____	____	____
11	____	____	____	____	____	____	____	____	____	____	____	____	____
12(#)	____	____	____	____	____	____	____	____	____	____	____	____	____
13	____	____	____	____	____	____	____	____	____	____	____	____	____
14	____	____	____	____	____	____	____	____	____	____	____	____	____
15(*,&,#)	____	____	____	____	____	____	____	____	____	____	____	____	____
16	____	____	____	____	____	____	____	____	____	____	____	____	____
17	____	____	____	____	____	____	____	____	____	____	____	____	____
18	____	____	____	____	____	____	____	____	____	____	____	____	____
19	____	____	____	____	____	____	____	____	____	____	____	____	____
20(*,&,#)	____	____	____	____	____	____	____	____	____	____	____	____	____

(*) Lake Renewal -- Move indicator up 5 units (for small # plants) or 10 units..
(#) Conference trial
(&) Settle P/L accounts
(^) Appeal to conscience
all All options (incl. blue and orange) available beginning this trial

4

Exhibit 4

Board for Tracking Quality of Lake Water



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MATRIX "0"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-1	1	+10
2	+1	2	+8
3	+2	3	+7
4	+3	4	+6
5	+4	5	+4
6	+5	6	+3
7	+6	7	+1
8	+7	8	-1

MATRIX "-1"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-2	1	+9
2	0	2	+7
3	+1	3	+6
4	+2	4	+4
5	+3	5	+2
6	+4	6	0
7	+5	7	-1
8	+6	8	-2

MATRIX "-2"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-3	1	+8
2	-1	2	+6
3	0	3	+4
4	+1	4	+2
5	+2	5	0
6	+4	6	-1
7	+5	7	-2
8	+6	8	-3

MATRIX "-3"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-4	1	+6
2	-2	2	+4
3	0	3	+2
4	+1	4	0
5	+2	5	-2
6	+4	6	-4
7	+5	7	-5
8	+6	8	-6

MATRIX "-4"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-5	1	+4
2	-3	2	+2
3	0	3	0
4	+1	4	-2
5	+2	5	-4
6	+3	6	-5
7	+4	7	-6
8	+5	8	-7

MATRIX "-5"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-6	1	+2
2	-4	2	0
3	-2	3	-2
4	0	4	-4
5	+1	5	-5
6	+2	6	-6
7	+3	7	-7
8	+4	8	-8

MATRIX "-6"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	-8	1	0
2	-7	2	-2
3	-5	3	-4
4	-2	4	-5
5	-1	5	-6
6	0	6	-7
7	+1	7	-8
8	+2	8	-9

MATRIX "+1"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	0	1	+11
2	+2	2	+9
3	+3	3	+8
4	+4	4	+7
5	+5	5	+5
6	+6	6	+4
7	+7	7	+2
8	+8	8	0

MATRIX "+2"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	+0	1	+12
2	+1	2	+10
3	+2	3	+9
4	+3	4	+8
5	+5	5	+6
6	+7	6	+5
7	+9	7	+3
8	+10	8	+1

MATRIX "+3"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	+1	1	+13
2	+2	2	+11
3	+3	3	+9
4	+4	4	+7
5	+6	5	+6
6	+8	6	+5
7	+10	7	+4
8	+11	8	+3

MATRIX "+4"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	+2	1	+14
2	+3	2	+13
3	+4	3	+11
4	+5	4	+10
5	+7	5	+8
6	+9	6	+7
7	+11	7	+6
8	+12	8	+5

MATRIX "+5"

NUMBER OF BLACK PLANTS IN TRIAL	OUTCOME	NUMBER OF RED PLANTS IN TRIAL	OUTCOME
1	+3	1	+15
2	+4	2	+14
3	+5	3	+12
4	+6	4	+11
5	+8	5	+9
6	+10	6	+8
7	+12	7	+7
8	+13	8	+6

Module 2

Day 3

Greenlights Case

Pollution Prevention and Finance
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

For the Instructor: Teaching Note on "Green Lights' Economics: Graphic Design Considers a Lighting Upgrade"

By Michael Tucker, Associate Professor of Finance, Fairfield University

This case is appropriate for second-level undergraduate or MBA finance classes, typically financial management. It is a simple case that could also be employed in a corporate finance course at the beginning of the semester. Sensitivity analysis may by added (see Question 3) to complicate the solution.

"Doing well" (making money) and "doing good" (reducing environmental harm) are the main focus of this case. While installing more efficient lighting will not solve the world's environmental problems, it does reduce energy use, which in turn reduces the carbon dioxide emissions implicated in global warming. The present value cost of global warming is enormous. Multiplying that cost by even a low probability of occurrence still leaves a rather large present value that an instructor may take a crack at calculating through class discussion. Of course, the timing of the damage of global warming is uncertain.

Green Lights is a significant pollution prevention program. It shows how the government can step in to help business do things more efficiently without regulation. While rebates from utility companies are an added sweetener, the savings accrued by reducing energy use would still make upgrades economically viable. Typically, however, many firms want payback in a short period of time, often one year or less. This means that rebates are the difference between going ahead and doing nothing.

Note: The NPPC has copies of the Excel spreadsheets used for calculating the answers to this case; both Macintosh and DOS formats are available. If you would like to receive these spreadsheets on a 3.5-inch disk, contact the NPPC directly.

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Answers

1. "Taylor wanted to know how much his savings would be if he only installed the motion sensors (thereby reducing the hours of light usage) compared to the savings he would accomplish by only installing new ballasts and lamps (thereby reducing energy consumed per hour of usage)."

Answer: Table A-1 shows the savings under new ballasts and lamps only (without motion detectors). Column 1 shows the new hours of usage; Column 2 shows the cost of operating lights ($0.09 kWh) under reduced hours (1,125) with old fixture usage (0.336) after taxes (6%) equaling (0.09 * 1,125 * 0.336 * 1.06 = $36.06) for savings in the President's Office. The savings from just installing the motion detectors is shown as the total of Column 2 — $168.69 — maintaining the same fixtures but reducing the hours they are in use. Column 3 shows the reduction in kWh from installing new fixtures. Using Column 3 and information from Table 1, one can calculate the savings under old hours without using sensors, e.g., 2,250 hours for the President's Office at $0.09/kWh, with the 6% tax times the reduction in kWh usage of 0.124 equaling savings of $26.62. Summing Column 4 totals $471.91 in savings from reducing kWh without installing sensors, i.e., no reduction in hours. Peak demand savings are only achieved if new fixtures are installed. The savings of $121.92 ($5.00 per peak hour demand reduction of 1.92, which is the sum of Column 3, reduction in kWh, times 12 times 1.06 [tax]) is therefore additional and added to the $471.91, bringing the grand total savings from new fixtures to $593.83.

TABLE A-1: BREAKOUT OF SAVINGS FROM REDUCTION IN LIGHTING HOURS FROM MOTION DETECTION INSTALLATION AND REDUCTION IN WATTAGE FROM FIXTURE CHANGES

	Reduction in Hours	Savings at Old Wattage	Reduction in kWh	Savings at Old Hours	
President's Office	1,125	$ 36.06	0.124	$ 26.62	
Signs	–	–	0.114	95.27	
Loading	1,500	48.08	0.216	46.36	
Kitchen	1.125	18.03	0.108	23.18	
Bathroom 1	500	4.01	0.024	2.29	
Workspace 1	450	14.42	0.124	26.62	
Bathroom 2	–	–	0.045	2.15	
Entrance	–	–	0.108	23.18	
Workspace 2	750	48.08	0.248	53.23	
Other	–	–	0.806	173.01	
Totals:	**5,450**	**$168.69**	**1.92**	**$471.91**	**savings**
				121.92	**peak demand reduction**
				$593.83	**total saved from kW reduction**

2. "Having been a business major in college, Taylor was familiar with net present value (NPV) analysis. He wanted to know the NPV of the installation's cash flows, taking into consideration that any of his savings would be taxed 31% by the federal government and 4.5% by the state. The 50% rebate offered by NP&E would save him $1,250, but the 6% state sales tax would apply to the entire $2,500 cost. For tax purposes, Taylor intended to expense the entire cost of the installation. Looking at 10 years worth of cash flows would be sufficient for the analysis. When Taylor first prepared a business plan for his company, he applied a 20% discount rate to projected cash flows. He recalled from a college finance course that, in some cases, it was appropriate to apply a risk-free discount rate to cash flows if there was no uncertainty attached to their occurrence. Currently the Treasury Bill rate was 6%. Of course, calculating the IRR would also be useful, particularly given his uncertainty about which rate to use; it was also a calculation that the EPA required of its Green Lights participants."

Answer: Pre-tax savings of $682.50 (Table 1) translate into after-tax savings of $440.21 {(1-0.045-0.31)* 682.5}. The $2,500 installation is increased by 6% to account for taxes to $2,650 less the $1,250 rebate, bringing the after-tax cost to $1,400. The tax shield on the $1,400 outlay {(0.31+0.045) * 1,400} of $497 reduces the cash flow cost to $903. Treating the savings of $440.21 as an annuity at both 6% and 20% arrives at the present value savings figures of $3,239.98 (6% discount) and $1,845.57 (20% discount). Subtracting the after-tax cost of $903 from both figures gives NPVs of $2,336.98 (6%) and $942.57 (20%). Payback in years is calculated as 903/440.21 = 2.05 — see Table A-2. (The IRR can be calculated with a financial calculator or a spreadsheet program such as Excel or Lotus.)

The savings from the installation are virtually certain and should therefore be discounted at a lower discount rate than projects involving business risk. The only risk that is entailed here is the risk that the firm will go out of business in less than 10 years; even then, the building with fixtures could be sold and some of the sales proceeds attributed to the new fixtures.

TABLE A-2: NPV OF SAVINGS ASSUMING 10-YEAR HORIZON AND NO CHANGE IN USE OR RATES

Pre-Tax Savings	$ 682.50	
After-Tax Savings	440.21	
Installation Cost w/6% tax	(2,650.00)	
Rebate	1,250.00	
Cost	(1,400.00)	
Tax Shield on Outlay	497.00	
After-Tax Cash Outlay	(903.00)	
PV of 10-year Savings Annuity	3,239.98	$1,845.57
Discount Rate	6.0%	20.0%
NPV	2,336.98	942.57
Payback (years)	2.05	
Internal Rate of Return	48%	

3. "Taylor knew that SNP&L would not be keeping rates at 9¢/kWh forever. Assuming future inflation to be 3.5% per year, he wondered what the installation's NPV would be, beginning with the following year, when he would begin realizing savings from the installation. Concomitant with rate hikes was the assumption that the local economy would be improving and Graphic Design would be getting more work. This would lead to expanded hours of operation, with both workspaces being used up to 5% more each year for the next seven years, by which time their use would be maximized. What would the incremental NPV of Taylor's savings be under this scenario? It would be useful to take a look at NPV under a range of possible rate hikes from 0% to 7% to get a better idea of just how good deal this might be.

Answer: The first year of increased electricity costs occurs in 1995, when rates rise to $0.09315 (1.035 * .09). First the status quo operating cost is calculated (Panel 1 of Table A-3): Workspaces 1 and 2 are both in use for 2,250 hours in 1994, increasing at a rate of 5% in 1995 to 2,363 hours and continuing increases until the year 2000, when they have reached maximum utilization. The kWh use for the two workspaces is 2,268 (in 1994) minus (.336 * 2,250 for Workspace 1 plus .672 * 2,250 for Workspace 2). Other kWh use is held fixed at 8,873 (1994) throughout the scenario as is peak demand of 4.52 (all data from Table 1). The total cost with tax for operations of $1351 is arrived by multiplying total kWh usage (11,141) by cost ($0.09), adding peak demand cost for the year ($5*4.52*12) and boosting the total by the tax rate (6%). The same analysis is performed using the proposal figures of hour usage (1,800 and 1,500, respectively) for Workspaces 1 and 2, other hour usage of 4,247, and peak demand of 2.61. The savings are $682 in 1994 (1351-668).

Note: In Year 7, workspace use flattens out and no longer increases, but savings are still growing because of utility price hikes. The present value of saving across the ten years discounted at 6% is $7,235; at 20%, it is $3,359. Subtracting the cost of $903 arrives at NPVs of $6,332 (at the 6% discount rate) and $2,456 (at 20%) with an IRR of 58%.

Note: By placing the 3.5% electricity hike and the 5% per annum increase in separate cells in the spreadsheet and relating them in the model with dollar signs (locking in the cells), it is possible to look at a number of different scenarios. Data tables and graphs may then be added to the analysis.

4. "What are the financial and environmental implications of selling the old lighting system? By selling it, does Graphic Design perpetuate the use of inefficient equipment?"

Answer: While Taylor gets some ready cash from the sale of the old lighting system, he does perpetuate the use of inefficient lighting by someone else. Those new users (and they might be in another country, because used equipment is routinely exported) save money by going with used equipment, but the present value of their savings evaporates when electricity use differentials are accounted for.

The possibility of selling another party "radioactive" ballasts was also raised in the case. There has been no scientific proof of the existence of more than background radiation being emitted from ballasts or of the harm that can be done by them. It is a controversy similar to harm done by power lines. Scientific proof is inconclusive (i.e., no statistical findings show harm while anecdotal evidence continues to raise questions).

TABLE A-3: NPV OF SAVINGS FROM INSTALLATION ASSUMING WORKSPACE USE GROWTH OF 5% AND 3.5% ANNUAL INCREASE IN ELECTRICITY COSTS

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
kWh cost	$ 0.09	0.09315	0.099785	0.110633	0.126954	0.150781	0.185349	0.235815	0.310524	0.423212	0.596983
Status Quo											
Hours of Use											
Workspace 1	2,250	2,363	2,481	2,605	2,735	2,872	3,015	3,166	3,166	3,166	3,166
Workspace 2	2,250	2,363	2,481	2,605	2,735	2,872	3,015	3,166	3,166	3,166	3,166
Annual kWh Usage											
Workspaces 1 & 2	2,268	2,381	2,500	2,625	2,757	2,895	3,039	3,191	3,191	3,191	3,191
Remaining Lighting	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873
Total	11,141	11,254	11,373	11,498	11,630	11,767	11,912	12,064	12,064	12,064	12,064
Peak kWh Demand	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52
Total Cost w/Tax	$1,351	$1,399	$1,491	$1,636	$1,853	$2,168	$2,628	$3,303	$4,259	$5,700	$7,922
With Green Lights Installation											
Hours of Use											
Workspace 1	1,800	1,890	1,985	2,084	2,188	2,297	2,412	2,533	2,533	2,533	2,533
Workspace 2	1,500	1,575	1,654	1,736	1,823	1,914	2,010	2,111	2,111	2,111	2,111
Annual kWh Usage											
Workspaces 1 & 2	1,018	1,068	1,122	1,178	1,237	1,299	1,364	1,432	1,432	1,432	1,432
Remaining Lighting	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247
Total	5,265	5,316	5,369	5,425	5,484	5,546	5,611	5,679	5,679	5,679	5,679
Peak kWh Demand	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
Total Cost w/Tax	$668	$691	$734	$802	$904	$1,052	$1,268	$1,585	$2,035	$2,713	$3,760
Savings	682	708	757	834	949	1,116	1,360	1,718	2,224	2,986	4,162
Tax	242	251	269	296	337	396	483	610	789	1,060	1,478
Net Savings	$440	$457	$488	$538	$612	$720	$877	$1,108	$1,434	$1,926	$2,685

Install Cost w/6% tax	$(2,650)
Rebate	1,250
Cost	(1,400)
Tax Shield on Outlay	497
After-Tax Cash Outlay	(903)

PV Savings 1995–2004	$7,235	$3,359
Discount Rate	6%	20%
NPV	$6,332	$2,456
IRR	58%	

Sensitivity analysis under diff. rate hikes:	0%	0.5%	1%	1.5%	2%	2.5%	3%	3.5%	4%	4.5%	5%	5.5%	6%	6.5%	7%
	$2,482	2,781	3,137	3,561	4,071	4,685	5,428	6,332	7,433	8,781	10,435	12,471	14,982	18,086	21,930

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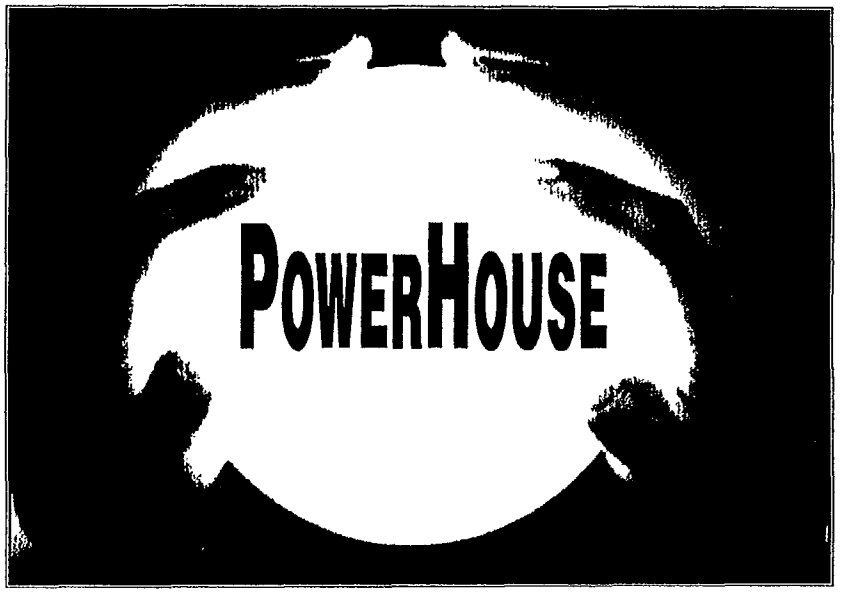
Module 3

Day 3

"The Powerhouse" Manual



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Please check your technical supplement and tutorial booklet and the file on your game disk entitled README.TXT for information on the changes made and additional features added to **POWERHOUSE** after this manuscript went to press.

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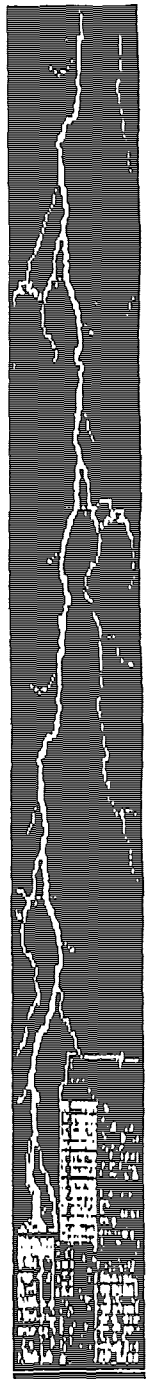


THE POWER is in your hands...

The beginning of the 21st century was a time of world-wide hope and optimism. A communication revolution had cleared the way for a thriving global network of business and commerce. International conflicts eased as world affairs fell increasingly under the control of the United Nations, a powerful alliance of that embraced all nations. And most of all, technology blossomed, offering prosperity and comfort to advanced countries, and promise to developing ones.

Before long, however, the leadership of the powerful U.N. would be tested. As the second decade of the century commenced, the same surge in technology that had offered so much hope began to signal doom as it demanded a higher price than the world was able to pay. Fuel demands began to outstrip available supplies.

Across the globe, despite decades of talk of cheap and clean alternative fuels, industry, transportation, even everyday life leaned heavily upon the fossil fuels: coal, oil, and natural gas. Eventually the world could not avoid a terrifying realization: reserves were far leaner than even the most conservative experts had predicted. With devastating swiftness, an energy crisis of unprecedented severity struck.

The world entered a state of panic. The energy industry reeled. Small companies collapsed, merged, or were taken over; corruption spread; and the crisis worsened. With no relief in sight,the U.N. made a dramatic move: it shut down all energy companies, hand-picked four of the world's shrewdest business minds, and turned the industry over to them.

