JAMES A. GRAASKAMP COLLECTION OF TEACHING MATERIALS

II. CLASSES AT THE UNIVERSITY OF WISCONSIN--MADISON

Q. Examples of Multidisciplinary Coursework

1. Materials Concerning Graaskamp's Role as Guest Lecturer in Conservation 300 (Multiple Years, Beginning in 1967)

e. Assorted lecture notes, including fragments

University of Wisconsin Clay Schoenfeld

OUTLINE--RESOURCE CONSERVATION LECTURE

Tuesday, October 10, 1972

Prof. James A. Graaskamp

I. The process of civilization has always been related to the rate of industrialization. However, mass production plus mass consumption has led to a critical mass of by-products and resource consumption which threatens to implode industrialized civilization itself.

A. David Brower (organizer of the Sierra Club and Friends of the Earth, etc.) uses the 6 days of Genesis as a figure of speech for what has been 4 billion years to that a day in Genesis equals something like 666 million years. On that standard life didn't begin until Tuesday noon. At 4:00 p.m. Saturday the big reptiles came on and 3 minutes before midnight on Saturday man appeared. At 1/4 of a second before midnight Christ arrived and 1/40 of a second before midnight the industrial revolution began. Thus in 1/40 of a second man is struggling to shift from frontier economics where land, air, and water are his cheapest goods to a spaceship economy within which everything must be recycled and accounted for. ("Encounters With the Archdruid"--by John McPhee--New Yorker, March 1971)

B. The rate of resource consumption in 1/40 of a second as a result of industrialization is generally well recognized concern about the next 1/40 of a second but.....

1. Technology was not the whim of "business" but rather the result of a social decision to support and pursue the presumed benefits of growth with single-minded relentlessness.
2. There are no simplisitc responses to growth. The romantics hold with a return to preservation of the natural world. The conservationists hold with a reduction of the waste of unnecessary growth, a leveling of living standards and conscious trade-off of the future for needs of the present.
3. The values which determine the criteria of economic decisions are not made by business but by society and these values shift as information is available to shape them.

C. Any organized undertaking is an enterprise,and a subset of those are enterprises with a cash cycle. The cash cycle must be at least at a point of equilibrium. Enterprises in which the cash cycle is supposed to be positive, i.e. profitable, are called business. Management Dynamics, The New Synthesis by John A. Beckett.

1. The industrial age is characterized by incomplete definition of systems, be it accounting, packaging, energy or legal.
2. All cash cycle systems can properly account for only outlays and receipts which flow through the enterprise and thus cannot reflect externalities.
3. Packaging engineering carries the product from the production line to the supermarket to the point of use but provides no built-in functional solution to the empty box, bottle or can.

4. Even the law is an incomplete system. We have exclusive private rights and exclusive governmental rights, and a tremendous area of common rights to air and water, etc. which are difficult to define in order to protect. "The Property Interface".

D. Economics of business behavior is closely tied to the law of responsibility for behavior and to the politics which create much of that law. As an awareness of our environmental dilemma has reached the majority of persons, the insecurity of discovering that America cannot produce an answer to every question has led to a good deal of political hysteria.

1. Paranoia for any political viewpoint produces bad politics as it cannot distinguish between friend or foe.
2. Those who are opposed to growth must be opposed to one of its major instruments, i.e. business, and impute to business the single-mindedness of society's values in general with a good deal of name calling.
3. As a result more businessmen are guilty of misconceptions about environmentalists than about environment.
4. Businessmen feel there is a double standard in the politics of environment. Citizens are relatively patient with problems created by their own sewage or automobile and will await technological solutions or improvements at a rate which will not seriously affect the real estate tax or the capital cost of their car.
5. What is self serving pragmatism by the consumer is regarded as malevolent insensitive negligence by the corporate conspiracy which does not instantly correct its paper mills and power plants.
6. Solvency ...

E. I submit the problem of environmental control of business enterprise is not one of ethics for management as a group; rather it is a question of resolving short-term economic constraints so that the individual enterprise can survive in the long run or receive some equitable compensation should society require its dissolution.

II. The economics of environmental control are quite different for society as a group than for the firm as an individual entity operating in a market economy.

A. Assuming for the moment society could put a dollar value on benefits of environmental conservation programs, the net product of services, goods, and well being would be increased by incurring cost to a point where marginal cost equalled marginal benefit.

B. No such benefit-cost relationship may govern the decision of the individual firm. With some exceptions environmental control costs provide no direct benefit to the individual firm, and if these costs cannot be shifted to the consumer in the price tag, the firm must relocate, go broker, or begin the following projects:

1. An increase in cost requires an increase in price if the firm was at its equilibrium.
2. An increase in price means a decline in units purchased.
3. As units sold decreases, average cost per unit increase requires a second increase in price.
4. Thus it can be shown that a conservation cost must increase total cost and price by a multiple of the original expenditure--affecting the entire revenue flow of the firm.