The resulting megacorporations -- acting on the most urgent U.N. mandate of the modern era -- became known as the PowerHouses.

Now, the year is 2020. The four PowerHouses share a mission -- to supply a power-starved world with energy -- but each operates in fierce competition with the other, and each dreams of a day when the world's entire energy infrastructure falls under the control of one.

You are a PowerHouse CEO. The future is in your hands. You will start with nothing but money and your own business acumen. How will you meet the demands of an energy-hungry world? Which resources will you research and exploit? Can you succeed and thrive in the face of cutthroat, winner-take-all competition? Will you build an empire, or will your enterprise crumble?

In the end, only one PowerHouse can prevail. Will it be you?

Where Do I Start?

To get the most enjoyment out of your new game as soon as possible, we recommend that you start by reading the *Technical Supplement and Tutorial* booklet included with this game. After you have finished with the tutorial, we suggest that you read this *Game Manual* to get a better understanding of the game's features, or consult the sections that deal with the parts of the game you find most interesting or confusing. Please be sure to check a file on the game disk called README.TXT. This file explains aspects of the game that have been added or altered since this manual went to press, and should be considered part of the game's documentation.

Installation

For complete instructions on how to install **PowerHouse**, how to start the game, and where to get technical help if you need it, please refer to the *Technical Supplement and Tutorial* booklet.

Game Overview

In **PowerHouse**, you are the Chief Executive Officer of one of four PowerHouses — giant megacorporations in competition to dominate the world's energy industry. The PowerHouses work closely with the U.N., which will open territories one at a time to your business. Your ultimate goal is to be the most successful PowerHouse in the world. The game ends after 100 years, or when only one PowerHouse remains in operation — whichever comes first. If at the end of 100 years, more than one PowerHouse remain, the one that has the most wealth (in the form of cash, energy production sites, and other assets) is the winner.

Your short-term goals are to maximize profits and to find cheaper and more efficient ways to produce electricity from nine energy types: oil, natural gas, coal, nuclear, solar, hydroelectric, tidal, wind, and geothermal. While oil, coal, and natural gas may offer easy money at first, you would be wise not to depend on them — they won't be there forever.

At the start of the game, you and the other PowerHouses will compete for business in one territory. When the U.N. decides that an adequate portion of that territory's energy needs have been met, it will open another territory. As the game continues, the U.N. will open each territory, one at a time, until all are open.

To help you decide which types of plants to build and where to build them, you may hire survey teams. The survey teams will analyze a section of the territory and, in a few months, will report to you their best *estimate* of the available energy types for each map section.

You may then begin building the structures necessary to produce and sell electricity. With time, you will want to develop better ways to extract energy and produce electricity. To do this, invest your profits in research and development. You may hire scientists and assign them to research specific aspects of energy production. When they make a breakthrough, they'll let you know.

As you work on extraction, production, and R&D, you'll do so with competition from the other PowerHouses, and in a world of changing political and natural dynamics. Elections and coups can act in your favor, or can do you serious harm. Storms, earthquakes and other natural disasters may also come into play.

The game will end when one of the following happens:

* You run out of money, in which case you lose the game.
* You retire after 100 years (or your entire Length of Play). You will receive a rating after you retire, based on how well you performed throughout your career.
* You drive all of your competitors out of business, or buy them all out -- in which case you win!

Game Time & Interface

PowerHouse is a turn-based game, with each turn representing one month. The month and year will be displayed on the information bar near the top of the main game screen.

A mouse is required to play **PowerHouse**. When this manual tells you to click on or select something, you should click on it with your left mouse button unless the instructions specify that you use the right one.

Most of the action will take place in the main game screen, which consists of a map of the world; a row of buttons along the bottom; a control panel on the right side; a smaller "zoom map" in the upper right; and a menu bar along the top of the screen.

The main map screen is a partial view of your world map. To see the rest of the map, scroll around by placing your mouse pointer on the very edges of the screen, or by using the four arrow keys on your keyboard.

On the zoom map, the black square represents the area you are currently viewing on your main map view. Click anywhere directly on the zoom map to jump to that area on your main map view.

Many of the commands in **PowerHouse** may be issued via *Buttons* — small illustrated squares that function when you click on them with your mouse. Also, mouse-activated *Arrows* will often appear where information is listed. A down arrow will display the next portion of the list, while an up arrow will display the previous portion of the list.

Keyboard Commands

Several commands may be issued from the keyboard, as well as the mouse. Whenever you see a menu option that has an underlined letter, you may select the menu option by pressing the underlined character on your keyboard.

When your main game screen is in view you may use your up, down, left, and right arrow keys to scroll around your world map.

In addition, the E-mail system has several keyboard commands that are listed in detail in the Keyboard Commands in E-mail section of this manual.

Concepts

As you begin playing **PowerHouse**, you will benefit from having an understanding of the following basic concepts:

Units: All energy quantities in the game are expressed in terms of energy units. An energy unit is a fictitious, standard measurement of energy that applies to all energy types in the game, as well as to all electricity produced and sold. For example, the quantity of 1,000 units of coal is equal to the amount of coal which, when converted to electricity, will produce 1,000 units of electricity. Likewise, 1,000 units of crude oil is equal to the amount of crude oil which, when refined and burned at 100 percent efficiency, will produce 1,000 units of electricity. Thus, you will not have to worry about things like barrels of oil, tons of coal, kilowatt hours of electricity, etc.

The Map: Most of the game play in **PowerHouse** will take place on a map of the world on your main game screen. The world map is made up of squares, or tiles, each of which represents an area of 200 miles by 200 miles.Whenever you build a site, the site will be placed on a single map square.

Each square has the potential to produce energy from up to four sources. You may, however, only extract one source from a square at a time. Each square also has several additional pieces of stored information associated with it, such as its likelihood of natural disaster, and its nation's government type. (Some of this information is hidden within the game system, so you will not be able to access it.) You may get information quickly about any map square by right-clicking directly on the square.

"Sites" and "Rigs": Each time you build on a square — whether you build an oil structure, a wind farm, or a capacitor — you are building a *site*. Each site can hold anywhere from one to ten *rigs*. When you build a site, it will have only one rig until you build more. In this manual, the term *rig* refers to oil rigs, wind turbines, solar panels, capacitor structures, etc. — any individual component of a *site*. Thus, an oil site can have ten oil rigs, a wind site can have ten wind turbines, a solar site can have ten solar arrays, etc.

Yield: On any map square, the amount of energy that you can get from each resource is expressed as its *yield*. For oil, natural gas, and coal, *yield* refers to the total number of units of energy contained in the entire quantity of the substance that lies beneath the square. If a square has an oil yield of 5,000, for example, it means that if you extract all of the oil from the square, it will produce 5,000 units of energy in the form of electricity.

For the other energy types (solar, nuclear, hydroelectric, geothermal, tidal, and wind), yield refers to the total *monthly* energy units that any single rig on the square has the potential to produce. If a square has a wind yield of 150, this means that a wind turbine (or rig), if it is sophisticated enough, can produce a maximum of 150 units of energy in the form of electricity from wind. Keep in mind that some of the yield figures you will see are estimates, and may ultimately be wrong.

It may not be easy to harness 100 percent of a resource's yield on any particular square, however. This is where technology levels come into play. Oil, coal and gas deposits exist at varying depths beneath the earth. One oil deposit may consist of 5,000 units of oil near the surface. Another may consist of 5,000 units of oil far below the surface. While you will be able to extract the first deposit easily, you will only be able to reach the deeper oil in the second deposit if you have an oil rig of a higher technology level.

For resources other than oil, gas, and coal, technology advances can mean the ability to harness a greater *percentage* of a resource's *monthly* yield. If a square has a wind yield of 200, a low-technology wind site may be able to produce 75 units of electricity per month, while a high-tech site can produce 200 per month.

Getting Started

When you first start up **PowerHouse**, you will see several title screens and an animated introduction. If you wish to skip these, just hit the <Enter> key or click your mouse until you see the panel that says "**PowerHouse** Startup."

Choose an option by clicking on its listing on the panel.

* Choose **Quick Start New Game** to begin a new game on a world map with real world data.

* Choose **Load an Old Game** to continue a game you have previously saved. This will bring up a list of saved games. To load one, click on its name to highlight it, and then click on the OK button.

* Choose **Set the Challenge** to take control of your game conditions. If you choose this option, you may determine how much money you and your competitors will begin with. The amounts shown are expressed in millions of dollars. To change the settings, click on the up or down arrows beside each figure to raise or lower it. You may not set a figure lower than M $2,000 (2 billion dollars), or higher than M $5,000 (5 billion dollars). By default, at the beginning of the game, your company is the Blueground Corporation. You may change the name of your company and of your competitors (See **Corporation Details** under the **Game Options** section of this manual).

The **Play as Earth** check box indicates whether your game will take place on a map of earth, or on a planet of randomly generated land and sea masses. Playing on a fictitious planet carries the extra challenge of unfamiliarity. If this box is marked with an "X," your game will take place on earth.

If you play on earth, you may also decide between **Real World Resource Distribution**, in which the supply and location of energy resources will closely reflect those of the real world, and **Random Resource Distribution**, in which you must discover resource deposits entirely on your own. Click on the circle next to the option you wish to select, so that it is filled in.

If you would like to play a shortened game, you may set your **Length of Play** to 25, 50, or 75 years in addition to the default setting of 100 years.

You may determine the game's starting territory or you may begin in the default territory, which is determined by the computer. If you wish to determine the first open territory, click on **Choose Starting Territory** and click on the **Yes** button. A map of the world will appear. Select a territory. The territory outlined in red is the currently selected one. When you have chosen a territory, click on **OK**.

Menu Items

The following menu items may be accessed by selecting them in the menu bar at the top of the main game screen.

File Menu

After you have set your game conditions, the main game screen will appear. Click on the **File** menu on the menu bar at the top of the screen to access the following items:

* **About** lists some important information about the game.
* **Open** brings up a list of saved games. To resume a saved game, select it, and then click on OK.
* **Save As** allows you to name and save your games. To save a game, click on **Save As**, type a name for your game in the box that appears, then click on OK.
* **Save** saves your current game under its current name.
* **Restart** restarts the game. Before you restart, be sure to save your current game if you would like to continue it later.
* **Exit** quits the game and brings you to the Windows Program Manager.

Game Options

Click on **Options** on the menu bar to set the following game options:

* **Scroll Speed:** This option adjusts the speed at which you can scroll around the map. To adjust it, select **Scroll Speed.** On the box that appears, hold your mouse button down on the left or right arrows to set the speed faster or slower, or click on and drag the sliding square. Select OK when you have finished.

* **Music:** Click on the On/Off button to turn the game music on or off. When the button says "On," the music is currently on; when it says "Off," the music is currently off.

* **FX:** Click the On/Off button to control the game's sound effects. When the button says "On," the sound effects are currently on; when it says "Off," they are currently off.

* **Anims:** When the option is switched on, many of the game features will be animated (wind turbines will spin, oil rigs will flash, etc.).

* **Video ENN:** The Energy News Network is an independent world-wide news outfit that keeps a close watch on the activities of the PowerHouses. If this option is switched on, you will see ENN reports at the beginning of each month detailing what, if any, events have occurred that will affect the energy industry.

* **Reports - End Month:** If this option is switched on, several reports detailing the status and activities of your company will automatically be displayed at the beginning of each month. If this option is switched off, these reports will still be available to you via buttons and/or menu items, but they will not appear automatically. Select the reports you would like to display from the list that appears.

* **End Turn Save:** When this option is switched on, your game will be saved automatically after each turn.

* **Difficulty:** This option displays the difficulty settings that are in place for the current game.

* **Corporation Details:** This option displays some information about each PowerHouse corporation: its name, its CEO, and whether it is controlled by a human or computer player. You may change these settings. When the corporation information is displayed, your mouse pointer turns into a text insert bar. Use it to place the cursor in a text box and change the names with your keyboard.

  Under the "**Controlled by**" column, you may assign human or computer control to each corporation. A human player will control a corporation if its box next to "Human Player" is marked with an "X." Click on the **Logo** button to choose and assign corporate logos.

* **Hot Icons:** This option allows you to determine which reports you will be able to access directly from the main game screen. A button will appear within the row at the bottom of the main game screen for each report you select under **Hot Icons.** You may then click on any of these "hot icon" buttons to call up its report without having to go through the menus. For a complete list of the available reports and what they can tell you, see the **Reports and Information Screens** section of this manual.

  You will begin the game with eleven default hot icons, but you may assign up to thirteen. To assign a hot icon, use the arrows to view the available reports, and click on those you wish to select. Those outlined by a red square will appear along the hot icons row. To remove a hot icon, click on it again so that the red frame disappears. Click on OK to continue.

Departments

The **Departments** menu allows you to easily access several reports and screens, many of which are also available elsewhere in the game. This manual discusses each item under the **Departments** menu in its appropriate section.

Overlays

The **Overlays** menu allows you to display several points of information as overlays on your main game map.You may see at a glance, for example, the energy output of each of your production sites. To do so, select Output per Site under the **Overlays** menu, and a number

will appear on each square on the main map that houses a production site.

For more details, see the Overlays section of this manual.

Help Menu

While Help is switched on, the info bar on your main game screen will display some tips regarding the current build mode you are in.

The Main Game Screen

At the top edge of the main map view you will see the name of the corporation currently taking a turn, its available funds in millions of dollars, and the current month and year.

The buttons along the bottom — the "hot icons" — are your tools to access the different types of information available to you. The control panel (see Control Panel section of this manual) on the right allows you to build and manage energy structures, communicate with your crews by electronic mail (E-mail), and end your turns by clicking on the "End Turn" button. The menu bar allows you to access some of your reports and control your game options.

Control Panel

The buttons on the Control Panel allow you to build, destroy, and repair structures, dispatch survey teams, and end your turn each month.

To build any structure, just click on its button in the control panel, and then click on the spot on your main map where you would like to build it. The single icon just beneath the zoom map — the **build mode indicator** — shows the build mode you are currently in. If the build mode icon looks like a volcano, for example, you will know that you are in the mode to build a geothermal plant.

The bar just beneath the build mode indicator will flash a few pieces of information about the build mode you are in:

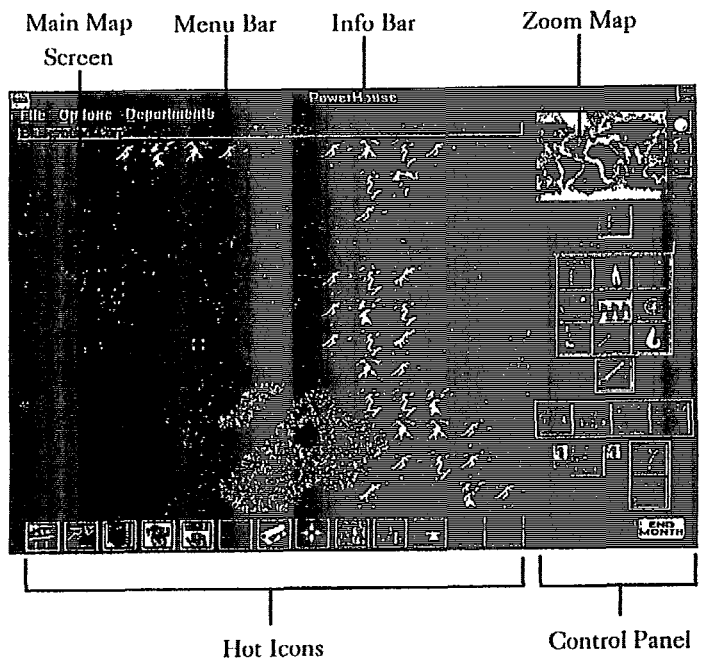
Build: This is the one-time cost to build the selected structure.

Maintain: This is the cost to keep the selected structure in good condition. It does not include the structure's operating cost. Maintenance costs will be subtracted from your funds periodically, at various intervals depending on the type of the structure.

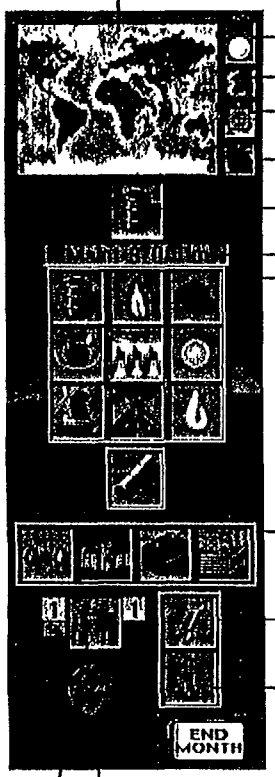
Run: This is the cost to operate the structure each month. Run costs will be subtracted from your funds periodically, at intervals depending on the type of the structure.

The following buttons are available on your control panel:

The Main Game Screen



The Control Panel



Oil Rig: This is the apparatus that extracts crude oil from the ground. If you have a working oil rig, you will need to have both a Refinery and a Generator in operation in order to produce saleable electricity.

When you are in the oil rig mode, two separate build, maintain, and run prices will appear, separated by a slash, on the information bar. The higher of the two applies to offshore rigs, and the lower applies to onshore rigs. Maintenance and running costs are calculated every month for offshore rigs, and every 6 months for land rigs.

Natural Gas Rig: This extracts natural gas from the earth. When you have a gas rig, you will also need to have a working Generator in order to produce electricity. When you are in the gas rig mode, two separate build, maintain, and run prices will appear, separated by a slash, on the information bar. The higher of the two applies to offshore rigs, and the lower applies to rigs on land. Maintenance and running costs are calculated monthly for offshore rigs, and every 6 months for land rigs.

Coal Mine: Coal mines extract coal from the earth. You will need to have a working generator, in addition to the mine, in order to produce electricity from coal. Maintenance and running costs are calculated yearly.

Nuclear Plant: Nuclear plants operate independently to produce electricity from nuclear fission, or, if you hire skilled researchers, eventually nuclear fusion. Maintenance and running costs are calculated every month.

Hydroelectric Dam: Hydroelectric Dams trap water in reservoirs and release it through turbines to produce electricity. They are the only structure that can be built on rivers, and they can *only* be built on rivers. Maintenance and running costs are calculated every 2 months.

Solar Plant: Solar plants take in energy from the sun and convert it to electricity. Maintenance and running costs are calculated yearly.

Wind Farm: Wind farms produce energy with wind-driven turbines. Maintenance and running costs are calculated every year.

Geothermal Plants: Geothermal plants extract and harness the heat generated within the earth. Maintenance and running costs are calculated every year.

Tidal/Wave Plants: Tidal/Wave plants harness the energy of the rising and falling tides and the ocean waves. They can only be built on the ocean. Maintenance and running costs are calculated every year.

Pipe: Pipe can be used to transport gas and oil from rigs to refineries, and from refineries to generators. You do not have to use pipes, however. When you build a network of oil rigs, refineries, mines, and generators, each will automatically be connected to the nearest other(s) via freight — that is, by rail or ship. (See **About Connections** in this manual.) Pipelines are not cheap to build, but after you have built one, it is cheaper to move something via pipe than via freight.

Maintenance and running costs for pipes are calculated every month. The build cost for pipe is expressed as the cost per 200 miles, or per map square.

To build a pipeline, select the pipe icon on the control pane and click on each map square between the two sites you would like to connect. The pipe will appear on the map.

Refinery: Refineries receive crude oil, convert it into usable fuel, and pass it along to generators to produce electricity. Maintenance and running costs are calculated every year.

Generator: Generators receive coal, gas, and refined oil and convert it to electricity.

Capacitor: A capacitor is essentially a very large battery. If a territory has any excess electricity at the end of the month, a capacitor can store it for use at another time. If a site is producing excess electricity (in which case you will be notified at the end of the month), build a capacitor in within five map squares of the site. (There must be no more than five squares next to each other, including diagonally, between any two linked sites.) The capacitor will store as much energy as its capacity will handle. The stored energy will automatically be used when the territory needs additional energy. Capacitors will only store energy if 100 percent of the territory's energy needs are being met.

Transformer: You may use transformers to pass electricity from one territory to another. To pass electricity from a site in one territory to another territory, place a transformer within five map squares of the site (no more than five connected squares -- including diagonal connections -- must be between the two connected sites). If necessary, build a chain of transformers (each within five squares of the other) from the production site into the receiving territory. Excess energy will flow into the receiving territory. Transformers will only work if a site is producing excess energy (energy which is not being used by its home territory)

Note on Capacitors and Transformers: A production site will *first* attempt to pass energy into its own territory. *If* the territory's needs are being met, the site will "look for" a transformer. If there is no transformer, or if a connected transformer cannot handle all the excess, the site will *then* look to pass its energy to a capacitor.

Zoom Map

The zoom map is the small world map in the upper right corner of the main game screen. You may click anywhere directly on your zoom map to move quickly to any location on your main map. To the right of the zoom map are four buttons, which activate the following functions, from top to bottom:

The **Magnify** button displays a magnified view of your main map.

The **Overlay Button** brings up a series of overlays on your main map. The overlay that will appear will be the one that is currently selected under the Overlays menu on the menu bar. To display an overlay, select the Overlays Menu on the menu bar, and select one of the options from the list that appears. Then click on the Overlay Button on the main game screen. On your main map, an information box will appear on every map square that contains infor-

mation for the selected overlay. For more information, see Overlays section in this manual.

The **Marker** button causes your main map view to jump to your marker. The marker is an automatic game function that lets you find certain map squares easily (see **About the Marker** section in this manual).

The **Borders** button switches on and off the territory borders on your main map display. The territories with red borders are currently open. When the U.N. opens a territory, its border will turn red.

Other Control Panel Icons:

Clean Up Site: Your sites may be destroyed by wars, by natural disasters, or by mechanical failure or human error at the site. The **Clean Up Site** function allows you to clean up sites that have been destroyed. Click on this button and then select the damaged site. A panel will inform you how much the clean-up project will cost. When you clean up a site, it will be restored to its natural state. You may want to do this to foster a spirit of environmentalism. Governments may remember it, and treat you well in the future.

Be careful; if you click on an *operating* site while in **Clean Up Site** mode, the site will be destroyed, and *then* cleaned up.

Close Site: This function allows to you to destroy a site, turning it to rubble. When a site has stopped producing fuel or is a high accident risk, you may want to destroy it. The **Close Site** function will *not* clean up the site — all the wreckage will remain.

About Connections

Some site types will need to be connected with other sites in order to produce electricity. An oil extraction site, for example, must be connected to a Refinery, and the Refinery must be connected to a Generator. The Generator will then produce electricity.

A natural gas extraction site must be connected directly to a Generator. A coal mine must also be connected directly to a Generator. None of the other extraction sites need to be connected.

When you build each type of site mentioned above, it will be automatically be connected to the closest appropriate site. All you have to do is build the right kinds of sites. The game will automatically connect them by freight (truck and ship).

You may elect to take more control over your site connections. You may, for example, change a connection so that the fuel is moved to a destination site other than closest one (which is the default). To do so, right-click on the site of origin and select the **Transport** button. When the transport panel appears, click directly on the main map screen on the new destination site.

You may also change the connection mode from its default setting of freight to pipe. To do this, simply build a pipeline between the two sites that you would like to connect. A pipeline will automatically override the default setting of freight.

To check where a site is sending its output, right-click on the site of origin, and check the listing next to *Generator Site Ref*, or *Refinery Site Ref* for the reference number of the current destination site.

If you have a pipeline in place, but would like to use freight instead, right-click on the origin site, click on the **Transport** button, and click on the freight button on the panel that appears. The button for the currently selected transport mode (pipe or freight) will be highlighted on the transport panel.

The **Best** button will assign the closest appropriate connection by freight.

Surveys

One of the first things you might want to do when your game begins is to dispatch one or more survey teams to an open territory. Survey teams spend three months in the field, and then report to you what they believe to be the most promising energy types to pursue in the surveyed area.

You may, of course, build production sites without surveying first, but you will run the risk of, say, building a coal mine on a site that has no coal.

The **Survey Team** icon — the one showing a pair of binoculars — can be found on the lower part of the control panel. To either side of the icon is a number. The number to the right is the total number of survey teams you currently employ. The one on the left is the number of your survey teams that are *not* currently assigned to a job. The arrow beneath the number on the left will bring you to each currently working survey team in succession each time you click on it.

To dispatch a survey team, click on the survey team icon, and then click on the main map screen in an open territory where you would like to survey. The team will appear on the map. *It will survey a block of nine map squares*, including and surrounding the square where you placed it.

Note: A team can not survey land in a territory that has not been opened by the U.N., so if you place a team next to a border, it will survey only the open territory squares in its range.

To check a working team's status, click on it on the main map while survey mode is *not* selected. When the survey is complete, you will get an E-mail message informing you of the results.

You may hire as many as five survey teams. To hire or fire teams, select **Departments** on the main menu bar, then select **Personnel - Survey**. A panel will appear, informing you how much each hired team will cost you. When you hire a survey team, you will immediately have to pay out the equivalent of three months' wages to outfit the team, in addition to their regular wages for the first month. Likewise, when you fire a team, you will have to pay out two months' severance wages.

Use the up and down arrows to set the number of teams you would like to employ. You may only fire teams that are not working.

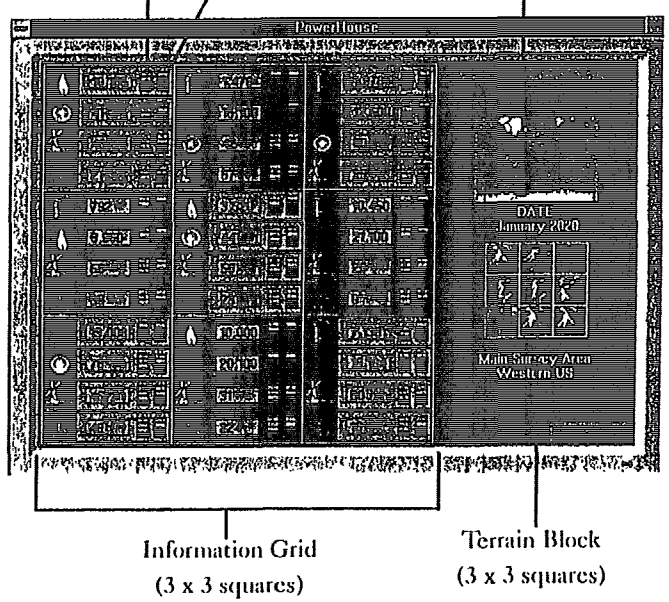
To check the status of any working survey team, select **Current Surveys** from the **Departments** menu, select a listed team, and click on the **Go To** button.

Survey Results

As soon as a team completes a survey, its foreman will send you a message by E-mail (see the **E-mail** section of this manual for instructions on how to use E-mail). When you access the message, you'll see an information grid that is split into nine blocks tic-tac-toe style. Each block represents one of the nine squares surveyed. The crosshairs on the mini-map to the left indicate the location of the survey, and the nine-square terrain block beneath it shows what the area's terrain looks like.

In the main display, each of the nine grid blocks is further divided into four horizontal panels. The panels indicate the four types of

Survey Results Screen



energy, as indicated by the icons, believed to be available on that map square. The number next to it indicates the estimated *yield*, or the number of energy units estimated to be available at the site.

Remember: for oil, gas, and coal, *yield* refers to the total number of energy units believed to lie beneath the earth at the site. For the rest of the energy types, it refers to the total number of energy units available at to each rig *each month*. The more technically advanced sites will be able to harness a greater percentage of the overall yield.

Note: There may be less than four types of energy available on a square, and some squares may have no energy resources. If a square has less than four energy sources, blank panels will appear.

The blue bar next to each number shows the ease level of each energy type at the square. The ease level refers to how easy or difficult it is to harness that type of energy at that particular square. Solar energy, for example, will be easier to obtain at a sunny place than a dark and cold one; oil will be easier to extract if a deposit is close to the surface, etc. When *more* blue fills the indicator bar, the energy type is *more* difficult to extract.

The red bar indicates the environmental impact that is expected to occur if the energy type is extracted at the particular square. A large coal mine, for example, may have a greater impact on a site than a small wind farm. When *more* red fills the indicator bar, the environmental impact is *greater*.

To go to a specific square on the Main Game Screen from the E-mail **Survey Results** screen, click on the nine-square terrain block on the square to which you would like to go.

Use the **Next** and **Previous** buttons to view any other survey reports in your E-mail directory.

Accessing Survey Output from the Departments Menu

After you have read the E-mail report on your survey results, you may delete the message(s) from E-mail. The information will remain in your records. To access your survey records at any time, select **Departments** from the menu bar, and then select **Output from Surveys**. You will see a small world map with a black dot marking every map square that has been surveyed. Click on a black dot.

A new panel will appear, containing information about a single map square. Each surveyed square will have a reference number (Ref.).

The information panel for each map square displays the survey estimates for four (or fewer) energy types, their estimated yield, and the environmental impact expected to result from their extraction.

The **Next** button displays the information for the next surveyed map square in your records; the **Prev** button displays the information for the previous square. The **OK** button returns you to the main game screen.

When you are viewing information panels pertaining to individual map squares, you may not know precisely where to find a specific square on your main map. There is an easy way to do so. First, find the information panel in **Output from Surveys** corresponding with the square you wish to find. Then select **OK**. When you return to the main game screen, your **marker** will automatically move to the map square corresponding to the last information panel you viewed. If you do not see the marker, select the **Marker** button next to your zoom map, and the main screen will find it.

***Note: You may quickly retrieve survey data, along with other important information, for each map square simply by right-clicking directly on that map square. You mal also access Survey Results from the Overlays menu.*

Note: Remember, surveys produce estimates, and may ultimately be wrong!

E-mail

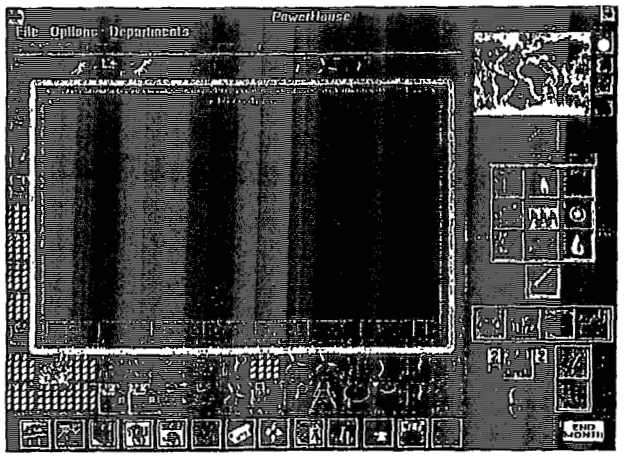
Much of your corporate communications will take place by electronic mail. Through this system you will get updates about individual sites, levels of production, research & development breakthroughs, and world events. Occasionally, you may also send messages to your crews in the field.

At the beginning of each month, the "e" on your control panel will spin if you have any E-mail messages waiting for you. Select the spinning "e" to enter the system.

When you do so, a screen will list your numbered messages.You may interact with the E-mail system by using your mouse and/or your keyboard. To read a message using your mouse, click on the message listing so that it is highlighted with a star, and then click on the **View** button at the bottom of the screen.

The **Delete** button selects the current message (marked with an arrow) so that it will be deleted as soon as you exit E-mail. The **Junk All** button causes every message to be deleted when you exit. Any message

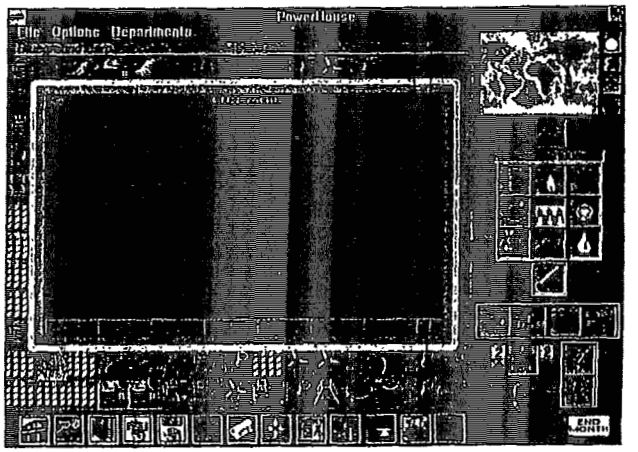
Message List Screen



marked with an asterisk will be deleted when you exit E-mail. Any messages not deleted will remain in your system month-to-month, so it may be a good idea to delete unneeded messages. The **Exit** button exits E-mail. The up and down arrows allow you to scroll through your message list.

The **Abort** and **Suspend** buttons will not function when dimmed. You may only use these buttons to respond to a specific type of message — one that asks you for a response. When the buttons are highlighted, they will function. If a message asks you if you would like to *suspend* or *abort* a certain project, you may issue the appropriate command directly from E-mail. **Abort** will permanently close and clean up a site. **Suspend** will suspend a site until its crew receives further orders from you. While a site is suspended, you will have to pay its maintenance costs, but not running costs.

Individual Message Screen



Keyboard Commands in E-mail

There are two types of screens in E-mail: the message list screen, and the individual message screen The following keyboard commands are available from the *List Screen*:

<D> or <J> - Delete current message

<A> - Junk all messages

<Space> - View message

<Esc> - Exit E-mail

<Up Arrow >- Move up message list by one

<Down Arrow> - Move down list by one

<Left Arrow> - Move up list by ten

<Right Arrow> - Move down list by ten

The following keyboard commands are available from the *Individual Message* screen:

<Return> - Delete this message and return to list screen.

<Esc> - Return to list screen

<D>, <J>, or <Space> - Delete this message and view next message

<Left Arrow> - View previous message

<Right Arrow> - View next message

<A> - Abort

<S> - Suspend

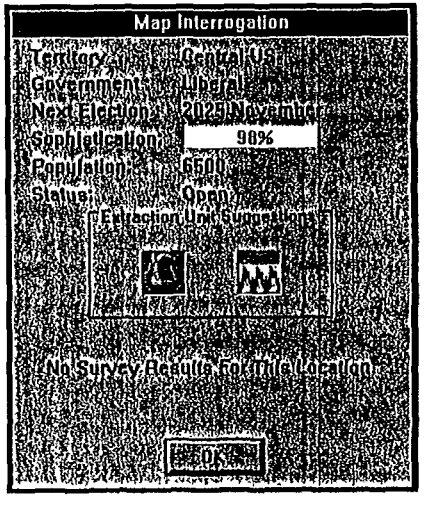
Territory Information

To access some quick information about any territory (even those that are still closed) right click on any empty map square. The following information will be displayed:

Government: Each territory in the game will operate under one of six *government* systems. Each system will behave differently and will respond to the PowerHouses in different ways. Democracies will periodically have elections, which may result in government shifts. Non-democracies will not have elections, but may have a high likelihood of political upheavals. These may bring in democracies or new non-democracies.

Some government types, when they first come to power, might decide to nationalize the energy industry in their territory. In this case, they will seize all of your sites and kick you out. There is *nothing* you can do about this!

Some government types have higher environmental standards than others. Those with low tolerance for ecological damage may shut off your business, or even kick you out, if you fail to keep your sites clean. Less fortunate governments may be overthrown simply for allowing too much ecological damage.



Some government types will charge higher fees and demand higher royalties. Some systems have a greater tendency toward instability, and some will adjust the terms of your contracts on a take-it-or-it-leave basis.

When neighboring territories have different government systems, the likelihood of war increases. Wars can cause the destruction of sites, but they may also act in your favor by driving fuel prices up.

Liberal Democracies will have a very low tolerance for environmental damage. They will also have a relatively low coup risk, but coups may result in Fascist or Communist systems. There is a slight chance that Liberal Democracies will seize your sites. Elections may result in shifts to Moderate or Conservative systems.

Moderate Democracies have a medium environmental tolerance. Coup risk is low, but coups may bring in Fascist or Communist systems. Elections can bring in Liberal or Conservative Systems.

Conservative Democracies have a high environmental tolerance. Coups may bring in Fascist or Communist regimes, and elections may bring in Liberal or Moderate Democracies.

Communist territories have an extremely high environmental tolerance. There is a relatively high likelihood that a Communist government will seize sites. They do not have elections, and have a moderate risk of political coups.

Fascist territories have an extremely high environmental tolerance, no elections, and a high risk of coups. Fascist governments are most likely to change contracts without warning. They will occasionally seize sites.

Corporate territories are run by a council of large corporations, each of which governs and polices its own massive work force. They have a high environmental tolerance, no elections, and a low chance of coups.

Next Election: If the territory is a democracy, elections may result in political shifts that may affect royalties, prices, and environmental stances.

Sophistication: This rating measures how much energy the territory demands. It reflects technological advancement, wealth, and education. The scale is relative: at the beginning of the game, the most sophisticated territory will have a rating of 100%, and the least sophisticated will have a rating of 0%. Sophistication ratings will change throughout the game. When the sophistication rating of a territory climbs, the territory will demand more energy per capita.

Population: Population levels may fluctuate throughout the game. Population and sophistication together determine a territory's energy demand.

Status: You may only do business in territories that have been assigned "opened" status by the U.N.

Extraction Unit Suggestions: Prior to any surveying, these energy types are generally believed to be the most promising in the selected territory. These are very rough estimates and should not be relied upon.

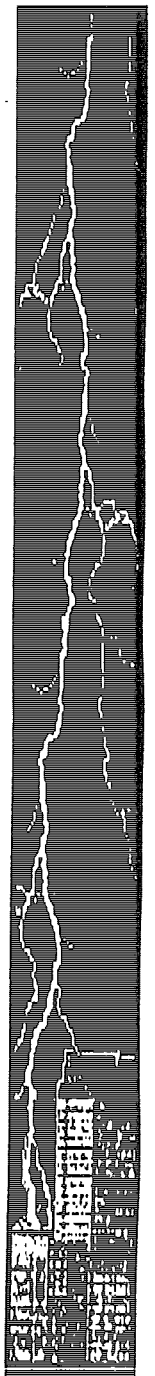
Building Sites

To build any kind of site, select the type of site you would like to build by clicking on its icon on your control panel. When the build mode indicator displays the icon for the site you would like to build, just click on the spot on your main map where you would like to build the site.

Some sites cannot be built on some squares. A hydroelectric site, for example, cannot be built on dry land. If the site cannot be built, a message panel will let you know.

If the square can support the site, the host territory may offer you a deal. The deal will usually include a one-time **Extraction Permit** fee, and a **Royalty**, expressed as a percentage of the profits from this site that you must surrender to the host nation each month. If a deal is offered, the host nation will automatically agree to buy whatever energy is produced on the site, as long as the nation needs energy. If you have any survey results on record that apply to the selected energy type on the selected square, this data will also be displayed.

If you accept the deal, your site will be built.



Construction of any type of site will take one month. After that, however, some sites may take a while before they begin operating. Oil and gas rigs will spend time drilling for crude oil or gas; nuclear plants will spend time setting up the internal mechanisms for producing nuclear energy; etc. In the meantime, the site will appear on its map square, but it will not produce energy until it begins to operate. Each site will notify you of its status via E-mail each month until it strikes.

Extraction Sites Panel

To check the status of any operating site, right-click its icon on the main map. The Extraction Sites panel will display the following information:

Note: Not every item listed here will appear in every Extraction Site Panel.

Ref: The site's reference number

Energy: The energy source that is being exploited at the site.