C. Contrary to superficial analysis, the firm must make decisions serving a variety of claims on its abilities, including:

1. The price and quantity requirements of the consumer.
2. The return of capital required by the lender.
3. The profit required by the investor.
4. Employment stability and growth required by the community.
5. Tax revenues required by the society.
6. Equitable distribution of cost to effect efficient allocation of resources.

III. There can be an economic motivation for industrial utilization of environmental conservation practices which increase sales or lower costs of production.

A. Regeneration of natural resources (i.e., trees, fish).

B. Use of marginal supplies of scarce resources (i.e., taconite ore).

C. Reclamation of resources from waste (chemicals from paper liquor) The theoretical answer to waste disposal is recycling but the popular view that all wastes can become resources falters on technology and markets. In a moment we will look at two cases, one successful and one partly successful.

D. Loss prevention to reduce non-productive resource consumption (fire prevention). The lagoon in this picture serves as an emergency water supply for the sprinkler fire system. Sprinklers themselves reduce fire losses and fire rates to a point where the insurance premium savings will pay for the entire water supply system in less than 5 years. The fountain aerates the water to prevent algae which would clog the fire pumps, and in cases of rural plant location, the pond also serves as a third stage sedimentation pond for sewer plant effluent. In this case good loss control was good economics.

E. Good esthetics--good economics to increase sales or lower costs (subdividing clusters). The creation of urban building sites is a manufacturing process. Smaller lots in a clustered plan allow the property developer to leave many acres in their natural state, thereby creating attractive open space. At the same time the amount of sewer, street and curb, and other improvement costs are reduced. The need to grade down the ridges or cut the trees, both at great expense, is eliminated.

Resource Conservation Lecture

IV. When the economic system does not of itself allocate social cost of any particular production factor to the producer and then to the user of that service or good, economists seek legislative and economic devices to internalize the social costs.

A. Internalize social costs by shifting cost back to industrial source and consumer through price structure. For example, the Industrial Revolution began to produce a large number of accidents, injuries to workers in the course and scope of their employment. This strict law of liability provided some recourse where the employer or a fellow employee was demonstrably negligent and the cause of an injury to another employee thereby. However, recovery was slow and uncertain and charities and welfare agencies carried the burden of the injured worker. Finally the issue of fault was removed and employers were required to carry insurance for full medical benefits, lost wages, and benefits to the survivors of those who were killed in industrial accidents.

1. The premium for this insurance was based on individual company losses so that companies had an economic incentive to reduce losses with safety programs and safer equipment.
2. The average cost of such insurance is included in the price of the product to be paid by all the users of that product. The unusual benefits or costs of loss experience for each firm provides an economic force bringing about conservation of human resources.
3. Economists and legislators are now seeking ways to internalize the costs of resource conservation, that is to shift the full burden of environmental consideration onto the user of the product or the manufacturing firm responsible.

B. Create legal penalties for failure to follow specified conservation practices.

C. Create special incentives in the form of subsidy, tax relief, or privilege.

D. Create intangible standards of social approval for desired patterns of response to environmental conservation.

V. Consider the experience of the paper industry in Wisconsin. The paper-making process requires tremendous volumes of water, most of which can be returned to the surface water without pollution. However, much of this water may be carrying something called sulphite liquor, a harmless, non-toxic dark residue which does break down with the oxygen in the water. Such large quantities are involved that the river is left little of oxygen to support BOD of plants, fish, or sewage reduction.

A. In the 1930's the industry was asked to correct conditions in the Fox River Valley and the industry voluntarily formed the Pulp Manufacturer's Research League, financed it, and implemented the recommendations. Industrial concern for conservation can be voluntary, self-financed, and of many years standing.

Resource Conservation Lecture

B. Sulphite liquor is a by-product of cooking wood to make paper. Wood can be compared to masonry, with cellulose fibers as the bricks and lignin as the mortar. By cooking woodchips in a bisulphate solution, the lignin is dissolved by sulfonation and some of the cellulose is reduced to pentose sugars. Only half the log become pulp and the balance goes into a solution with all the chemical elements of wood except the cellulowe.

C. Industrial conservation demands chemical technology which may not exist. The problem has been to dispose of 2 1/4 million tons of sulphite liquor other than by returning it to surface water sources.

1. Disposal in volume first led to development of soil filtration methods, lagoon for sedimentation, and timed discharges at high flow periods of the river. No benefit derived.
2. Chemists then developed methods for using these rich organic wastes for fuel and roadbinder, a low benefit value but high volume consumer of the waste.
3. More recently these organic sulphite liquors have been converted to adhesives and yeast. These products have a high benefit value but can be produced in such quantities that the market could not use all the yeast and adhesives that could be made from available sulphite liquor. (3,4,5,6)
4. The chart will indicate that high value utilization now uses about 30% of available sulphite liquor of participating paper companies and the need to waste these liquors through disposal has fallen to less than 2%. Low benefit value uses are also declining as a per cent of liquor available. Markets have still to be found for more than 50% of total available SSL.