Yield: For oil, gas, and coal, yield refers to the total number of units estimated to be at the site. For the rest of the energy types, yield refers to the maximum number of energy units available for each rig each month. The green and red bar is a visual expression of how good the yield is. The entire bar represents the maximum yield for any site (for oil, gas and coal, the maximum is 25,500 units; for the others the maximum yield is 85 units per rig per month). The green section represents the estimated yield at that particular site. Look for sites with the greenest yield bars. After *non-fossil* fuel sites begin operating, the yield displayed will always be accurate. For *fossil* fuels, you can never really be sure how much stuff is down there until you have extracted it all.

Ease: A *Good* ease level means that the energy source is easy to exploit. In the case of oil, gas, and coal, *Good* means that the fuel is near the surface, and is likely to be recovered soon after drilling begins. For solar, the site may lie in a sunny place; for tidal, the waves may be are particularly large, and so on. A *Bad* ease level means that some time and effort is likely to be required before any energy is extracted.

Impact: Impact indicates the *anticipated* environmental damage that is likely to result from a certain type of structure to the square. The range is: *Trivial*, *Little*, *Average*, *Much*, and *Great*.

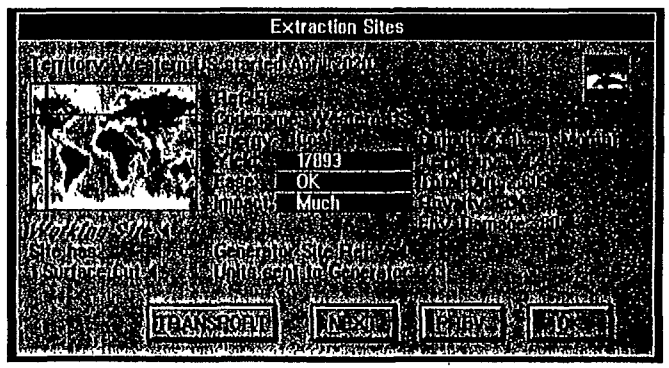
Output: The number of units of the energy type produced at the site during the previous month.

Terr. Buys: The territory's total energy needs. The territory will buy all of the energy you produce until its needs are met. After 100 percent of territory's energy needs are met, you may still work to produce a higher percentage of its supply. A territory's energy needs are likely to increase. If you are producing a surplus there, and the territory's government looks favorably upon you, it may buy more electricity from you.

Total Out: The total number of energy units the site has produced since it began operation.

Royalty: The percentage of your profits from this site that you must pay to the host territory.

Env. Damage: This shows how much environmental damage has occurred at the site to date. High damage levels may result in fines, and may ultimately result in the destruction of a site.



Working Site/Work Suspended: This indicator shows whether the site is currently *working* or *suspended*. You may change the status of the site by clicking directly on this status indicator.

"Site Has" Indicator: Any site has the capacity to house as many as ten rigs. To increase or decrease the number of rigs in operation at a site, click directly on the "Site has" listing. Then use the up and down arrows on the panel to increase or decrease the number of rigs. An "*H*" next to a rig indicates that the rig has "hit," or is currently producing energy or fuel. A "*D*" next to a rig indicates that the rig is "drilling" and is not yet productive. You may also click the "Site has" listing to upgrade the tech level of a rig or rigs on a site (see **R&D Breakthroughs and Upgrading Sites** section of this manual).

Generator/ Refinery Site Reference: For oil, gas, and coal sites, this is the reference number for the generator or refinery to which the selected site is sending its fuel.

Units Sent to Generator/Refinery: For coal, oil, or gas sites, this is the number of units sent to the appropriate production site.

Transport: Click here if you would like to change how fuel is being transported from a coal, oil, or gas site. By default, your fuel will transported by freight. If you build a pipeline, it will automatically replace the freight system. (See **About Connections**).

Next: Click here to view the Extraction Site Panel for the next site (in chronological order of construction).

Prev: Click here to view the Extraction Site Panel for the previous site (in chronological order of construction).

OK: Click here to return to the main game screen.

Research and Development

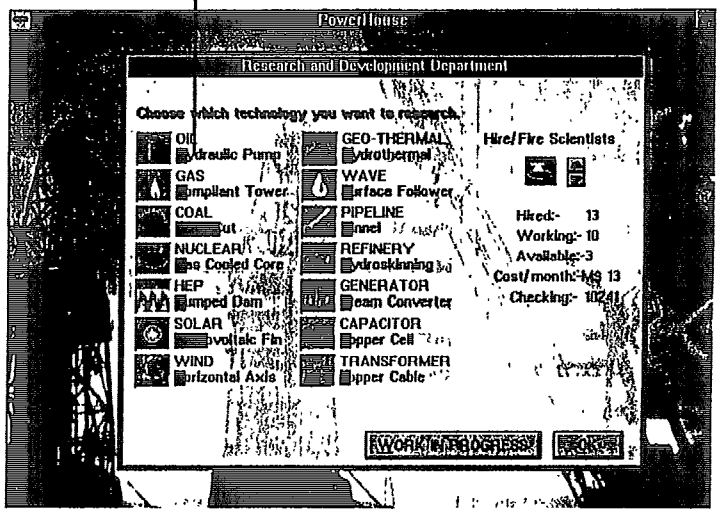
One way to get the edge on your competitors is to develop better, more efficient, or more productive technologies. To do this, you will hire teams of scientists and assign them to specific research projects. There are many areas of R&D to choose from, so you will have to decide whether you want to concentrate your staff on a few projects for quicker results, or spread your researchers out to work on a wider variety of projects.

You may assign research teams to each energy extraction type, as well as to refineries, generators, capacitors, transformers, and pipes. For each of these, there are **ten technology levels.** The technology advances will mean different improvements for each type of structure and for each level.

On the R&D screen, tech levels are displayed as red and yellow bars beneath each technology type. The red indicates your current level,

R&D Screen

Tech level indicator



...d the yellow indicates the entire technology range. Once the bar is completely red, you have reached the highest tech level for that type of site.

After a technical breakthrough, any new rig or site will automatically be built at its new tech level. Its cost may go up or down, depending on the nature of the improvement. Any sites or rigs built *before* the breakthrough, however, will remain at the old tech level until you upgrade them. When you make a breakthrough, you might want to upgrade all of your existing sites to the new level, if you can afford to (*see* ***R&D Breakthroughs and Upgrading Sites***). In the long run, this will increase production.

Technological breakthroughs will mean different types of advances for different types of sites.

Note: Some "advances" will offer no direct benefits, but rather are intermediate steps to other breakthroughs.

Oil Rigs, Gas Rigs, and Coal Mines

Some technological advances for these types of sites will allow you to reach further into the earth. Other advances may give a structure the ability to extract a higher percentage of the yield at a certain level. Some advances will cause the structures to increase in cost, and other will make them cheaper.

Nuclear, Wind, Solar, Tidal, Hydroelectric, and Geothermal Plants

Some of the ten technology advances for these types of sites will improve efficiency. The higher levels will be able to extract a higher percentage of the total monthly yield for their energy type. Other advances will not improve performance, but will lower building and maintenance costs.

Refineries, Capacitors, Transformers, Generators

These sites will improve in capacity as their technology levels climb. Refineries will process more fuel and refine a higher percentage of the crude; capacitors will able to store more energy; transformers will transport more energy, and generators will be able to take in more fuel and produce more energy.

Keep in mind that these technologies often work together. A high-efficiency refinery, for example, will turn out an increased flow of fuel, but if the generator to which it is connected remains low-tech, the generator may not be able to handle the refinery's increased output, and waste will result.

A chain of transformers will only operate at the level of its lowest-technology transformer.

Pipes

Higher tech levels of pipe will be able to transport higher quantities of fuel. A pipeline is only as efficient as it lowest-level component.

Surveys

Accuracy of surveys will improve as tech levels rise.

Note: Many technological advances in all site types will make your sites more environmentally friendly.

Hiring & Assigning Scientists

To hire research teams and assign them to projects, select the R&D button on the hot icons panel (if it's there), or click on the **Departments** menu and select **R&D**. The Research and Development Department screen will appear.

To hire teams, click on the up arrow. The "**Hired**" heading refers to the total number of teams you have working for you; "**Working**" refers to those currently assigned to a project; and "**Available**" refers to those not currently assigned to a project. After you have hired a pool of research teams, you may assign them to projects.

To do this, click on the icon for the type of technology you would like to research. The Research Assignment panel will appear. The listed project is the specific project to be researched. Beneath it is a description of the advantage it offers, such as "More Efficiency," or "Cheaper Construction." A few projects will promise "No

Improvements." Don't let this discourage you — sometimes it's necessary to strive for a relatively useless advance in order to reach the following level.

A project will usually succeed quicker if you have more teams working on it, although if you assign *too* many you will get less value out of each. As you reach higher technology levels, advances will become increasingly difficult, and will require more time and/or more scientists.

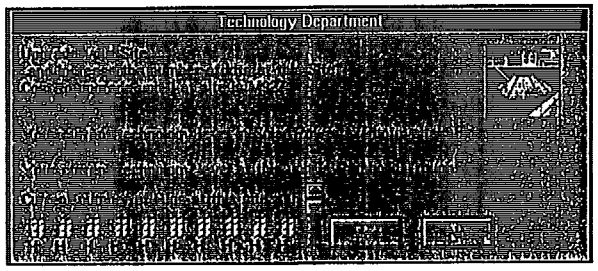
Select **Work in Progress** to see a list of how many scientists you currently have researching each technology. As soon as a staff makes a breakthrough, it will notify you via E-mail.

Note: After a research team makes a breakthrough, its members will continue working in the same field unless you either reassign them or let them go.

R&D Breakthroughs & Upgrading Sites

After your scientists have made an R&D breakthrough, any new rigs that you build will automatically be state-of-the art. But your existing rigs will be outdated — you may want to upgrade them.

To upgrade an existing site, right-click on the site on your main game screen. Then click on the name of the rig type (beneath the words "**Site has**"), or on the words "**Mixed Levels**" if you have different tech levels at the site. (You may also click on the blue arrow next to the name.)



Doing so will bring up the technology panel. This panel tells you *your current technology level* — the highest level you have attained for that type of site; and the *current technology level at this unit*, or the lowest tech level currently being utilized at the site. If these are different, you have the option to upgrade the site.

To upgrade a rig, just click on the **Yes** button. If you have more than one rig at a site, you will have to click on the **Yes** button once for each rig you would like to upgrade. The *cost to upgrade* is the upgrade cost per rig.

After you have upgraded every rig at a site, *your tech level* will be the same as the *tech level at this unit* on the technology panel.

If you add rigs to a site (using the up and down arrows on the technology panel), any rig you add will automatically be built using the highest tech level you have reached.

Reports and Information Screens

As the game progresses, you will want to monitor your corporation's standing in many areas and check your progress against that of your competitors. You will have access to several reports and data screens, which will allow you to do so.

Financial Reports

The following financial reports can be accessed by selecting **Departments** from your menu bar, and then clicking on **Financial Reports**:

Annual Turnover: "Turnover" is the amount of money brought in as a result of electricity sales. This report is a color-coded graph depicting the turnover in billions of dollars for each PowerHouse.

Annual Profit: This report is a color-coded bar graph showing the annual profit of each PowerHouse.

Year-to-Date Turnover: This is a graph showing the income from electricity sales of each corporation, month by month, for the current year.

Production and Demand: This displays the total energy demand in all territories (De), and the percentage of that total that each corporation is currently supplying (Pr).

Environmental Damage: This chart shows how much money each corporation has paid as a result of fines, closed down sites, or any other expenses related to environmental damage.

Energy Turnover - The World: This pie chart shows the relative combined income of all corporations, for each energy type.

Energy Turnover for You: This pie chart shows your corporation's relative income from all energy sources.

Energy Reports: This report accesses a list of each energy type. Select an energy type to view the income that each type has brought to each corporation.

Income Report: This report details your corporation's income. You may go to any entry's location on the main map by selecting the line on the report, and clicking on the Go To button.

Outgoings Report: This report details your corporation's expenses.

Extraction Unit Concentration: This is a color-coded world map showing the locations of each corporation's extraction sites.

Profit and Loss: This report details your income, outgoings (expenses), and profits for the current month.

Deposit Map: This report shows you a general picture of the potential extraction locations for each energy type. Select a type you would like to view. The shaded areas represent regions where the energy type is likely to be.

Performance Report/Comparison Report: This report lists each corporation, its checking account balance, and a chart indicating whether or not it is currently exploiting each energy source. A "Y" indicates that it is producing the energy type, an "N" indicates that it is not.

Other Reports

* **Working Sites:** To access this report, select the **Departments** menu and click on Working Sites. The report is a world map that displays the location of each of your corporation's sites. Sites which are not producing any output, or which are causing high-level environmental damage will be indicated.

* **Energy Needs:** This report lists every open territory, and several pieces of information about each. You may go directly to any territory from this screen by selecting the territory name and clicking on the **Go To** button. The following information is listed here:

  Total NRG is the total number of units that the territory demands, based on its population and sophistication level. If a territory has not yet been opened by the U.N., it will simply say "Closed."

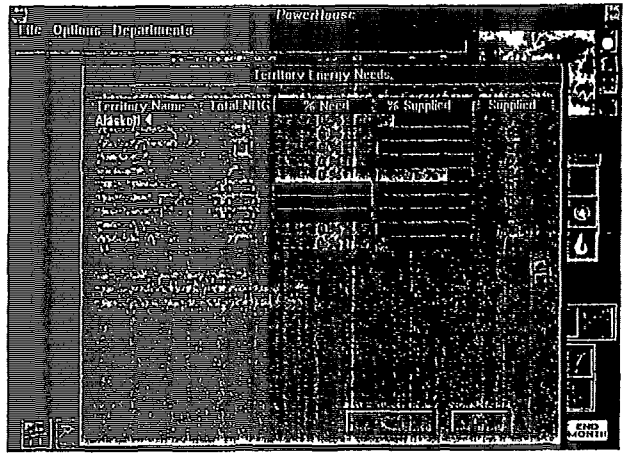
  % Need Met is the percent of the territory's total demand that is currently being filled.

  Whenever any territory's need falls below 25 %, the U.N. will open a new territory.

  % You Supply is the percentage of the territory's total demand that *your corporation* is currently supplying.

  Supplied is the total number of units of energy *your corporation* is currently supplying.

  The **Fuel** button displays information about the fossil fuel production and consumption of the selected territory. The green



bar shows the amount of each fuel type that has been processed in the territory. The yellow shows how much fuel, if any, has been wasted.

* **Most Dangerous Sites:** A certain degree of risk is inherent in the operation of any large power utility. Your sites will have varying degrees of danger, depending on the nature and tech level of each facility, its size, and its geographic location. Select the **Most Dangerous Sites** display from the Departments menu for a list of the ten highest-risk sites that you own.

The danger levels are as follows: *Very Low, Low, Medium, High Very High, Dangerous, Very Dangerous, Critical, and Very Critical.*

Danger levels reflect the natural conditions of the location as well as the condition of the site there. A site built in a place where earthquakes are common, for example, might have a high danger level. The most dangerous sites are the most likely to be destroyed by natural disaster or by accident on-site. To move to any site from this list, select the site, and click on the **Move To** button.

* *[Energy Type]* **Annual Turnover:** You may display a graph comparing how much money each corporation has received from each energy type. Select **Hot Icons** under the **Options** menu, and choose which energy source(s) you would like to display.

Overlays

The **Overlays** menu gives you the option to display as map overlays many important pieces of information about you and your competitors. Each overlay will appear as a series of panels atop each map square to which the information category applies. To activate any of the overlays, click on **Overlays** in the menu bar, and select an overlay. Use the **Overlay button** next to your Zoom Map to switch the selected overlay on and off.

The following overlays are available:

* **Environmental Pollution** - rates the degree of pollution each site is causing. The scale ranges from 1 to 16, with 16 representing the highest level of pollution.

* **Number of Rigs** - *displays the number of rigs on each site.*

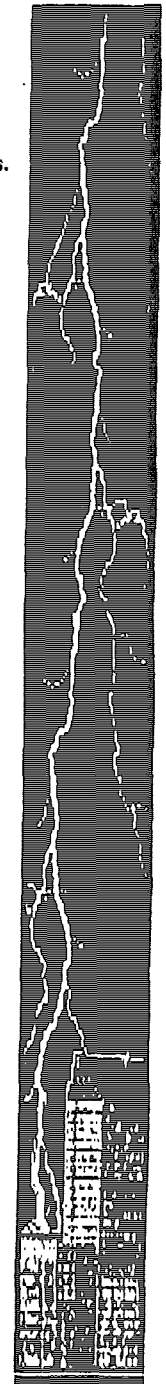
* **Output per Site** - displays the site's total output in energy units for the previous month.

* **Cost to Operate** - displays the current annual operating costs for each site.

* **Tech Level** - displays a bar indicator of which tech level is operating on each site. If a site contains rigs of various levels, a letter "M" will appear.

* **Survey Information** - When switched on, this displays the yield, as estimated by your survey teams, of the selected energy type. While this overlay is on, the yield display will be determined by *the current build mode.* Select geothermal on your control panel, for example, to display estimates for geothermal energy. Only surveyed map squares will have a numerical entry. Non-surveyed squares believed to contain deposits of the energy type will be marked by a plain blue square.

* **Highest Yield** - displays the energy type with the highest estimated yield for each square. Because non-fossil fuels have a monthly yield and fossil fuels have a one-time yield, one unit one



non-fossil fuel yield is equal to 300 units of fossil fuel.

* **Corporation displays** - Switch each corporation's overlay on to display a clearer indication of who occupies each map square. When a corporation is switched on, a colored rectangle will appear over each of its sites. These overlay options operate independently of the **Overlay button** -- when a corporation's overlay is switched on, gameplay will continue as with the overlay on until it is turned off.

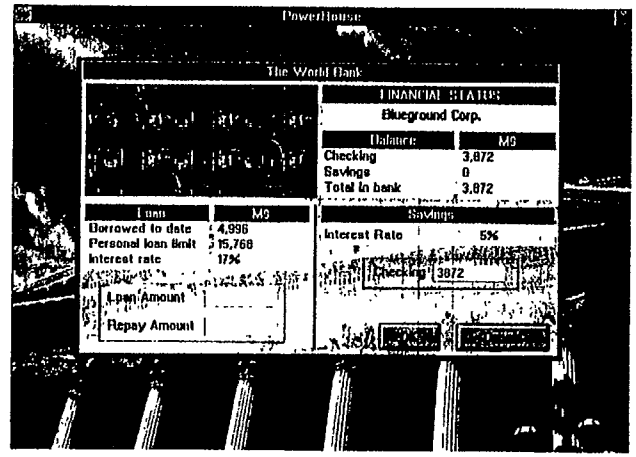
The Bank

You may access the bank screen by selecting its icon from the hot icons row (if it's there), or by selecting **Bank Liaison** from the **Departments** menu. All figures in the bank screen are expressed in millions of dollars. At the bank, you have a checking account and a savings account. All of your money will be placed in your checking account until you move it into your savings account. Any money you spend must come from your checking account. Money in your checking account, however, will not earn interest.

Only the money in your savings account will earn interest, but as long as money is in the savings account, you may not spend it. To spend money from your savings account, you must first move it to your checking account.

To transfer money from your checking account to your savings account in the bank screen, click on the white box next to the word "*Checking*" so that a cursor appears in the box. Using your keyboard, type in the amount of money that you would like to remain in your checking account (the amount must not, of course, be greater than your overall total in the bank). Then press the <Enter> key. The remainder of your money will automatically be transferred to your savings account, where it will earn interest at the rate shown.