D. This progress had required capital investment in research, then market development, and then productive hardware.

E. An alternative approach is to find new ways of making paper with less water water-inputs from outside. Water can be recycled or less water may be required for paper in solutions.

F. Ultimately we need to use less paper per capita but this may require significant restructuring of our communication, packaging, and waste collection systems. Recycling paper requires the home-owner to sort and society to collect from a million households raw material formerly handled in mass as a log from only a few points of lumbering at a time. Cable TV with data retrieval may eliminate the need for newspaper lineage for advertising or telephone book.

G. While significant dislocations take place in the paper industry to eliminate old-style plants or unneeded output for the benefit of posterity, how does society internalize the cost of inequity to the present generation whose jobs are eliminated and whose properties are made worthless by the closing of a mill? How does one dismantle and internalize the cost of a microsocial system?

Resource Conservation Lecture

VI. While the scale of waste material for an industry requires a long-term approach, the single firm may be able to achieve dramatic advancement. Business Week of January 1, 1972 reports that Dow Chemical has made some interesting progress on pollution control at the Midland, Michigan installations which produce some 500 products from Saran Wrap to tongue-twisting industrial chemicals. While it does not serve our purposes to review their intensification of reclamation and recycling procedures which in general represent more thorough applications of existing technology, some elements of management philosophy are significant.

A. While companies generally know to the penny what treatment facilities cost they rarely credit whatever savings may occur or net increase in product may result so they cannot correctly evaluate cost-benefit relationships and thereby justify capital expenditures.

B. The company has three goals - eliminate pollution, find ways to off-set the costs, and decentralize their program to put operating responsibility with operating people - what their president calls building to building and department to department accountability. For example, when planning cooling towers design to eliminate thermal pollution of the Tittabawassee River, Dow chose 28 small towers rather than one large one, trading economies of scale in order to make each department foreman responsible for his own problems. Accountability to the law is a devise for internalizing social costs but it is a new motivation for management in the case of pollution.

C. Management has tied capital decisions to be contingent on a satisfactory solution of environmental impacts.

D. Dow made a profit center division called Environmental Control Systems Group of its environmental labs and technicians 12 years ago and expects this group not only to solve Dow's problems but to sell their technical skills and products to other companies and municipalities. This year, for the first time, this division turned a small profit on revenues of about 10 million.

E. The program is seldom touted on slogans of corporate responsibility but rather on hard-headed necessity of surviving in the face of tougher regulations, the constraints imposed by their site at Midland, and rising waste treatment costs. In Midland, Dow had 400 acres devoted to production and another 400 acres for waste treatment. Said Dow "The outhouse was getting bigger than the house" and Dow no longer regards waste treatment as an acceptable solution.

VII. While the paper and chemical industries may be making some progress, the steel and power industries continue to provide unlimited number of horror stories relative to air pollution.

Resource Conservation Lecture

A. The problem for blast furnace and foundry operations may be one of nonexistant control technology or one of cost. In many cases there are no off-setting by-products and often clean air may be at the expense of dirty water or increments of energy which causes additional need for the contamination of larger power plants.

B. Firms voluntarily developed successful control installations but experienced unexpectedly high capital investment and operating costs. Only a few completely successful control installations have been made, largely in Michigan, on blast furnace cupolas.

1. Costs of initial installation were more than one million dollars per cupola, more than 25% of the total cost.
2. On these large units the fans, pumps, and other motors required at least 1,400 total horsepower--so that electric power to run systems for scrubbing the air with water ranged from $40,000 to $100,000 per year depending on hours of use.
3. Corrosive action of waste led to frequent breakdowns and high repair bills at an annual cost of at least 30% of the original cost.
4. Control equipment is economically out of reach of most companies and cannot be paid for out of increase prices without dislocation. On a smaller scale a small foundry costing $750,000 to build would require at least $300,000 for additional air filtration systems with high operating costs.

C. In the absence of economically acceptable control procedures, industry must continue conversion to oxygen processes to remain competitive with overseas supplies and alternative domestic materials.

1. Alternatives of changing the process requires use of an induction furnace which cannot produce in sufficient quantities.
2. Present modernization would postpone replacement construction if pollution control processes were discovered tomorrow. Control of the old style furnace is possible but not at a cost which will allow the foundry to stay in business.
3. A change in melting procedures might require complete reconstruction of the steel industry, a process which must take at least 20 years.