If you run short on funds, the bank will loan you money. You may borrow up to your *Personal Loan Limit*, which is set by the bank. To take out a loan, click on the box next to "*Loan Amount*," type in the amount you would like to borrow, and press the <Enter> key. If you cannot



meet your expenses during the month-end calculations, you will automatically be loaned the necessary funds and notified of the loan.

To repay a loan or a portion of a loan, select the box next to *Repay Amount*, type in the amount of your payment, and press the <Enter> key.

Click on **OK** to exit the bank screen.

The Stock Market

You may access the stock market screen by selecting **Stock Market Liaison** under the Departments menu, or by selecting its icon on the hot icons row, if it is there.

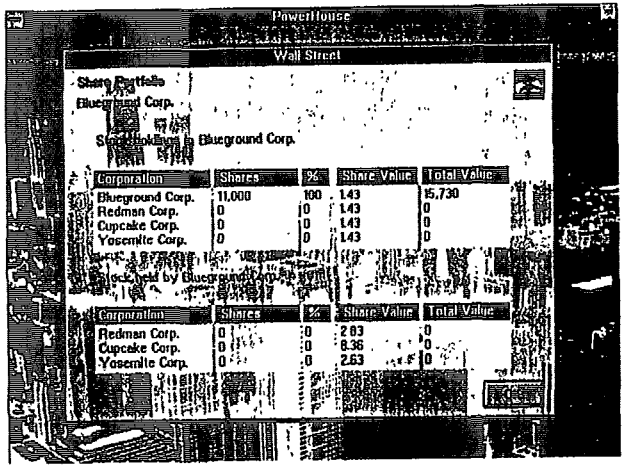
The stock market screen consists of two information displays. The top display itemizes the stock ownership of your company. You will own 100 percent of your company until you choose to sell some of your stock. The listed share value is expressed in millions of dollars per share.

The lower display shows the stock that you own.

You may raise money by selling stock in your corporation, and you may speculate by buying stock in the other PowerHouses. To issue shares of your stock, click directly on your corporation's name in the stock holdings display. On the panel that appears, type in the number of shares you would like to offer for sale, then click on OK. If one of the corporations accepts your offer, the transaction will appear on the stock market panel. If you sell more than 50 percent of your stock, you will lose your corporation (and the game, if you don't control any of the other corporations).

To buy stock in another corporation, click on the corporation's name in the bottom info display. If the corporation is currently offering stock for sale, a panel will appear, giving you the option to accept the offer. If no stock is up for sale, no panel will appear.

Aggressive trading may pay off. If you manage to buy more than 50 percent of another corporation's stock, you will have the option to take the corporation over. In this case, the corporation will continue to operate, but you will control it just as you control your own. If you manage to buy more than two thirds of a company's stock (66.6 percent), you will have the option to liquidate its assets and absorb the profits. If you liquidate the corporation's assets, you will receive cash equal to one



half each structure's original build cost *times* the percentage of the corporation's stock that you own:

> Cash Received = Build Cost of all Sites x 1/2 x shares you own/total shares

You do not *have* to exercise either option at all, and you will not have to make the decision right away. After you have reached 51% or 66.6% stock ownership, buttons will appear on the stock market screen giving you the option to take over or liquidate at your leisure.

If you manage to control all corporations operating in the game, you win the game.

"Unique" Operations

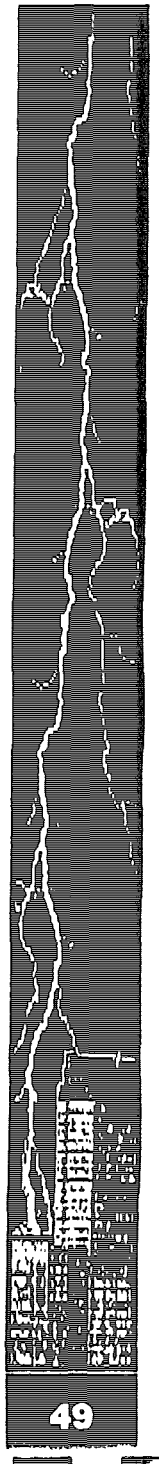
In the corporate world, the drive for power is a strong one, and to satisfy it, some will stop at nothing. The PowerHouses, unfortunately, will not always be pillars of honesty and honor -- you'll have to watch your back. Fortunately, you too will be able to benefit from the devious and underhanded practices of corporate warfare.

You will have several varieties of covert activity at your disposal -- but remember: should you decide to take advantage of them, you run the risk of being caught and punished.

To engage in the more unsavory aspects of the business world, select **Unique Operations** from the **Departments** menu. On the Unique Operations screen, use the up arrow to hire unique operators. Click on **Setup** to assign a mission. After a mission is complete, you will be notified of its success or failure via E-mail.

The following options are available:

> **Sabotage Site** - This gives you the option to blow up an opponent's production site. Click on **Sabotage Site**, then select the site you would like to sabotage.



research, and lift their breakthroughs for your own gain.

Falsify Survey - You may throw your competitors off by bribing their surveyors to report false information. Select **Falsify Survey**, and then select the competitor's survey in progress on the main map. The survey results will be randomized. You may then sit back in smug satisfaction and watch your enemy drill for a huge oil deposit that doesn't exist.

Bribe Territory - You may bribe a territory to view your corporation more favorably, and to throw more business your way.

Slur Opponent- You may bribe a territory to dislike another corporation, and to treat it poorly.

Internal Security/Infiltrate Opponent - See below.

When you carry out a unique operation, one of several things will happen:

* You may succeed,and your target never finds out about your plot.
* You may succeed, but your target figures out that it was you who caused its misfortune. In this case, the target may retaliate.
* You may fail, and the intended target finds out about your plan. In this case, your opponent may hold a grudge, despite your not having gained anything.
* The worst scenario: Your mission fails, and your plan is publicly revealed. In this case the U.N. will castigate you, and the public (and the various governments) will look unfavorably upon your corporation.

If you are shrewd in planning your unique operations, you stand to benefit considerably. But if you are careless, you could suffer damage. And remember, the others may target you in their own unique operations.

To minimize sabotage against you, you may hire **Internal Security** and nents. You will be more likely to find out who has targeted you in both successful and failed missions.

When you hire **Infiltrate Opponent** teams, you instruct them to investigate specific opponents. In this case, you are more likely to find out about the specific opponent's schemes against you, and you are more likely to be able to expose it publicly if you do uncover a scheme.

You may hire a maximum total of five Unique Operations Teams, including infiltrate and internal security teams.

About the Marker

The Marker is an automatic function that lets you find specific squares quickly and easily. The Marker will always move to last selected map square. It will respond to several types of actions, including the following:

* When you right-click on any map square to retrieve information about it, the marker will move to that square.
* When you view survey information via **Output from Surveys** under the Departments menu, the marker will move to the square corresponding to the last information screen displayed. To find it, close **Output from Surveys**, and select the **Marker** button next to the Zoom Map.
* When viewing the **Working Sites** display in the Departments menu, you may click directly on the display map. An information panel for the selected square will appear, and the marker will move to that square.
* When viewing the **Most Dangerous Sites** list, click on any site name listed, and the marker will move to that square.

(*see* Surveys). The marker will move to the site of each working survey team in succession.

A Note on Gameplay

A territory will buy all the energy it can get from any corporation as long as less than 100 percent of the territory's energy need is being filled. Thus, when a territory first opens, the PowerHouses will likely race to see who can supply the greatest percentage of the territory's need before 100 percent of that need is met.

If the corporations are together producing more electricity in a territory than the territory needs, it becomes a buyer's market. The territory can then determine how much energy it will buy from each corporation based on the government's preferences regarding the PowerHouses. (This may be a good time for bribing and slurring with your Unique Operations Teams.)

Government preferences are based chiefly on environmental issues: Who has kept the cleanest sites? Has anyone destroyed a site and abandoned the wreckage? etc. If a government likes each PowerHouse equally, its territory will buy equal amounts of electricity from each PowerHouse (assuming each is producing equally). If it likes one in particular, it will buy a greater share from the one it likes.

Territory energy needs will also change as time passes. Say, for example, that both you and another corporation are producing excess electricity in a territory, but the territory's government likes you more than it likes your competitor. When the territory's energy need climbs, it will probably buy more of its additional electricity from you.

If you are producing more energy in a territory than you can sell in that territory, you may send it out via Transformer, or store it in a Capacitor. Energy will automatically go first to its home territory (until 100 percent of the need there is met). Then, any excess will go to a Transformer if one is within range. If there is no Transformer, or if a Transformer cannot handle all the excess energy that is being produced, the excess

the energy will flow first to the closer of the two, then to the further.

If excess electricity is not sold, sent out via Transformer, or stored in a Capacitor, then it is wasted. You will be warned if this occurs.

Appendix

The following reference lists the ten technology levels for each type of rig in **PowerHouse**:

Oil/Gas Onshore

1. Hydraulic Pump
2. Pressure Pump
3. Beam/Rod Pump
4. Gas Lift System
5. Lateral Bore
6. Cyclic Pump
7. Deep Bore
8. Vacuum Pump
9. Twin Bore
10. Smart Bore

Oil/Gas Offshore

1. Compliant Tower
2. Jack-Up Rig
3. Jacket Structure
4. Semi-Submersible
5. Tension Leg Rig
6. Submersible Rig
7. Free Submersible
8. Deep Submersible
9. Twin Drill Rig
10. Smart Drill Rig

Coal

1. Surface Cut
2. Lateral Cut
3. Vertical Cut
4. Deep Cut
5. Multi-Layer Cut
6. Surface Sensors
7. Multiple Fan Cut
8. Deep Seam
9. Deep Sensors

Nuclear

1. Gas Cooled Core
2. Breeder Reactor
3. Fast Breeder
4. Twin Core System
5. Distributed Core
6. Fission-Fusion
7. Laser Fusion
8. Magnetic Fusion
9. Deuterium Fusion

1. Pumped Dam
2. Storage Dam
3, Semi-Sub System
4. Frequent Flow
5. Constant Flow
6. Partial Run
7. Run-of-River
8. Micro-Run System
9. Multi-Micro Run
10. Run-of-Stream

1. Parabolic Dish
2. Parabolic Trough
3. Photovoltaic Fin
4. Central Receiver
5. Focused Array
6. Power Tower
7. Salt Gradient
8. Altitude Cell
9. Suborbital Cell
10. Orbital Cell

Wind

1. Horizontal Axis
2. Vertical Axis
3. Darrieus Design
4. Dispersed Grid
5. Multi-Fan System
6. Multi-Mini Fan
7. Octal Fan System
8. Multi-Layer Grid
9. Connected Grid
10. Dodecahedral Fan

Geothermal

1. Hydrothermal
2. Single Flash
3. Double Flash
4. Dry Steam
5. Binary Cycle
6. Hot Brine
7. Hot Dry Rock
8. Deep Hot Rock
9. Magma System
10. Deep Magma

Wave

1. Surface Follower
2. Duck Float
3. Floating Tank
4. Water Column
5. Focused Column
6. Cathodic Barrier
7. Dispersed Grid
8. Direct Turbine
9. Mini Turbine
10. Run-of-Wave

Transformers

1. Copper Cable
2. Optical Cable
3. Gold-Capped Node
4. Gold Glaze Cable
5. Superconductor
6. Cool Super-C
7. Warm Super-C
8. Microwave Beam
9. Laser Carrier
10. Satellite Beam

Capacitors

1. Copper Cell
2. Zinc Cell
3. Zinc Gel-Cell
4. Magnesium Cell
5. Sodium Cell
6. Potassium Cell
7. Gold Liquid-Cell
8. Platinum Liquid
9. Gold Ell-Cell
10. Platinum Gel

Generators

1. Steam Converter
2. Steam Tower
3. Vacuum-Sealing
4. Twin Piston
5. Quad Piston
6. Direct Heat
7. Octo Piston
8. Magnetic Turbine
9. EM Turbine
10. GPE Drop-System

Refinery

1. Hydroskinning
2. Integrated Cut
3. Atmospheric Cut
4. Catalytic Reform
5. Molecular Shift
6. Dry Chemical Cut
7. Bio-Mineral Cut
8. Bio-cracking
9. Bacterial Cut
10. Enzyme Cracking

Designers' Notes

We are big fans of many business games, but have especially fond memories of a type that is seldom seen these days — the *oil tycoon* games. These cast you as a wildcatter, trying to build an oil company, and thereby make a million or six. They were smallish games because they remained focused on one task — oil production and sales — but they were lots of fun. We wanted to recapture that fun, and to enhance it with new elements like empire-building, changing technology, and fierce competition.

At the same time, it struck us that the energy crisis seems to be "old news," even though the speed at which we're using up the world's fossil fuels still seems to be accelerating. In practice, as much of Asia becomes significantly better off over the coming decades, consumption of electricity per head will grow exponentially, given the high population growth in these nations. Unless major new sources of energy are found and used, a crisis seems inevitable not too many years from now. Ever keen to see the silver lining to a dark cloud, it struck us that this represented a major strategic challenge to the world — what better subject matter to incorporate right into our new game?! So **PowerHouse** was born.

PowerHouse is unique in that it combines a compelling storyline with an expanded business empire/energy game; it is the only game to cover all nine major energy sources, and adds research into new technologies (some still only theoretically possible at the time of writing).

Another exciting element of this game was the ability to use realistic data for quite a bit of the underlying model. Data on worldwide population growth and per capita energy consumption, as well as the basic costs and revenue streams of the energy industry, are fascinating as well as rewarding to include. But don't worry! We have used the realistic data as a base for our model, rather than using all the tables exactly as is, so as to ensure that every game you play will be different. This is no "puzzle" to be worked out, but an open economic game with more than a touch of realism.

One of our first decisions was to render the game in Super VGA graphics; not only would this give the game that crisper, cleaner look most strategy gamers are so fond of, but also, by allowing us to present more data or icons on each screen, it would allow us to build a streamlined, more intuitive interface made up of fewer screens. We also decided to make the game turn-based, in response to customer requests.

Another early decision was to simplify the number of tasks the player has to do each turn. Our own *Air Bucks* offers the power of more flexibility, for example *allowing* the users to set prices, but at the same time it *requires* you to set the prices. With **PowerHouse**, we've worked hard to create a game which offers you significant decision-making ability, without *requiring* such an enormous micro-management burden. We make games, not spreadsheets with graphics (*that* market is *way* too competitive for us!!)

At the same time, we have strived, too, to maintain the almost unsurpassed feedback and information supply of *Lords of the Realm*, to enable you to make decisions in the game based on sensible facts. The game lets you know *why* things happen a certain way, allowing you to focus on working out how you want to improve the situation.

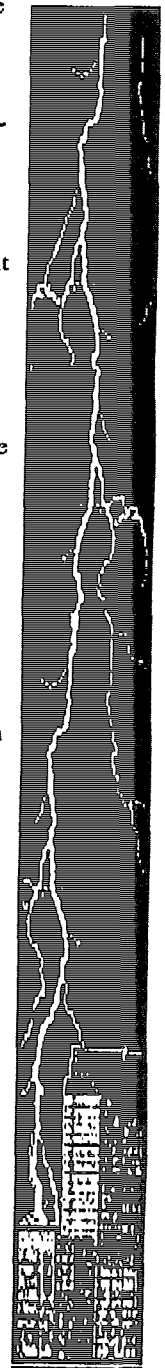
Ever since we launched *Air Bucks*, many of our users have asked us to produce Windows versions of our games. We had not done so prior to **PowerHouse**, since the graphics overhead of Windows would slow our games to a crawl. As we were starting to code **PowerHouse**, though, *Microsoft* began showing off WinG, a device which lets developers get back much of the speed of DOS from within Windows. **PowerHouse** seemed like the perfect game for our first major Windows product (with its turn-based structure, SVGA graphics and tile-based terrain map) so, for those of you who have been waiting so long, you time has come.

PowerHouse is also very much a CD game, as it includes full-motion video, photographs, and professional voice acting (i.e. speech!). All of the ENN reports, for example, are video-based, using a combination of filmed actors and file footage of real generators, oil rigs, and the like.

We have also worked hard to ensure that the computer opponents give you a good run for your money.

The result of our work goes far beyond the old "energy baron" games by providing a rich blend of building, power grabbing, and cutthroat competition. When we set out to make a business game, we *mean* business!

David Lester & Chris Foster



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Module 2

Day 4

Carlsbad Highlands Case

Instructor's Manual:
Bank of America and the Carlsbad Highlands Foreclosure (A, B)

Abstract

The (A) case focuses on the dilemma faced by Bank of America executive Jim Jackson when the bank acquired in foreclosure a parcel of land in San Diego County ("Carlsbad Highlands") whose development was constrained by an endangered species listing. The decision at hand was: What should the bank do with the property, which had an appraised value far below the amount of the bank loan? This question had to be answered in the context of a sophisticated, although new, bank policy on environmental stewardship; a long history of controversy surrounding the Endangered Species Act and its interpretation; and a complex multi-species conservation planning process underway in San Diego County at the time. The (B) case describes the outcome of the (A) case: the creation, from the Carlsbad Highlands property, of the nation's first "conservation bank." A conservation bank is a parcel of habitat that is actively managed for its natural resource values. The benefits of this management are sold as "credits," with regulatory preapproval, to developers to mitigate environmental impacts to sensitive habitat.

Courses and Levels

This case is designed for use in upper-division undergraduate or graduate level courses in Business and Society, Environmental Management, Business Ethics, Public Policy, or Real Estate.

Case Analysis

The immediate issue in this case is how the bank should handle property it owns whose use is restricted by an endangered species listing. The broader issues concern societal and corporate strategies for integrating the values of economic development and environmental sustainability, and the role of market mechanisms in promoting conservation. The challenge for students--as it was for the Bank of America--is to develop an innovative, collaborative solution to a complex, multiple-stakeholder problem.

Research Methods

This case was prepared based on a review of publicly-available documents, press reports, and interviews with federal and state regulators, bank officials, and a consultant who helped

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negotiate the implementation agreement. The final case was reviewed for accuracy by James M. Jackson, Vice President of Bank of America, who granted permission for its publication. The case has benefited from the comments of anonymous reviewers from the Western Casewriters Association and the North American Case Research Association and of participants in the 1996 annual meeting of the Western Casewriters Association, where the case was presented. It has been classroom tested in the author's class at San Jose State University, "Managing Environmental Issues."

Discussion Questions - A

QUESTION 1: What is the problem here, from the perspective of: Bank of America, the US Fish and Wildlife Service and California Department of Fish and Game, environmentalists, and developers with mitigation requirements, such as Caltrans?

From the perspective of Bank of America, the immediate problem is its acquisition of property in foreclosure whose value has dipped far below the amount of the mortgage loan, threatening a loss to the bank of over $6 million. The bank's primary concern is to avoid or minimize its loss on this loan. Secondarily, B of A is also institutionally committed to a strategy of environmental stewardship and, specifically, to a goal of encouraging "economic activity that respects preservation of natural habitats and biological diversity." The bank's environmental officers are interested in developing initiatives to achieve that goal and may see the Carlsbad Highlands foreclosure as an opportunity to do so.

Regulators are charged with enforcing federal and state environmental laws protecting endangered species within the context of new initiatives at both the federal and state levels of regional conservation planning. Within this context, they are interested in streamlining the complex process of reviewing individual permit applications from developers and others. Regulators have an interest in developing a market for conservation values, if it will facilitate region-wide planning.

For their part, environmentalists are primarily concerned with assuring the survival of endangered and threatened species and conserving the habitat on which they depend. The established system of piecemeal, case-by-case mitigation has been unsatisfactory because it has resulted in the set-aside of fragmented, poorly-managed parcels of habitat. The environmentalists' goal is the establishment of sizable, well-managed nature preserves.

Developers are interested in simplifying the permitting process, avoiding regulatory delays, and minimizing costs. They do not want to be bothered with shopping for mitigation property and securing regulatory approval--a process that is fraught with uncertainty and can take six months or more. In particular, they seek to avoid taking title to property that they have no interest in owning, just to satisfy a mitigation requirement.