D. Industry, of course, depends on power and our demand for electric power requires combustion of coal to produce the steam to turn the turbine which runs the generator. Most waste recycling or preparation for discharge requires huge inputs of additional power. Business is simply a special subdivision of the social process concerned with converting natural resources to the products required by the society in which it operates. Conversion means applied energy and energy requires large scale combustion of chemical reduction. Thus many business problems are really a sub-category of the energy dilemma.

Resource Conservation Lecture

VIII. Last November 2 the Senate passed The Federal Water Pollution Control Act on a role call vote of 86 to 0, a unanimity which might be difficult to obtain for a nonbinding resolution in support of motherhood. Nevertheless, it has established that no one has the right to pollute and that the national goal will be elimination of all waste discharges into the nation's waterways by 1985.

A. This year the zero discharge bill
It is opposed by business and thus the Nixon administration and wild claims have been made as to its economic impact on posterity.

B. Nevertheless, it represents a reasonable two-stage program and sets zero discharge as a goal not a legal requirement, a goal which will be circumscribed by cost considerations.

1. By 1976 companies must apply the "best practicable" technology to control water pollution.
2. By 1981 companies are to achieve zero discharge unless they can show it cannot be done at a reasonable cost, in which case they must employ the best available technology.
3. The phrases "best practicable" and "best available" are defined to consider the ages of the plants, their sizes, their processes and cost of controls.
4. If research indicates total cost to be prohibitive the goal can be abandoned as an explicit feature of the bill.

C. Why is industry opposed to a bill that seemingly safeguards its economic interests? For that matter with all of the qualifications why would the Senate postulate zero discharge? Businessmen are people and people never react favorably to rapid change in philosophy.

1. In 1965 the water pollution law then enacted permitted each state to determine how its rivers and lakes would be used and the water quality standards appropriate to the use. These, in turn, would impose specific limits of effluent on all polluters. Thus the limits would vary from stream to stream depending on its intended use. In theory this focused on ends, not means. It linked cause (effluent) to effect (water quality) and by relating use to the degree of control it related abatement cost to benefits and citizen priority.
2. In practice it was very hard to implement as many state legislators did not wish to set water quality standards or could not establish relationships of effluents to water use which would be supportable in court.
3. Thus the Senate on Public Works decided to shift from the technical difficulties of water quality standards to direct control of the cause. That was a radical change for it ended the policy assumption that one legitimate use of waterways is to assimulate waste. To move from awareness of the problem in the early 60's to a premise that "industry shalt not pollute" has been too rapid a philosophic evolution for Nixon and some who maintain their industry leaders to swallow.

4. Note, however, that the leader such as Dow have already dismissed treatment as an answer. In short, the Senate, is telling business that treat and dump is no answer and that what is needed is 10 years of R & D based on the assumption that closed cycle systems are the norm - not modified waste discharge.

D. The Nixon argument is based on fear of high cost and capital investment to achieve zero discharge. While no one knows precisely what it would cost, Senator Muskie countered that price tag based on unknown or scanty data serves no useful purpose other than to intimidate business in Congress.

E. Since many companies are moving toward closed loop recycling of water before they are compelled to do so, the cost cannot necessarily be prohibitive and many find recycling cheaper than expensive treatment.

F. The major economic problem which can be identified are those of local governments which must provide sewer service as all communities would be required under the bill to have secondary treatment plants under way by 1974 and ultimately zero discharge just like industry. Like industry local government is a cash cycle enterprise and are strapped fur funds which must come from higher real estate taxes or higher utility costs for each of the voters. For the municipality the voter is a common stock holder and the mayor has no more latitude than the company president in decisions of this magnitude when they are accountable to their constituents.

G. The voter is also a cash cycle enterprise committed to solvency, ultimately environmental control must mean less of everything at higher prices. The business decision process simply reflects the general ability of our people to adapt to changing awareness of the realities and responsibilities of a spaceship economy. Look how far we have come in public education since 1960!

H. I predict business will have achieved recycling of its water, controls on its exhausts, and elimination of its solid wastes of useable by-products about the time that the average home owner is driving nothing more than a Volkswagon, is recycling his house water supply, and properly venting his furnace.

OUTLINE #1

CONSTRAINTS ON FREEDOM OF FIRM TO MAKE DECISIONS TO INCUR COST OF CONSERVATION PRACTICES

1. THE PRICE AND QUANTITY REQUIREMENTS OF THE CONSUMER.
2. THE RETURN ON CAPITAL REQUIRED BY THE LENDER.
3. THE PROFIT REQUIRED BY THE INVESTOR.
4. EMPLOYMENT STABILITY AND GROWTH REQUIRED BY THE COMMUNITY.
5. TAX REVENUES REQUIRED BY THE SOCIETY.
6. EQUITABLE DISTRIBUTION OF COST TO EFFECT EFFICIENT ALLOCATION OF RESOURCES REQUIRED BY ECONOMIC SYSTEM.

OUTLINE #2

POSITIVE ECONOMIC INCENTIVES FOR INDUSTRIAL CONSERVATION OF ENVIRONMENT

1. REGENERATION OF NATURAL RESOURCES (TREES, FISH).
2. USE OF MARGINAL SUPPLIES OF SCARCE RESOURCES (TACONITE ORE).
3. RECLAMATION OF RESOURCES FROM WASTE (CHEMICALS FROM PAPER LIQUOR).
4. LOSS PREVENTION TO REDUCE NON-PRODUCTIVE RESOURCE CONSUMPTION (FIRE PREVENTION).
5. GOOD ESTHETICS--GOOD ECONOMICS TO INCREASE SALES OR LOWER COSTS (SUBDIVIDING CLUSTERS).

OUTLINE #3

ARTIFICIAL ECONOMIC INCENTIVES FOR INDUSTRIAL CONSERVATION OF ENVIRONMENT

1. INTERNALIZE SOCIAL COSTS BY SHIFTING COST BACK TO INDUSTRIAL SOURCE AND CONSUMER THROUGH PRICE STRUCTURE.

2. CREATE LEGAL PENALTIES FOR FAILURE TO FOLLOW SPECIFIED CONSERVATION PRACTICES.

3. CREATE SPECIAL INCENTIVES IN THE FORM OF SUBSIDY, TAX RELIEF, OR PRIVILEGE.

4. CREATE INTANGIBLE STANDARDS OF SOCIAL APPROVAL FOR DESIRED PATTERNS OF RESPONSE TO ENVIRONMENTAL CONSERVATION.

OUTLINE #4

EXPERIENCE OF PULP MANUFACTURERS RESEARCH LEAGUE
ILLUSTRATES SOME MAJOR ELEMENTS OF
INDUSTRIAL CONSERVATION

1. INDUSTRIAL CONCERN FOR CONSERVATION CAN BE VOLUNTARY, SELF-FINANCED, AND OF MANY YEARS STANDING.

2. INDUSTRIAL CONSERVATION DEMANDS CHEMICAL TECHNOLOGY WHICH MAY NOT EXIST.

3. CREATION OF A SALEABLE PRODUCT FROM WASTE MAY PRODUCE THE PRODUCT IN SUCH QUANTITIES AS TO BREAK THE MARKET PRICE.

4. LIMITED CAPACITY OF MARKET TO ABSORB A SINGLE USEFUL BY-PRODUCT MAY REQUIRE A VARIETY OF WASTE CONVERSION PRODUCTS AND PROCESSES.

5. VARIATIONS IN PRODUCTION PROCESS PRODUCING WASTE MAY REQUIRE ALTERNATIVE WASTE PROCESSING TECHNIQUES.

6. WASTE CONTROL MEANS SIMULTANEOUS DEVELOPMENT OF TECHNIQUES:

   A. TO NEUTRALIZE LARGE QUANTITIES OF WASTE ECONOMICALLY.

   B. TO PRODUCE SALEABLE BY-PRODUCTS REQUIRING LARGE QUANTITIES OF MATERIAL TO OFFSET WASTE CONTROL COSTS.

   C. TO CREATE HIGH VALUE PRODUCTS SELLING AT A PROFIT ON CAPITAL INVESTED FOR WASTE CONTROL.

7. CAPITAL INVESTMENT INCLUDES <u>RESEARCH</u>, <u>PRODUCTIVE HARDWARE</u>, AND <u>MARKET DEVELOPMENT</u>.

OUTLINE #5

EXPERIENCE OF STEEL MILLS SUGGESTS MAJOR DILEMMAS OF INDUSTRIAL CONSERVATION

1. A BLAST FURNACE OR FOUNDRY AIR CONTAMINANTS ARE CORROSIVE, OFFENSIVE, AND DAMAGING TO LIVING STANDARDS.

2. FIRMS VOLUNTARILY DEVELOPED SUCCESSFUL CONTROL INSTALLATIONS BUT EXPERIENCED UNEXPECTEDLY HIGH CAPITAL INVESTMENT AND OPERATING COSTS.

3. CONTROL EQUIPMENT IS ECONOMICALLY OUT OF REACH OF MOST COMPANIES AND CAN NOT BE PAID FOR OUT OF INCREASE PRICES WITHOUT DISLOCATION.

4. CHANGE IN STEEL MAKING PROCESSES IS POSSIBLE BUT CANNOT PRODUCE SUFFICIENT VOLUMES OF STEEL TO MEET NEEDS.

5. IN THE ABSENCE OF ECONOMICALLY ACCEPTABLE CONTROL PROCEDURES, INDUSTRY MUST CONTINUE CONVERSION TO OXYGEN PROCESSES TO REMAIN COMPETITIVE WITH OVERSEAS SUPPLIES AND ALTERNATIVE DOMESTIC MATERIALS.