QUESTION 2: What are Jim Jackson's (and Bank of America's) options with respect to the Carlsbad Highlands property? Identify at least three options and state their possible advantages and disadvantages.

The three most obvious options for this property, as described in the final section of the (A) case, are:

1. Land speculation. Sell the property to a developer willing to speculate that at some point a change in the regulatory environment will create an opportunity to build homes on the property.

Advantages: The bank might get rid of the property quickly.

Disadvantages: The bank would take a significant loss (as high as $6.7 million) and would run the risk of being indirectly responsible for further environmental degradation to the property. The bank might not find a buyer at any price.

Note: A variation on this option would be for the bank to hold the property for a period of time, betting that the regulatory environment would change, lessening environmental restrictions on the property. The land could then be sold to a developer at a higher market price. In effect, the bank itself could speculate with the property. This strategy would be risky, given the high degree of uncertainty in the regulatory environment.

2. Agriculture. Sell the property to a farmer to raise tomatoes or another agricultural crop--the property's original use. Jackson estimated that the property might be worth $2.1 million as farmland.

Advantages: The bank would take a smaller loss ($3.5 to $5.8 million, depending on the price). The City of Carlsbad is supportive. The sale could proceed quickly (a willing buyer is already at hand).

Disadvantages: Given the environmental restrictions on the property, a farmer willing to buy the land might not obtain the necessary permits. Some environmental degradation would result.

3. Mitigation. Sell the property, or portions of it, to one or more private developers or public agencies with mitigation requirements.

Advantages: The property probably has higher value for conservation than for either of the other two possible uses. This use would also result in complete preservation of habitat.

Disadvantages: Potential buyers (e.g., Caltrans) are uncertain about whether or not the property will be approved by regulators. It would be difficult to sell small portions of the land to developers with small mitigation requirements. There is no established market for conservation values, making it difficult to estimate the value of the property as habitat.

QUESTION 3: Evaluate these options with respect to the bank's financial goals.

The bank seeks to avoid or minimize financial loss on its loan to the Carlsbad Highlands developer, who has defaulted.

1. Land speculation. The appraiser estimated a price for such a use at $112,000. This is a low estimate; the price could be considerably higher. Jackson could solicit a second appraisal, but it is unlikely to be very useful. Jackson has no way of assigning a definitive value, short of finding a willing buyer; he does not now have such a buyer.

2. Agriculture. This option is be worth somewhere between $1 million (the value of the offer on the table) and $2.1 million (Jackson's estimate based on $8,000 per acre), if federal and state agencies are willing to authorize construction of a farmer's ranch home and farm buildings. The City is favorable to this option, but it is not the government agency that must provide the permits.

3. Mitigtion. Jackson does not know the value of the property for mitigation. A nearby property, superior in its conservation values, sold for about $13,000 an acre. If sold for the same price, Carlsbad Highlands would fetch about $3.4 million. However, since CH has fewer nesting birds, is only 40 percent coastal sage scrub, and is degraded by dirt biking, its value for mitigation could be less. (If the CH property were sold at 40 percent of the price of the neighboring property--on the assumption that it contained only 40 percent coastal sage scrub--the price would be about $1.4 million.) This option also entails significant costs in time, as Jackson or other B of A managers would have to work with developers to secure regulatory approval.

QUESTION 4: How do these options fare, when evaluated against the bank's environmental principles and goals?

The bank's goals include protecting natural habitat and biological diversity. Developing the property for housing would be most destrutive of habitat and would threaten at least one nesting pair of ESA-listed gnatcatchers. Farming would be less destructive, although it might entail clearing land used by the nesting pair. Clearly, selling the property for mitigation is most consistent with the bank's stated environmental values. If the bank can go further and establish an institutional model or precedent that will help establish a market for conservation values, it will have made major progress towards its fourth environmental goal.

Teaching Tip: One way to approach the class discussion up to this point would be to write the three options along the left hand side of the board and then create four headings: advantages, disadvantages, cost (range), and environmental impacts. These notes can then provide the basis for a full class discussion of the following question.

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QUESTION 5: If you were Jackson, which option would you select and why?

Jackson's primary objective is to minimize the bank's loss on the loan. His secondary objective is to meet the bank's environmental goal of habitat preservation.

Students will probably conclude, based on data in the case, that the best option for Jackson is to attempt to sell the property for mitigation. This option is clearly superior with respect to the bank's environmental goals. A mitigation sale will also probably generate the smallest loss for the bank. However, given the high degree of uncertainty involved in costing out all three options, some students may argue either for selling to a farmer or to a land speculator.

QUESTION 6: What actions should Jackson take to implement his plan successfully?

In many respects, this is the hardest question. Most students will conclude that Jackson should try to sell the land for mitigation. Only the very best students will make the conceptual leap that Jim Jackson and other officers of Bank of America did in formulating the innovative solution of a conservation bank, described in the (B) case.

The core issue here is: What does Jackson (and the bank) need to do to market Carlsbad Highlands successfully and quickly as mitigation property?

One way to approach this question is to ask students to review their responses to Question 1, focusing on the key objectives of the stakeholders. This review can be used to focus attention on the following issues that Jackson's solution must address.

Government preapproval: Developers want to buy conservation value (for mitigation) and the bank wants to sell conservation value (its Carlsbad Highlands property), but neither can complete the transaction without the active involvement of the government. Since the government created the market for conservation values through its regulatory authority, it must be involved in sanctioning market transactions in conservation values.

In order to implement a successful mitigation sale, Jackson will need to seek government preapproval for sale of Carlsbad Highlands. This will require negotations with government regulators and coordination with the ongoing process of habitat conservation planning already underway in San Diego County.

Management of the property for its conservation value: Developers need to buy conservation value (for mitigation), but they are uninterested in the actual day-to-day management of mitigation property. The bank, similarly, wants to sell conservation value, but has no interest or expertise in managing a nature conservancy. Environmentalists, for their part, have an

interest in the establishment and longterm management of nature preserves, as well as expertise. Who should manage the property? This discussion suggests that a third party, perhaps an independent conservation group such as the Nature Conservancy, should be called in to provide ongoing, professional management of the property to enhance its conservation value.

Mechanism for purchasing conservation value without purchasing land: Developers need to buy conservation value, but have no interest in actually owning the land, both because of the management issue (above) and also because of various transfer costs involved. This discussion suggests that the bank should establish an institutional mechanism to enable the sale and purchase of conservation value (for mitigation) without transfer of the land outright.

Students should be pushed to consider what kind of institutional mechanism could address these concerns. A possible answer: establish a professionally-managed preserve and sell "credits" or "shares" in the preserve to developers to meet mitigation requirements, with regulatory preapproval. This solution would meet the needs of diverse stakeholders by creating an institutional mechanism, sanctioned by regulators, for the bank to sell conservation values (mitigation) to developers.

Epilogue - A

Jim Jackson's initial assessment of the problem posed in the (A) case was that the optimal use for the Carlsbad Highlands property was as gnatcatcher habitat sold for mitigation. However, he recognized that his problem was complicated by the fact that no established market for conservation values existed. His initial efforts to sell pieces of the property to developers seeking mitigation property (e.g., to Caltrans) were thwarted by buyer uncertainty over whether or not regulators would approve the land for mitigation purposes. At this point, Jackson decided to seek preapproval of the land's use as mitigation from the appropriate regulatory agencies.

Jackson described the brainstorm where he realized the need for government preapproval of mitigation property:

"I kept thinking to myself--try to think outside the lines...The process of trying to sell property to Caltrans was what really convinced me how screwed up the system was. Caltrans was involved in a guessing game. They'd go out and find some property for mitigation, and they'd take it to the feds, and the government would say, 'no, that's not right, just three bushes and two birds, keep looking.' It was like that kid's game, 'I'm thinking of a color.' It made me realize that we needed a preapproved bank, something that would take the guessing out of it. I realized if we could do that, we'd really have a product to sell, a superior product. Our property would get preferential treatment in the marketplace. I wanted to be able to offer the best product in the mitigation marketplace. It was basically a marketing decision."

Once he had decided to seek preapproval, Jackson sought institutional support from the bank's Department of Environmental Policies and Programs in San Francisco. The bank's environmental staff brought in a consulting firm, Mike McCollum and Associates, that had experience in habitat conservation planning. Over a several month period in 1994 and early 1995, McCollum worked with state and federal regulators (the U.S. Fish and Wildlife Service, California Department of Fish and Game, and the California Resources Agency), environmentalists, developers, and bank officials to develop a framework for establishing the Carlsbad Highlands property as a permanent nature preserve.

The critical innovation that emerged from this process of collaborative negotiation was to designate the Carlsbad Highlands property as a "conservation bank," allowing the bank, with regulatory preapproval, to sell "credits" in the property to developers requiring mitigation. The conservation bank innovation is described in the (B) case.

Discussion Questions - B

The (B) case may simply be handed out in class to students at the completion of the case discussion, to inform students of the outcome of the case. Alternatively, the (B) case may be used as the basis for discussion of the following additional questions.

QUESTION 1: The conservation bank implementation agreement was negotiated by the bank, regulators, and other stakeholders in a process of collaborative negotiation. In what ways did the nature of the problem faced by the bank require a collaborative solution?

One of the teaching objectives of the (A) case is to enable students to recognize that Jim Jackson's problem could not be solved by the bank acting unilaterally. Rather, it could only be solved through collaborative negotiations with multiple stakeholders.

In her book Collaborating: Finding Common Ground to Multiparty Problems (1989), Barbara Gray defines collaboration as "a process in which those parties with a stake in [a] problem actively seek a mutually determined solution" (p. xviii).

In her view, problems for which collaboration offers an advantage over other kinds of decision making may include those where: the problem is ill-defined; several stakeholders have a vested interest in the problem and are interdependent; stakeholders are not already organized; stakeholders have different levels of power or resources; stakeholders have different levels of expertise or information; the problem is characterized by technical complexity or scientific uncertainty; a history of adversarial relationships among the stakeholders; unilateral or incremental solutions may be less than satisfactory; and existing processes are insufficient or may make

the problem worse (p. 10).

Several of these factors appear to have been present in this situation. Points students may wish to discuss include:

Several stakeholders in this case had powerful vested interests. Land values were high, so the bank was threatened by a very substantial loss on its loan. Ecological values were also high, so environmentalists and regulators were very concerned about the fate of this parcel of property.

The stakeholders were highly interdependent. The bank could not solve its problem without government preapproval; developers could not proceed with development without government permits; the government needed the bank or other private landowners to sell property for mitigation, and so forth. A unilateral solution to the bank's problem was not only "less than satisfactory," but impossible.

Teaching Tip: If students have not yet been exposed to Gray's theoretical work on collaborating, they may be asked to develop similar theoretical ideas inductively. For example, they may be asked: What conclusions can we draw from this case about the kind of problems for which a collaborative solution is desirable, or necessary? If the instructor follows this strategy, Gray's theoretical ideas may be introduced after students have concluded their own inductive reasoning exercise.

QUESTION 2: What benefits did the conservation bank have for stakeholders in this case that they could not have achieved through unilateral action?

Gray argues in her book that the "objective of collaboration is to create a richer, more comprehensive appreciation of the problem among the stakeholders than any one of them could construct alone" (p. 5).

In this case, the conservation bank solution entailed benefits to the stakeholders that none of them could have obtained through unilateral action. It offered Bank of America a way to recoup at least some of the losses on its loan in a timely fashion; environmentalists a mechanism for funding a substantial and properly managed nature preserve; and developers a mechanism for complying with mitigation requirements without having to find appropriate property, secure approval, and buy the land. Regulators gained a streamlined permitting process, and society gained conservation at a lower overall cost.

QUESTION 3: What was the role of the bank's environmental principles and environmental strategy in determining the outcome of this case?

The bank provided strong institutional support for the conservation bank solution, in the form of the its Department of Environmental Policies and Programs and its articulated goal to conserve natural habitats. In the absence of these organizational and institutional supports, Jackson would have

been more likely to have followed "the path of least resistance" and to have sold the property to a land speculator or a farmer.

QUESTION 4: Based on the information in the (A) and (B) case, in what kinds of situations are conservation banks most likely to emerge?

This is a speculative question, because Carlsbad Highlands was the nation's first conservation bank of its type. However, the case does permit students to make some inferences about the kinds of situations in which conservation banking is likely to be most widely used in the future. Several features of this situation may have been critical. First, land values in San Diego County were very high, so the landowner (here, the bank) had a strong incentive to sell the land, and developers had a strong incentive to satisfy their mitigation requirements so they could develop environmentally sensitive property. Second, ecological values also were high, so environmentalists and regulators had a strong incentive to conserve the land. Finally, the presence of the Natural Communities Conservation Program (the NCCP) meant that this particular conservation bank could be integrated into an ongoing regional planning process.

QUESTION 5: Some observers have argued that regulators ought to make more use of <u>market</u> <u>mechanisms</u> as a tool for achieving environmental protection. Do you believe that conservation banking is an example of a market mechanism? Do you believe that this approach will work better or worse than other approaches to species protection?

Conservation banking is an excellent example of the use of the market to promote environmental goals. By establishing an institutional framework for the purchase and sale of shares of conservation value, as described in the (B) case, government regulators provided economic incentives for a major landowner (the B of A) to set aside land for conservation and for developers to provide funding for a conservation effort. Credits in the bank are priced by the market, not by regulatory fiat. However, it is important to note that the market for credits would not exist without the regulatory authority of the government, under the Endangered Species Act and related state laws, to compel developers to mitigate the development of ecologically sensitive property.

<u>Epilogue</u> - <u>B</u>

As of October, 1995, the bank had sold conservation bank credits worth $1.1 million to Caltrans and almost 35 acres to various other parties. Jackson estimated that the bank might net $16,000 per acre when all credits had been sold, for a total of $4.2 million for the Carlsbad Highlands property. Thus, Jackson estimated the final cost to the bank as a loss of about $2.6 million on the loan and about $150,000 in development costs for the conservation bank (as compared with the appraiser's estimated loss of $6.7 million). Benefits to the bank included positive publicity for its environmental leadership and an institutional

model that might allow it to become a leader in establishing a market for conservation values. Statewide, the California Resources Agency's official policy on conservation banks had been used as the basis for establishing several other similar conservation banks elsewhere in California.

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Module 3

Day 4

"Jungle Survival"

Step 3: The Expert Ranking & Rationale

NOTE: As you give the participants the expert ranking, ask them to mark each number next to the appropriate item in the third column under "Step 3 — Survival Expert's Ranking" on their worksheets.

About the Expert

H. Morgan Smith is the former director of the Arctic, Desert, Tropic Information Center, a research and operations office supporting military and civilian aviation Mr. Smith is a specialist in crosscultural communication, public relations, and unconventional operations. He has 37 years of experience, 28 with the U.S. government. Fluent in Spanish, he has worked in Central and South America with presidents and remote tribal leaders. He is a fellow of the Explorers Club and has participated in over 70 expeditions to remote regions. He has authored more than 20 articles, manuals, and congressional briefs in support of international aviation and has established emergency survival training centers in six South American nations. Mr. Smith's ranking of the survival items follows.

1. *Machete*

   This is an all-purpose tool. With it you can do everything that is absolutely necessary for your survival. You can use it to dig holes and cut vines and other plants for water and food. It can be used to cut branches and palms for fire, beds, and shelter at night. If you eventually need to build a raft, you can use it to cut bamboo, balsa wood and vines into strips and then lace them together.

   Although the floor of the rain forest gets little light and vegetation is sparse, the machete is crucial for moving through the dense foliage by the river. Following the river is your quickest and most effective way to find civilization or be spotted by a rescue crew because this is the only place where there is an opening in the jungle canopy.

2. *Disposable Cigarette Lighter*

   In the rain forest, a fire is not only desirable, but important for survival. The lighter is necessary since it is nearly impossible for an amateur to start a fire in the dampness without it. Although the daytime temperature is around 75-85°, nights in the jungle are surprisingly cool. Fire can aid in food preparation and in de-toxing poisonous plants for food and first aid. Although hanging vines contain pure water, it is more difficult to extract. Having a fire will allow you to purify any water you find by boiling it. Cooking also removes the poison in some plants. As a preventative measure, anything you consume should first be tested in small quantities to avoid serious illness. The fire helps to keep the biting bugs away, which can become physically and psychologically unbearable.

   Although its signaling effectiveness is minimal, the smoke from the fire may be spotted in a clearing when you are traveling near the river.

   The psychological comfort that the fire provides is one of the greatest assets for the survivors.

3. *Gift Wrapped Decorative Candle (3" circumference)*
Since fire and traveling are both important, so is the candle. If the group decides to stay at the crash site, the candle's importance would be diminished because once a fire is started, it can be kept going. Since you will need to light numerous fires, the lighter may not last long. The candle greatly increases fire-producing capabilities and, therefore, survival chances. The wrapping paper can also be used to start the first fire. The candle is easy to work with and provides a steadier flame for first aid and disinfecting.

4. *Plastic "Space Blanket" (7' × 5½')*
This is also a multi-use item which will make survival not only achievable, but also more comfortable. The space blanket can be used as a carrying pack for water, food, and other items as the group travels during the day. At night, the space blanket can be rigged above the campsite to help start and protect the fire. Building a fire and keeping it going is critical to your survival. The space blanket is large enough to cover the fire and at the same time provide temporary shelter to the group as you huddle around it. It helps to bring the group together as you dry wood and clothing, or prepare food.

Since walking out of the jungle is important, your feet become one of your most important assets. If your feet remain wet for very long, you can develop "immersion foot," which can lead to "trenchfoot." This condition can easily disable someone as the skin of the feet becomes severely shriveled and begins to decay. It is important that you air out your feet by allowing them to "breathe." The fire and the shelter that the space blanket provides will help with this and will dry your shoes as well.

The reflective side of the space blanket could also serve as a signal on the river.

5. *Bottle of Liquid "GI-Type" Insect Repellant (2 oz.)*
Protection from insects, especially mosquitoes, ticks, and ants, is important for physical and psychological survival. These insects can be overwhelming in the tropics. This one small bottle of repellant, manufactured for the Army, is enough for six people and will last for three or four days when smeared over exposed skin. The insect repellant will be extremely important the first day since the survivors need to stay calm and rational to make crucial decisions.

6. *First Aid Kit*
This has many uses but is not as important as the items which aid in traveling and starting fires. The antiseptic in the kit guards against the infection of cuts and bites. The gauze can aid in rigging a shelter, but is not always necessary for minor cuts in the tropics since they need to breathe. The kit is ranked lower than the other items because the small amount of healing ointment available will not impact survival chances as much as the previous items. As long as wounds are kept clean, they will heal rapidly in the tropics.

7. *7 Large Green Garbage Bags*
   These can serve many of the same uses as the space blanket, but they are ranked lower because they are not as effective against rain, are not as sturdy, and are useless for signaling because they are green. It would be tempting to wear them as ponchos during the day, but thorns and branches would soon rip them to shreds and render them worthless. It is best to save them for nighttime. They will help keep you warm and dry, and protect you from insects while you attempt to rest for the next day's journey.

8. *1 Box of Granola Bars*
   The events that occur in the first few hours immediately following the crash will have a critical impact on the group's ultimate survival. The granola bars would serve to defer panic and fear of starvation at first. They are also an energy source while you make your plan of action for rescue. As with the insect repellant, this item is important to help keep the group rational while making decisions. Of course, insect repellant is more important because the first thing you will notice is the bugs, not your hunger. Also, once you become accustomed to the rain forest, you will discover that you will be able to relax and find enough food to survive.