6. PRESENT MODERNIZATION WOULD POSTPONE REPLACEMENT CONSTRUCTION IF POLLUTION CONTROL PROCESSES WERE DISCOVERED TOMORROW.

7. PROBLEM IS NOT PERFORMANCE OF KNOWN CONTROL TECHNOLOGY, BUT COST.

8. TYPICAL OF INDUSTRIAL POLLUTION PROBLEMS, THERE ARE FEW COST OFFSETS IN THE FORM OF USEABLE BY-PRODUCTS.

9. CONTROL OF PLANT LOCATIONS THROUGH ZONING.

10. REDUCTION OF OTHER SOURCES OF CONTAMINANTS TO REDUCE OVERALL POLLUTION.

11. DIRECT GOVERNMENT SUBSIDY OF CAPITAL COSTS.

12. LEGAL PENALTIES WOULD FORCE FOUNDRIES OUT OF BUSINESS WHERE ENFORCED.

13. WITHOUT INITIAL CAPITAL FOR INVESTMENT, INCOME TAX PROVISION FOR CAPITAL RECOVERY DOES NOT OPERATE.

CHART #5

TYPICAL COSTS OF BASIC AND CONTROL EQUIPMENT
INSTALLED IN LOS ANGELES COUNTY

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment	% of control to basic cost
Airblown asphalt system	500 bbls./batch	$ 10,500	Afterburner	$ 3,000	29%
Bulk gasoline loading rack	667,000 gals./day	88,000	Vapor control	50,000	57%
Carbon black plant	2,000 gals./day	5,000	Baghouse	5,000	100%
Coffee roaster	3 tons/hr.	35,000	Cyclone and afterburner	8,000	23%
Crucible furnace, yellow brass	4 furnaces @ 850 lbs. each/heat	10,000	Baghouse	17,000	170%
Cupola, gray iron	48" ID	40,000	Baghouse and quench tank	67,000	168%
Fiberboard production	32,000 lbs./hr.	10,000	Electric precipitator	15,000	150%
Fluid catalytic cracking unit	40,000 bbls./day	7,460,000	Afterburner and precipitator	3,469,000	47%

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October 4, 1972'

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Re: List of Slides, Prof. Graaskamp

1. Chart #1, Benefit Cost Triangle
2. Outline #1
**3. Outline #2 (make new slide)
4. Yates-American Slide
5. VW bus (street scene)
6. Single lot illustration (conventional vs cluster lot size)
7. Comp. utility layout (stick diagram of utility runs)
8. Comp. subdivision layout (two plats with green space)
9. Outline #3
10. Outline #4
11. Chart #2
12. Steel mill slide

The University of Wisconsin | Mr. Schoenfeld

267-300-2: Environmental Resource Management Principles and Problems

First Semester, 1968-69

Professor Graaskamp | Monday, November 1 | Industry

OUTLINE - RESOURCE CONSERVATION LECTURE

I. The rate of evolution in the process of civilization has always been a function of the rate of industrialization in the broad sense.

A. The tools, specialization, and scale of industry is praised for creating a miraculous standard of living and damned for destroying the natural balance and quality of the environment in which we live.

B. Historically industrial enterprise could be indicted for:

1. Waste of natural physical resources.
2. Contamination of air supply.
3. Pollution of all water resources.
4. Desecration of the natural landscape with industrial hardware.

C. With hindsight we condemn our industrial decision makers for lack of foresight although they accurately reflected the concerns of the great majority of their contemporaries and the competitive restraints on cost, price, and capital investment of the times.

D. Industrial management is now experiencing the same awareness of the environmental problems of our civilization that brought you here to this type of program. Industrial managers must live in the same environment and bear the cost of negligence like everyone else. It is foolish to accuse the pilot of an airliner of disregard for his passengers safety when it is the nose of the airplane that will hit the ground first.

E. The question of environmental control in the long-run is not one of ethics for management as a group; rather, it is a question of resolving short-term economic constraints so that the individual firm can survive for the long-run.

II. The economics of environmental control are quite different for society as a group than for the firm as an individual entity operating in a market economy.

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C. Contrary to superficial analysis, the firm must make decisions serving a variety of claims on its abilities, including:

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6. EQUITABLE DISTRIBUTION OF COST TO EFFECT EFFICIENT ALLOCATION OF RESOURCES.

D. Industry is a prime target for those who would reduce smog or water pollution because industrial smoke stacks with black smudges and rivers discolored with oil slick are dramatic symbols of disregard. However, the major source of pollution is the odorless, colorless carbon monoxide produced by the family auto and the major source of water pollution is the untreated sewage of those local citizens who want low property taxes.

1. In the short space of one hour we can only suggest factors in the decision making process of the single firm in regard to environment conservation.
2. First, some problems of waste and esthetics have economic self-interest correction features.
3. However, our principal stress will be on the water and air pollution dilemmas of a steel firm, a paper firm, and an electric power plant.

111. There can be an economic motivation for industrial utilization of environmental conservation practices which increase sales or lower costs of production.

A. REGENERATION OF NATURAL RESOURCES (I.E. TREES, FISH).

B. USE OF MARGINAL SUPPLIES OF SCARCE RESOURCES (I.E. TACONITE ORE).

C. PREVENTION OF LOSS OF RESOURCES DUE TO NATURAL CAUSES TO LOWER COST OF PRODUCTION (I.E. FIRE PREVENTION). Good esthetics can also be good economics. The attractive industrial plant near the expressway establishes a favorable name identification with many potential customers. However, the lagoon in this picture serves as an emergency water supply for the sprinkler fire system. Sprinklers themselves reduce fire losses and fire rates to a point where the insurance premium savings will pay for the entire water supply system in less than five years. The fountain aerates the water to prevent algae which would clog the fire pumps, and in cases of rural plant location, the pond also serves as a third stage sedimentation pond for sewer plant effluent.

D. ENVIRONMENT UNDISTURBED LOWERS COSTS (I.E. SUBDIVIDING). The creation of urban building sites is a manufacturing process. Smaller lots in a clustered plan allow the property developer to leave many acres in their natural state, thereby creating attractive open space. At the same time the amount of sewer, street and curb, and other improvement costs are reduced. The need to grade down the ridges or cut the trees, both at great expense, is eliminated.

E. GOOD ESTHETICS--GOOD ECONOMICS TO INCREASE SALES OR LOWER COSTS (I.E. ARCHITECTURAL LANDMARK).

IV. When the economic system does not of itself allocate social cost of any particular production factor to the producer and then to the user of that service or good, economists seek legislative and economic devices to internalize the social costs.

A. <u>INTERNALIZE SOCIAL COSTS</u> BY SHIFTING COST BACK TO INDUSTRIAL SOURCE AND CONSUMER THROUGH PRICE STRUCTURE. For example, the Industrial Revolution began to produce a large number of accidents, injuries to workers in the course and scope of their employment. This strict law of liability provided some recourse where the employer or a fellow employee was demonstrably negligent and the cause of an injury to another employee thereby. However, recovery was slow and uncertain and charities and welfare agencies carried the burden of the injured worker. Finally, the issue of fault was removed and employers were required to carry insurance for full medical benefits, lost wages, and benefits to the survivors of those who were killed in industrial accidents.

1. The premium for this insurance was based on individual company losses so that companies had an economic incentive to reduce losses with safety programs and safer equipment.
2. The average cost of such insurance is included in the price of the product to be paid by all the users of that product. The unusual benefits or costs of loss experience for each firm provides an economic force bringing about conservation of human resources.
3. Economists and legislators are now seeking ways to internalize the costs of resource conservation, that is to shift the full burden of environmental consideration onto the user of the product or the manufacturing firm responsible.

B. CREATE LEGAL PENALTIES FOR FAILURE TO FOLLOW SPECIFIED CONSERVATION PRACTICES.

C. CREATE SPECIAL INCENTIVES IN THE FORM OF SUBSIDY, TAX RELIEF, OR PRIVILEGE.

D. CREATE INTANGIBLE STANDARDS OF SOCIAL APPROVAL FOR DESIRED PATTERNS OF RESPONSE TO ENVIRONMENTAL CONSERVATION.

E. Water and air pollution are major areas of current debate. Workmen's compensation represents perhaps two per cent of modern labor costs but conservation of environment can mean as much as fifty per cent of product cost so that the increase in economic stakes magnifies the complexities of decisions in this area. We will find illustrative situations in the paper industry, the steel industry, and in public power.

V. Consider the experience of the paper industry in Wisconsin. The papermaking process requires tremendous volumes of water, most of which can be returned to the surface water without pollution. However, much of this water may be carrying something called sulphite liquor, a harmless, non-toxic dark residue which does break down with the oxygen in the water. Such large quantities are involved that the river is left little of oxygen to support BOD of plants, fish, or sewage reduction.

A. In the 1930's the industry was asked to correct conditions in the Fox River Valley and the industry voluntarily formed the Pulp Manufacturer's Research League, financed it, and implemented the recommendations. INDUSTRIAL CONCERN FOR CONSERVATION CAN BE VOLUNTARY, SELF-FINANCED, AND OF MANY YEARS STANDING.