9. *1 Gallon Thermos (empty)*
   This can be used to carry water, food, and other items as you travel. It could also be used as a floatation device if crossing a river becomes necessary. The most important use for the thermos is to carry purified water. Your jungle trek will be difficult, exhausting work; you should have water readily available when needed. Water can be boiled each night to fill the thermos for morning.

10. *Snake Bite Kit*
    Contrary to popular belief, poisonous snakes in the jungle pose little threat to humans and are seldom, if ever, seen. (If snakes are seen, however, they are easy to capture and can serve as a protein-packed food source.) But the kit has some other uses. It contains a suction cup that can serve as an eye wash cup to help remove objects from the eye. It also contains a small, very sharp knife which will aid in removing irritating thorns and splinters which may lead to serious infection.

11. *3 Golf Clubs*
    With the rain constantly coming down, the rain forest floor is extremely slippery for traveling. The golf clubs could be useful as walking sticks for anyone who gets injured or for the less stable survivors. Since the group must travel, the odds of someone falling and getting hurt greatly increase. A sturdy walking stick will help decrease the chances of this happening. The golf clubs can also be used to beat down the thick vegetation as you get near the river or to forage for food.

    Additionally, the golf clubs could be used to rig a shelter or a splint in the event that someone does get hurt.

12. *.38 Caliber Pistol (loaded)*

The wild animals are more scared of you than you are of them. A pistol is not needed for protection and could do more harm than good in a tense survival situation. Bullets can be used to start fires, but it is difficult and dangerous to get to the powder without a pair of pliers. At any rate, the devices you already have are more efficient to start a fire. As a signaling tool, the pistol is fairly useless because sound will not travel very far in the forest. You could get the attention of local people, but the chances of signaling a rescue plane are minimal. Although you could hunt with the pistol, meat is hard to find, and one can survive on the vegetation alone.

The pistol's advantages are counterbalanced by its very dangerous disadvantages. The people who inhabit the area, mainly the Choco Indians, are friendly and have been known to lead stranded people to safety. Having the pistol with you could alarm these people and, with some tribes, could mean the difference between life and death. The group must use extreme caution and good judgment. The chances of a person becoming irrational and dangerous are great in such a stressful situation. Having a dangerous weapon around could lead to a greater disaster than you already are facing. A wise decision is to give the pistol to one person and the ammunition to another. This could prevent accidents and irrational moves but would not change the ranking of this item.

13. *Portable Transistor Radio*

The radio will soon be useless in the wetness but could pick up a remote station for a short time. It could provide psychological comfort, but little else. There is absolutely no way to send signals with it. Once unworkable, it could be dismantled, and the internal pieces could be used for fishing hooks and lures

14. *1 Quart of Rum*

This item could be used for trade with the local people or as an empty container for carrying water. However, its potential harm outweighs these uses. If anyone drinks it, the alcohol could cause irrationality and is better discarded at the crash site than carried along. It is not useful as an antiseptic either, since the alcohol is not pure. Also, the chance of it being useful in starting a fire is limited because it contains water and other ingredients besides the flammable alcohol.

15. *Compass*

The compass may or may not be accurate in the forest since it is possible that it will not maintain magnetic North in this terrain. The mountainous terrain contains iron deposits which may interfere with the accuracy of the compass. **Even if it did work**, it would be dangerous and futile to follow it since you do not have a map or an accurate perception of where the plane crashed. It is important to follow the downward flow of water on the ground, not a north, south, east, or west direction. By doing so, you will eventually come to a large river. The only use for the compass would be to trade with the local indians in hope that they will guide you to a large river or to civilization.

5. Some answers are:

- Results of customer focus groups' requesting "environmentally friendly" products
- Publicity of competitors' economic success with TQEM
- Legislation requiring pollution prevention
- Inclusion of environmental quality criteria, such as those required by the Malcolm Baldridge Award, ISO-9000, and Ford Q-1.

The matrix at the end of this compendium's Resource List indicates 20 books and articles on TQM and industrial engineering.

Further information on quality awards can be obtained from the following organizations:

Malcolm Baldridge National Quality Award
A537 Administration Building
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001
301/975-2036

ISO 9000
CEEM Information Services
10521 Braddock Road
Fairfax, VA 22032
800/745-5565

Ford Q-1
Ford Motor Quality Publications
c/o EDCOR Data Services
P.O. Box 9079
Farmington Hills, MI 48333-9079
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• E-mail: nppc@umich.edu

The mission of the NPPC is to promote sustainable development by educating students, faculty, and professionals about pollution prevention; create educational materials; provide tools and strategies for addressing relevant environmental problems; and establish a national network of pollution prevention educators. In addition to developing educational materials and conducting research, the NPPC also offers an internship program, professional education and training, and conferences.

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We may also update the NPPC information available through gopher (gopher.snre.umich.edu) and anonymous FTP (ftp.snre.umich.edu). Please contact us if you have comments about our online resources or suggestions for publicizing our educational materials through the Internet. Thank you!

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Module 1

Day 5

Introduction to TQM

For the Instructor: Teaching Note on "Total Quality Management: A Methodology for Pollution Prevention"

Purpose

This exercise is designed for inclusion in an introductory Total Quality Management course. The material requires between 50 and 80 minutes of class time for discussion of the articles and case study. The reading material should be assigned to students prior to class. There are in-class discussion points as well as homework questions.

While designed for industrial engineering students, the material is appropriate for other engineering students and business school students (both undergraduate and graduate levels). Students should have a familiarity with the concepts of customer focus, continuous improvement, teamwork, and strong management commitment prior to the class.

Answers

1. Students should mention some of the following:
   - Customer focus calls for reduction of waste.
   - Root-cause analysis prevents waste rather than controls it.
   - "Zero waste" is analogous to "zero defects."
   - Deming's principles call for elimination of waste.
   - Continuous improvement of process waste also identifies quality issues.
   - Team approach encourages different perspectives on the problem.
2. Potential answers include:
   - Plant workers
   - People downstream from plant who use the river for drinking water
   - Fish downstream from plant
   - Birds dependent on fish for food
   - Fishermen
   - Farmers who use river water for irrigation
   - Children playing near dump (land or water)
   - Asthmatics downwind from plan
   - Homeowners near the plant who want to sell their houses
   - Nearby residents who are allergic to pollutants (air or water)
3. It doesn't get to the root of the problem. It controls existing waste rather than finding ways to prevent it. It is reactive to regulation rather than proactive. Also, environmental engineers are not familiar enough with the processes to suggest improvements.
4. The team approach allows more factors of the environmental issue to be considered, because more staff are contributing specialized knowledge of the various processes that affect those issues.

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5. Some answers are:

- Results of customer focus groups' requesting "environmentally friendly" products
- Publicity of competitors' economic success with TQEM
- Legislation requiring pollution prevention
- Inclusion of environmental quality criteria, such as those required by the Malcolm Baldridge Award, ISO-9000, and Ford Q-1.

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Module 2

Day 5

I.H.P.Case

WORLD RESOURCES INSTITUTE

Management Institute for Environment and Business
A program of the World Resources Institute

International Hardware Products, Inc.
Considering an ISO 14001 Environmental Management System

Teaching Note

The Management Institute for Environment and Business (MEB) is a Program of the World Resources Institute (WRI) that makes business people contributors to environmental progress. MEB helps universities, graduate schools and corporations integrate environmental issues into their educational programs, and provides new thinking about the relationship between business and the environment. To order this case please contact WRI Publications at 1-800-822-0504. For further information or reprint permission, write MEB, 1709 New York Avenue, NW, Washington, DC 20006 or fax (202) 737-1510.

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The IHP case provides an excellent overview of the ISO 14001 Environmental Management Specification Standard and the issues a company faces in choosing to adopt the standard. It also begins to address some of the issues in implementing the standard by providing the foundation for class exercises and discussion wherein the students write an environmental policy statement, identify environmental aspects, and think about possible objectives and targets.

We often use the case over two class periods. During the first session, we have the participants come to class with the case read and prepared. We then discuss the nature of the ISO 14000 and 14001 standards, the situation of IHP, and the relative advantages and disadvantages of adopting the standards (in general and for IHP). Then, we discuss the nature of environmental policy statements, provide some examples, and have the students write a policy statement for IHP for the next class. In the second class, we have them present their policy statements to the class and discuss them as described in the "Student Assignment," which follows. Then, we discuss issues related to identifying environmental aspects and formulating objectives and targets in relation to the significant aspects. This may also be done as a group exercise wherein the groups write objectives and targets. We then conclude with a short discussion about the remainder of the requirements for the standard including issues such as documentation, and training.

This teaching note was prepared by Professors Thomas J. Dean and Gerald E. Fryxell of the University of Tennessee at Knoxville as the basis for class discussion rather than to illustrate either effective or ineffective management strategies. While the case is based on consulting work with the company, the company's identity has been disguised. *Copyright World Resources Institute © 1997.*

Student Assignment and/or Discussion Questions

1. Summarize the benefits and costs associated with implementing an ISO 14001 environmental management system in general, and more specifically, at IHP. Which considerations would be most important to IHP corporate executives in deciding whether to fund ISO certification at the Tennessee facility?

Benefits

- Customer Requirements or Preferences. If the ISO 14001 standard is widely adopted, certification may become a prerequisite for doing business in this country and abroad. Many industrial buyers, especially those in the European Community, are expected to require or prefer their suppliers to be certified to the 14001 standard. ISO 14001 certification may also become a necessity in certain markets and industries. For example, ISO 9001 was adapted by the U.S. automobile industry as the QS 9000 standards which the large automobile manufacturers then imposed on their suppliers. Thus, IHP may want to demonstrate compliance with the standard in order to meet the present or future preferences or requirements of its customers. IHP corporate should make an assessment of the extent to which its domestic and international customers will expect certification, as well as the extent to which its competitors are currently pursuing certification. IHP could achieve a first mover advantage by being one of the first in the industry to pursue certification. However, it is currently unclear whether IHP's customers will require or prefer ISO 14001 registration. Indeed, there is not any current indication that its customers care. This is contrary to what is currently occurring in many other industries.

- Cost Savings. IHP may wish to save on the costs of compliance with environmental regulations by addressing environmental issues in a more cross-functional and integrated manner than it has done previously. Implementing an EMS may substantially reduce the costs of environmental management activities at IHP. Companies that have implemented proactive, cross-functionally integrated, and culturally supported environmental management systems have claimed substantial savings. For example, 3M believes it has saved over $500 million through its Pollution Prevention Pays program. Beyond more effective compliance, the implementation of pollution prevention, safe substitutes, waste reduction, and recycling techniques can yield substantial savings. An EMS is a tool for systematically addressing such issues and achieving associated savings. Finally, an EMS may reduce the probabilities of environmental crises and violations and the associated risks and liabilities (which can be substantial). Clearly, avoiding noncompliance, cleanup costs, and lawsuits are in IHP's best interest.

- Executive Protection. Implementation of an EMS may both reduce the risk of corporate officials facing criminal charges for noncompliance and reduce penalties associated with such charges. A current trend in regulatory enforcement is to take criminal action against corporate officials responsible for their organization's environmental damages. Such charges have resulted in prison sentences for corporate officials. Pointing this out would be an effective way for Rick to get top management's attention. This may be especially pertinent because IHP's corporate environmental policy clearly attempts to "pass the buck" of environmental responsibility down to the division and facility managers. We enjoy making this point by asking the students if they know of the existence of the new executive position in corporations, the "CJO." The point usually hits home when we inform them that this refers to the "Chief Jailable Official."

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An ISO-certifiable EMS may avoid such problems in two ways. First, having a proactive, integrated EMS will likely reduce the probabilities of noncompliance and environmental crisis. Second, establishment of an EMS shows commitment and good faith effort on the part of management, and such efforts are considered in Department of Justice sentencing guidelines.

- Improve Environmental Performance. IHP may wish to use its EMS to improve the environmental performance of its operations. Such a system will likely serve to further focus efforts on environmental issues and reduce wastes and discharges to the environment. Improved environmental performance can improve the conditions of the local community, the ecology, and the reputation of the firm.

- Company and Industry Leadership. IHP may wish to demonstrate the use of an ISO 14001 EMS in order to serve as a test and example for other company facilities and industry firms. Given that the ISO 14001 standard is in its early stages, IHP could be seen as a leader of facilities within the company and firms in the industry. There may be some significant reputational benefits associated with such leadership. With corporate environmental responsibility becoming more important both domestically and internationally, an EMS will likely become a larger competitive factor. Close reading of the case suggests that this is one of Rick Thompson's primary motivators. He wants his facility to be seen as cutting edge and in the lead of innovation in the company. He may also have his eye on money he can make for his facility as an ISO 14001 consultant to other IHP facilities.

Costs

- External Fees. Despite these potential benefits, management is still very concerned with costs and time commitments. As a cost-conscious supplier in a competitive industry, it can not easily justify the expenditure. There are substantial costs associated with the implementation of an ISO-certifiable EMS. Most obvious are the actual costs of certification by a registrar. Such costs for a firm the size of IHP would run from $20K-$30K.

- Internal Costs. Costs are involved in developing the formal management systems and procedures required by the standards. Employees require substantial training. General administrative costs are necessary to maintain the management system. Typically, these costs can be seven to ten times the external costs. Since IHP has already implemented ISO 9001, some of these costs may be reduced. Regardless, the costs could easily exceed $150K-$200K.

2. *Discuss the IHP ISO 14001 Gap Analysis.*

The gap analysis provides a better understanding of the nature of the ISO 14001 standard. Going through the different requirements provides students with more specific information regarding its content. In addition, the gap analysis clearly points out the differences between a compliance orientation and an EMS as envisioned in the standard. Clearly, IHP appears to be largely in compliance with applicable laws and regulations but is well short of having an ISO EMS. The standard represents a unique perspective that takes the firm out of its compliance orientation into the world of management systems focused on environmental performance and continuous improvement. This realization is perhaps one of the most crucial points of the case. Firms in many segments are achieving substantial savings and making significant environmental performance

improvements through such approaches. Moreover, the ISO standard permits each facility to determine its own objectives and targets. Thus, it can begin addressing those areas in which it sees the greatest return on its efforts, and the facility can be flexible in identifying the method it will use to reach its targets. This is a radical departure from having a regulatory agency (i.e., EPA or a state equivalent) dictate levels of acceptable pollution and require the use of specific technologies. As such, the standards represent a clear move in the right direction. One way to look at them is as a means of technology transfer wherein adopting firms learn a set of techniques and perspectives that move them in a direction many progressive companies have already gone.

3. In terms of management theory and practice how would you describe an environmental management system as exemplified in ISO 14001?

Despite many of the positive aspects of the ISO 14001 standard, it is important to realize that it may not reflect the most progressive system for managing environmental issues. It relies on a formal, centralized system of written policies and procedures and documentation of activities. This is opposed to current management thinking which focuses on concepts such as decentralization, empowerment, vision, and organizational culture. Instead, the ISO standard requires the creation of a substantial bureaucracy for ensuring the creation of policy, objectives and targets and the system to achieve them.

Nonetheless, ISO 14001 is part of a general movement toward broader stakeholder participation in the management of the firm. It may be interesting to observe that many of the previous sources of legitimacy for granting management a free hand in running its businesses has eroded. Because managers of large companies may not be the dominant owners, for example, it is hard to base their autonomy on property rights alone. Moreover, instances of market failures abound, especially in the area of environmental impacts where externalities associated with the social costs of pollution are often not taken into account in management decision making. Thus, the ISO 9000 and ISO 14000 standards can be considered intelligent responses to the erosion of managerial legitimacy.

4. Write an environmental policy statement for IHP of Tennessee.

We treat this aspect of the case as an assignment to the students. They may either write a policy statement in class as a group exercise or prepare it for the next class period. In preparation for this assignment, we present them with examples of other companies' environmental policy statements, which are often quite extensive. Clearly, they should consider IHP's parent company's environmental policy, but it is clearly lacking (an interesting point in itself; see following discussion) This is also a good time to introduce the students to the CERES (Coalition for Environmentally Responsible Economies) principles, and the International Chamber of Commerce's Business Charter for Sustainable Development. Finally, the ISO 14001 standard clearly states several requirements for the policy statement. The ISO definition of an environmental policy is as follows: "Statement by the organization of its intention and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets."

Discussion of the current IHP corporate environmental policy: Note that the current corporate policy focusses largely on compliance and shows little in the way of enlightened thinking toward managing environmental issues. It is also rather legalistic and attempts to push ultimate responsibility for compliance into the hands of division and facility managers. Indeed, the policy is clearly an attempt to protect upper management from potential liability and prosecution. It is useful to note that the person in charge of the

corporate environmental committee is the firm's lawyer. Finally, and perhaps most importantly, Rick Thompson had to do some research to find IHP's corporate environmental policy. Despite the fact that responsibility for its implementation had been squarely placed on the facility's shoulders, operational managers in the plant were not even aware of the existence of the corporate policy.

After the students have written their statements, you should process their efforts in class. We like to start by having them write them on the board or overhead since they may be rather long. We then discuss them. Some of the issues to address include:

- the extent to which the policy commits the company to activities to which it may not want to be held. In their desire to promote social responsibility, some students will want to commit the company to a course of action that might impede its economic goals or reduce its discretion. It is useful to point out that such policies are subject to scrutiny by company lawyers and others who are careful to avoid overdoing it. This is somewhat of a reality check. You may wish to point out that such issues are what prevented many companies from adopting the Valdez/CERES principles.

- the extent to which the policy meets the requirements of the ISO 14001 standard. The policy requires a written environmental policy that is available to external parties. It also requires the policy statement to address a commitment to continuous improvement of the environmental management system, to comply with all relevant laws and regulations, and to the prevention of pollution.

- the recommendation that the policy should also be of the nature and in the format of a typical policy statement. That is, it should be relatively general and should not set specific goals as found in objectives. We prefer environmental policy statements that have a short two to three sentence statement followed by a set of items that deal with issues such as compliance and pollution prevention. The two to three sentence statement can then be published in various company reports without the remaining detail of the rest of the policy.

- examples of environmental policy statements, such as those from IBM, Procter and Gamble, and Bristol-Myers Squibb, are given in Appendices A - C.

5. Identify some of IHP's environmental aspects.

It is clearly not possible to perform a complete analysis of IHP's environmental aspects based on the information provided in the case. However, it is instructive to have the class discuss some of the various environmental aspects of IHP's operations. The compliance audit, the itemization of waste streams, and the creativity of the students make fertile ground for identifying major environmental aspects. Still, these lists create an activity trap for the students. There is little consideration within any of these lists of life cycle impacts. Life cycle perspectives are crucial to helping companies achieve the true purpose of the standards. After some time focusing on the lists, pointing out that the students have completely ignored life cycle issues may drive the point home regarding the current environmental perspectives of students and practitioners.

The process of identifying aspects also raises the question of how firms would actually go about doing this. There is a firm which has tried to get around the issue by stating that the only "significant" environmental aspects they will consider are those addressed by laws or regulations. While this is in keeping with the letter

of the 14001 standard, it is clearly not in keeping with its intent. Fortunately, the company's belief is that it will look at aspects more broadly once the EMS is put in place. According to the ISO 14004 document a firm should identify environmental aspects by reviewing each of its activities and processes and cataloguing environmental aspects associated with each. This is clearly a comprehensive, but time intensive, process.

In the discussion, it is important to distinguish between an environmental aspect and environmental impact. According to ISO, environmental aspects represent those elements of an organization's activities, products, and services that are likely to interact with the environment. An environmental impact is any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, or services. We are mostly concerned with aspects, since we wish to consider what could happen, not what does happen.

6. Develop some environmental objectives and targets for IHP.

This may also be completed in class, as a group project, or outside of class. Once you have identified environmental aspects, it is a fairly easy task to write associated objectives and targets. This activity may be used to make a several points:

- ☐ Distinguish between objectives and targets.

  ISO definition of environmental objectives: overall environmental goals, arising from the environmental policy and significant impacts, that an organization sets itself to achieve and that are quantified wherever practicable.

  ISO definition of environmental targets: Detailed performance requirement, quantified wherever practicable, applicable to the organization or parts thereof, that arise from the environmental objectives and that need to be set and met in order to achieve those objectives.

- ☐ Teach what proper objectives and targets should look like. The SMART acronym (specific, measurable, achievable, realistic, and timely) may be useful for discussion of targets.

- ☐ Discuss what factors would be considered in ranking the various environmental aspects for setting objectives and targets. Choosing which aspects to set objectives on should be a function of:

  1. The severity and probability of environmental impact (significance)
  2. Potential cost savings from improvement
  3. Priorities evident in the environmental policy
  4. Public perceptions and the impact of improvements on public perceptions
  5. The extent to which the results may be measured
  6. Environmental laws and regulations and expected changes therein.

- ☐ Recognize that one of the dangers of setting objectives is that you tend to get what you measure ("What gets measured gets done"), and the outcome may not be what was expected. It is crucial to understand the effect of setting objectives that have secondary impacts you did not foresee, especially if rewards are placed on their achievement. It is also important to recognize that many

objectives may be in direct conflict with one another. For example, decreasing air emissions may have direct impacts on the quantities of hazardous or solid waste produced.

7. Why did industry lead the way in developing these standards?

If industry doesn't respond to environmental problems, then regulators will. There are already some 15,000 pages of regulations in the United States, so it is unlikely that more regulation is the answer. Obviously, this is already more than most businesses can cope with. Note that ISO 14001 requires that the policy statement specify that a firm will comply with all relevant legislation and auditors will look to see that the firm has a methodology in place for staying on top of current regulations. Beyond this, businesses like the flexibility to determine which environmental aspects they will address and allow the facility or business unit to decide how it will reach specified targets for improvement. In some ways, ISO 14001 is industry's effort to take a more proactive role in heading off undesirable regulatory consequences.

If environmental standards were coming, then industry favored a single standard over a patchwork of standards. As BS 7750 (the British Standard) and EMAS (European Union) standards were emerging, industry was interested in a single global standard. Some of these standards were stricter than that of ISO 14001. For example, EMAS requires firms to make their aspects publicly available.

8. In what ways do the ISO 9000 and ISO 14000 standards differ in influencing business responsiveness? How would standards related to environmental management differ from those focusing on quality?

- ☐ One difference is that ISO 9000 focuses on the customer. ISO 14000, in contrast, focuses more broadly on multiple stakeholder groups (e.g., environmental organizations, regulators, communities, the environment). Indeed, some stakeholder groups may not even be aware of their relationship to a facility (e.g., a neighborhood linked by groundwater to the facility).

- ☐ Quality improvement is much easier to measure and improve than environmental performance. Indeed, the EPE (environmental performance evaluation) working group within ISO is having a difficult time reaching consensus on this complex issue. CEP's struggles with measuring IHP's corporate environmental performance clearly indicate how problematic such measurement is.

- ☐ Quality has few legal constraints aside from those related to product safety. Environmental management faces a confusing patchwork of laws from various agencies.

- ☐ Achievement of zero defects is at least approachable as a focus. Achieving zero environmental impacts is a much more difficult concept to grasp. For one thing, it is not currently possible to know the impact of various releases into the environment, because scientific knowledge is not complete.

- ☐ Audit criteria are much clearer for quality management systems than environmental management systems.

Altogether these points should impress on the students that ISO 14000 is substantially different from ISO 9000 and that the issues it addresses are more problematic.

9. What is Rick's biggest challenge in implementing ISO 14001?

Obtaining top management commitment for this initiative is likely to be Rick's biggest problem. Not only is there no clear evidence that corporate is solidly behind the effort, this company is very cost conscious. It is not clear that management will see the value in signing up for ISO 14001 at this time.

Epilogue

As of September 1997, IHP of Tennessee had yet to commit to developing an ISO 14001 EMS. IHP was concerned with the costs and did not see many immediate concrete benefits. Perhaps most important, Rick Thompson (who was driving the initiative) was transferred to another IHP facility. The new manager of quality assurance was interested in the standard but less motivated to pursue it. He did, however, attend a couple of seminars and workshops on ISO 14001. Essentially, the facility was taking a wait and see approach. It continued to monitor the industry as well as corporate's perspective on the standard. Corporate was also continuing to monitor acceptance of the standard but was largely occupied with acquisitions; corporate, too, was taking a wait-and-see approach. Meanwhile, many firms in the European Union were moving rapidly to implement the standard, and the Ministry for International Trade and Industry in Japan was asking major manufacturers to pursue certification. U.S. industry was also moving, albeit more slowly.

APPENDIX A

Environmental Policy Statements from IBM

A commitment to leadership, built upon respect.

IBM is committed to environmental affairs leadership in all of its business activities. IBM has long-standing corporate policies of providing a safe and healthful workplace and safe products (Policy Letter Number 127), protecting the environment (Number 129), and conserving energy and natural resources (Number 131), which were initiated in 1967, 1971, and 1974, respectively. These policies continue to guide our operations, and they are the foundation for the following corporate policy objectives:

- Provide a safe and healthful workplace, including avoiding or correcting hazards and ensuring that personnel are properly trained and have appropriate safety and emergency equipment.

- Be an environmentally responsible neighbor in the communities where we operate, and act promptly and responsibly to correct incidents or conditions that endanger health, safety, or the environment; report them to authorities promptly, and inform everyone who may be affected by them.

- Maintain respect for natural resources by practicing conservation and striving to recycle materials, purchase recycled materials, and use recyclable packaging and other materials.

- Develop, manufacture, and market products that are safe for their intended use, efficient in their use of energy, protective of the environment, and that can be recycled or disposed of safely.

- Use development and manufacturing processes that do not adversely affect the environment, including developing and improving operations and technologies to minimize waste, prevent air, water, and other pollution, minimize health and safety risks, and dispose of waste safely and responsibly.

- Ensure the responsible use of energy throughout our business, including conserving energy, improving energy efficiency, looking for safe energy sources, and giving preference to renewable over non-renewable energy sources when feasible.

- Assist in the development of technological solutions to global environmental problems, share appropriate pollution prevention technology and methods, and participate in efforts to improve environmental protection and understanding throughout industry.

- Meet or exceed all applicable government requirements. Where none exist, set and adhere to stringent standards of our own and continually improve these standards in

light of technological advances and new environmental data.

- Conduct rigorous audits and self-assessments of IBM's compliance with this policy, measure progress of IBM's environmental affairs performance, and report periodically to the Board of Directors.

Every employee and every contractor on IBM premises is expected to follow the company's policies and to report any environmental, health, or safety concern. Managers are expected to take prompt action.

APPENDIX B

Environmental Policy Statements from Procter & Gamble

Procter & Gamble continually strives to improve the environmental quality of its products, packaging, and operations around the world. To carry out this commitment it is Procter & Gamble's policy to:

- ☐ Ensure our products, packaging, and operations are safe for our employees, consumers, and the environment.
- ☐ Reduce or prevent the environmental impact of our products and packaging in their design, manufacture, distribution, use, and disposal, whenever possible.
- ☐ Meet or exceed the requirements of all environmental laws and regulations.
- ☐ Continually assess our environmental technology and programs, and monitor progress toward environmental goals.
- ☐ Provide our consumers, customers, employees, communities, public interest groups, and others with relevant and appropriate factual information about the environmental quality of P&G products, packaging, and operations.
- ☐ Ensure every employee understands and is responsible and accountable for incorporating environmental considerations in daily business activities.
- ☐ Have operating policies, programs, and resources in place to implement our environmental quality policy.

APPENDIX C

Environmental Policy Statements from Bristol-Myers Squibb

Environmental, Health, and Safety Policy

It is the policy of Bristol-Myers Squibb to protect the health, safety, and quality of life of its employees, customers, and the public, and to conduct all of its activities in an environmentally sustainable manner which takes into consideration the integrity of natural systems, i.e., land, water, air, and biodiversity.

Bristol-Myers Squibb will strive to continuously improve its environmental, health, and safety (EHS) performance by minimizing and, where feasible, eliminating negative EHS impacts associated with its facilities, activities, and products. Management will ensure that every employee understands the importance of and is responsible and accountable for, integrating EHS considerations into their daily responsibilities.

Bristol-Myers Squibb, its divisions, and business functions will consider the EHS concerns of stakeholders, and work in an integrated manner to identify, evaluate, and resolve EHS impacts related to the management of resources and their related byproducts, i.e., selection, use, and exposure.

To the extent feasible, Bristol-Myers Squibb will give preference to suppliers and contractors whose EHS commitment and practices are consistent with its own, and who have demonstrated environmentally responsible products, services, and management.

Bristol-Myers Squibb, its divisions, and business functions will develop and maintain EHS performance measures, conduct regular performance evaluations, and report findings to internal and external stakeholders.

Bristol-Myers Squibb will regularly evaluate the internal and external factors driving EHS concerns, and make appropriate revisions to this policy and related programs.

Compliance with all relevant government requirements and company policies and guidelines will be the minimum acceptable level of performance for the Company's divisions, business functions, and employees.

Module 3

Day 5

"The Fun Factory"

INSTRUCTOR'S MANUAL

The Fun Factory

TRAINING IN WASTE REDUCTION USING A MOCK INDUSTRIAL PROCESS

INTRODUCTION

The following exercise was first developed by the Minnesota Technical Assistance Program and the Waste Reduction Institute for Training and Application Research, Inc. (WRITAR) in order to provide training to regulators who might have opportunity to promote pollution prevention to the regulated community. In the process of testing the exercise, MNTAP found that this sort of training might have much wider application, and so this example is provided today so that others can have access to something that has developed into an excellent training tool. (It has since been extensively modified by the Tennessee Institute for Management and the Environment to serve a still wider audience.)

The goal of this training exercise is to give participants experience in recognizing waste reduction opportunities. This includes recognition not only of options which might reduce waste generation, but also some sense of the difficulties encountered in the implementation phase. These difficulties arise because of the natural human resistance to change, pressures of day-to-day operation of a business, and the difficulties inherent in selecting and justifying process modifications. All of these are represented in the training exercise.

But when complete, the exercise should leave participants with a feeling of empowerment. Discovery and implementation of waste reduction opportunities relies heavily on communication, as well as technical skills. What participants discover is that even in a completely unfamiliar situation, they can make waste reduction happen by listening to the right people and asking good questions.

This exercise has been used repeatedly by the University of Tennessee Center for Industrial Services Waste Reduction Assistant Program (WRAP) to assist industries, regulatory agencies, and those interested in the reduction of industrial wastes. This exercise provides real world manufacturing pressures, problems, and conflicts of interests. Although it is entitled "Fun Factory" - and it's hard to get too serious about Play-Doh - these are serious issues and concerns for every manufacturer.

Disclaimer: Although some colors are described as being hazardous materials and wastes, the props are in no way, shape, or form hazardous. This is a "mock" industrial process demonstration for training purposes.

REQUIRED MATERIALS

- Tables large enough for the sheds, the machinery, and all employees to assemble
- Cans of yellow Play-Doh
- Cans of blue Play-Doh
- Cans of any third color of Play-Doh
- Fun Factory Machines (these instructions assume older models), with dies and knives
- Waste Storage Shed (sheet of paper divided into sections - see back page)

(The quantity of materials needed may be determined by placing 3 to 5 participants at each Fun Factory set up, plus several DOD representatives.)

BACKGROUND

Your division, part of a giant defense contracting corporations, lost its only significant contract 14 months ago in a surprise policy reversal by Congress. Since then the division has been downsizing while it desperately seeks a new contract. Specifically, your division, and every other firm in your former industry, is competing in the proof of concept/proof of capability phase of what promises to be a major new DOD contract. As part of its new sole souring strategy, DOD plans to award the entire contract to the supplier who wins the competition. Success will be based on speed of production ramp up, delivery times for new products, quality of products, rejection rates, ability to quickly respond to rush orders, scrap, environmental compliance, and levels of hazardous waste materials generated.

DIVISION'S POSITIONS AND JOB DESCRIPTIONS

1 **VP of Marketing** - In charge of finding new contracts. Career suffered a direct hit when VP was surprised by Congress reversing policy and cutting former contract. Figures promotion to corporate level rides on getting this new contract. Firm believer in TQM, QFD, and BRIBES.

2 **Plant Engineer** - In charge of handling the drums, preparing the Play-Doh material for use in the machine, worker complaints, and company Christmas party. Developing ulcers is hobby.

3 **Storage Shed Manager** - Inventory control over wastes - proper labeling, proper storage, and reports quantity of wastes to Plant Engineer (reports are generally 3-4 months behind production). Feels company could save money by sending waste to brother-in-law's farm.

(1) **Line Operator** - Extrudes the products as ordered, cleans up the machinery. Minimum wage (plus $0.10 per hour premium due to seniority), glad to have the job. Believes Elvis is still alive.

(2) **Regulatory Compliance Coordinator** - Monitors the entire operation for environmental safety, and solid waste compliance. BS Chemistry, MS Environmental Engineering, CSP (Certified Safety Professional), CHWT (Certified Hazardous Waste Trainer), JCO (Jailable Corporate Officer).

DOD POSITIONS

(3) **DOD EH&S Compliance Inspector** - Monitors manufacturers for violation of environmental, safety, and health violations. Mysteriously dismissed from EPA after (what the Inspector thought) was a brilliant career in environmental compliance enforcement. Would like to get a high paying job in industry as an RCC. BS in Political Science. Has complete access to all production facilities. Has the right to reclassify any improperly produced goods from non-hazardous to hazardous classification. Faces serious jail time if press discovers noncompliant behavior before inspector does. Believes DODVRO is on the supplier's payroll.

(4) **DOD Vendor Relations Officer** - former purchasing agent who received promotion to DODVRO (without pay raise). Would like to run things by the book, but has trouble with big words. Marine, RWD (retired without distinction). Very particular about product dimensions, smooth aerodynamic surfaces on all products, and supplier's ability to deliver all products fast - especially rush orders. Thinks DODEH&SCI is an anal retentive twit infatuated with the false precision of environmental regs.

COMPANY POLICIES

1. QUALITY is everyone's responsibility. Objections by anyone to the appearance, performance, or condition of any product makes the part a "REJECT".

2. SAFETY is vital to the economic feasibility of staying in business. Unsafe acts will result in corrective counseling. Repeated unsafe acts may result in discharge.

RULES

1. This is a military specifications job; while the material is in the hands of the Plant Engineer, it may be kneaded, rolled, and worked. Once it is placed in the machine, it becomes either product or waste - there is no recycling or reuse of material.

2. Yellow Play-Doh is non-hazardous. Blue Play-Doh is very hazardous and the third color of dough is mildly hazardous. Any mixing of colors, no matter how trivial, results in hazardous waste. (DODEH&SCIs are real sticklers on this.)

3. JIT production must follow the sequence of customer orders.

INSTRUCTIONS TO PARTICIPANTS

1. Set up materials to each facility, have employees decide on which position they will assume. (Allocate role responsibilities if you run short of players.)

2. Once the Customer orders are received and understood, begin production.

3. Waste will be accumulated in the Storage Shed. Separate waste by color and type of waste. Waste will be either Quality Control Waste, Process Waste, or Clean up Waste. Quality Control Waste is defined as any product rejected by an employee from either your division or DOD. Process Waste is waste generated in the start up or end-of-run material. Each time production is completed, any material left in the machine will be pushed through and declared Process Waste. Clean up Waste is any material removed from the machine during the preparation for a color change.

4. Remember, you are in competition with the other companies for selection as sole source supplier.

5. Once you have completed production of all parts, form a Quality Circle to discuss your wastes and the improvements you made, or could make during future production runs.

CUSTOMER ORDERS (Write on board or show overhead)

First: order 3 Yellow Stars, made the width of a play-Doh can lid
Second: order 3 Stars, a third color, made the width of a Play-Doh can lid
Third: order 6 Blue Ropes, made 3 at a time, the length of a Play-Doh can w/o lid

INSTRUCTOR'S TRICKS

1. Before distributing the Play-Doh cans, place a piece of tape on the bottom of the yellow cans with an expiration date in the past). The tape should not be noticeable to the employees. After the exercise is over this will become important.

2. After the facilities have all begun production, give the DODVROs sealed envelopes with the rush order, one for each factory. Once a factory has completed the first set of 3 ropes, they are to reveal this EMERGENCY SPECIAL ORDER for 3 more stars of the third color. The employees cannot continue with the second set of ropes; they must clean up and begin immediate production of the new order. Timing and secrecy of this surprise special order is crucial. Put the rush order in a sealed envelope marked "TOP SECRET. Open and reveal only after plant has produced its first acceptable run of ropes. (Reveal contents before second set of ropes is begun.)" Inside the envelope, place the following:

Dear Supplier,

Heightening tensions worldwide demand three additional stars made from your third color. For the sake of world peace, we feel it is imperative that these stars be deployed ASAP. While this may be disruptive to your organization, it provides an excellent opportunity for you to demonstrate your quick response capability, a key criteria in our selection of our future sole source supplier. We appreciate your willingness to cooperate with us on this important matter.

Yours truly,

Your Friends in the Pentagon's Purchasing Department

POINTS TO COVER IN DEBRIEFING

1. Difference in amounts of Quality Control Waste between the colors.
   Usually gets smaller - Why? Reasons include: experience/learning curve, better procedures, "practice makes perfect." Also: Cutting equipment can be improved. Pocket knife is a good replacement, or paper is even better. Demonstrates the advantages of process improvement.

2. What happens to the blue process waste?
   Special Order usually causes higher wastes: shows need for communication, inventory control, need for special process (premiums) on special orders, especially since it generated large amount of very hazardous waste to process a mildly hazardous product.

3. Was the switch over good for your firm's profits?
   Not unless special orders carried higher price. How high is high enough to be profitable? Depends upon full cost. A classic application of ABC.

4. One solution requires adjustment in price (see pl 3). Another option is adjustment in plant and process. Compare your cleanup waste piles. Cleanup waste is usually the same for all three colors. Can be lessened by: process equipment dedicated to each specific color, better scheduling that would allow longer runs, better machine design for ease of cleaning. Need to involve process R&D.

5. How would we justify this new investment? Requires capital budgeting to include waste stream numbers.

6. Have the DODEH&SCIs examine the bottom of the yellow Play-Doh cans for additional information. Look at the expired cans! First in First out? Inventory control for shelf-life materials is essential. All yellow products are now Quality Control Waste!

What sort of relationship do you want between customer and supplier? What kind of relationship do you want between regulator and regulated?

7. Did you notice that third color (Super Dough) produced shapes with smoother surfaces? This was critical in producing smooth ropes where regular Play-Doh was in use. Could we educate the customer to accept ropes in third color, thereby increasing quality while decreasing throughput time and waste? However, this makes dedicated lines really important to avoid all the clean up waste that comes from Super Dough. Need to involve customers in making tradeoff between customer satisfaction and environmental impact.

8. What were the sources and impact of variation in this process? Shapes, types of dough, volume of orders, ram pressure, customer representatives (Purchasing versus compliance officers)?

9. Open the floor for input from the Quality Circles of other reduction options.

Quality Control is

Everyone's Responsibility

- **Make 3 Yellow Stars**

  (Non hazardous width of lid)

- **Make 3 I-Beams - Third Color**

  (Somewhat hazardous,

  width = diameter of Play-Doh lid)

- **Make 6 Blue Ropes**

  (Make 3 at a time)

  (Very Hazardous, Length of

  Play-Doh can without lid)

Separate Wastes by Color and Type:

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1. Quality Control Waste

2. Process Waste

3. Clean Up Waste

	Q.C. Waste	Process Waste	Clean-up Waste
Yellow			
Third Color			
Blue			