B. Sulphite liquor is a by-product of cooking wood to make paper. Wood can be compared to masonry, with cellulose fibers as the bricks and lignin as the mortar. By cooking woodchips in a bisulphate solution, the lignin is dissolved by sulfonation and some of the cellulose is reduced to pentose sugars. Only half the log becomes pulp and the balance goes into a solution with all the chemical elements of wood except the cellulose.

C. INDUSTRIAL CONSERVATION DEMANDS CHEMICAL TECHNOLOGY WHICH MAY NOT EXIST. The problem has been to dispose of 2½ million tons of sulphite liquor other than by returning it to surface water sources.

1. Disposal in volume first led to development of soil filtration methods,. lagoons for sedimentation, and timed discharges at high flow periods of the river. No benefit derived.
2. Chemists then developed methods for using these rich organic wastes for fuel and roadbinder, a low benefit value but high volume consumer of the waste.
3. More recently, these organic sulphite liquors have been converted to adhesives and yeast. These products have a high benefit value but can be produced in such quantities that the market could not use all the yeast and adhesives that could be made from available sulphite liquor. (3,4,5,6)

4. The chart will indicate that high value utilization now uses about 30 per cent of available sulphite liquor of participating paper companies and the need to waste these liquors through disposal has fallen to less than two per cent. Low benefit value uses are also declining as a per cent of liquor available. Markets have still to be found for more than 50 per cent of total available SSL.

D. THIS PROGRESS HAS REQUIRED CAPITAL INVESTMENT IN RESEARCH, THEN MARKET DEVELOPMENT, AND THEN PRODUCTIVE HARDWARE.

E. Another way to change the waste disposal problem is to find new ways of making paper with less water. Efficient use of water means less waste goes into solution. Efficient use of water means less is contaminated, less oxygen removed from rivers, more manageable volumes of waste.

VI. The steel industry can provide an unlimited number of horror stories in regard to air pollution. The typical blast furnace will emit iron oxide, silica fumes, carbon monoxide, sulfur dioxide, oil, and coke dust.

A. A BLAST FURNACE OR FOUNDRY AIR CONTAMINANTS ARE CORROSIVE, OFFENSIVE, AND DAMAGING TO LIVING STANDARDS. These products of the cupola will damage the surface of automobiles and buildings, blight vegetation, produce uncomfortable odors, and reduce visibility.

B. FIRMS VOLUNTARILY DEVELOPED SUCCESSFUL CONTROL INSTALLATIONS BUT EXPERIENCED UNEXPECTEDLY HIGH CAPITAL INVESTMENT AND OPERATING COSTS. Only a few completely successful control installations have been made, largely in Michigan, on blast furnace cupolas.

1. Costs of initial installation were more than one million dollars per cupola, more than 25 per cent of the total cost.
2. On these large units the fans, pumps, and other motors required at least 1,400 total horsepower--so that electric power to run systems for scrubbing the air with water ranged from $40,000 to $100,000 per year depending on hours of use.
3. Corrosive action of waste led to frequent breakdowns and high repair bills at an annual cost of at least 30 per cent of the original cost.

C. CONTROL EQUIPMENT IS ECONOMICALLY OUT OF REACH OF MOST COMPANIES AND CAN NOT BE PAID FOR OUT OF INCREASE PRICES WITHOUT DISLOCATION. On a smaller scale a small foundry costing $750,000 to build would require at least $300,000 for additional air filtration systems with high operating costs.

D. CHANGE IN STEEL MAKING PROCESSES IS POSSIBLE BUT CANNOT PRODUCE SUFFICIENT VOLUMES OF STEEL TO MEET NEEDS. Those systems which were installed did work but the cost cannot be supported by the present prices of steel or foundry products.

1. IN THE ABSENCE OF ECONOMICALLY ACCEPTABLE CONTROL PROCEDURES, INDUSTRY MUST CONTINUE CONVERSION TO OXYGEN PROCESSES TO REMAIN COMPETITIVE WITH OVERSEAS SUPPLIES AND ALTERNATIVE DOMESTIC MATERIALS. Alternatives of changing the process requires use of an induction furnace which cannot produce in sufficient quantities.
2. PRESENT MODERNIZATION WOULD POSTPONE REPLACEMENT CONSTRUCTION IF POLLUTION CONTROL PROCESSES WERE DISCOVERED TOMORROW. Control of the old style furnace is possible but not at a cost which will allow the foundry to stay in business.
3. A change in melting procedures might require complete reconstruction of the steel industry, a process which must take at least 20 years.
4. No one yet knows what the right control process should be and the steel industry must continue to modernize by current standards.

E. PROBLEM IS NOT PERFORMANCE OF KNOWN CONTROL TECHNOLOGY, BUT COST. The unsolved problem in industrial problems of air pollution is often not one of performance by known techniques, but rather of cost within the capacity of the capital structure and pricing framework of an industry. Consider the relationship of conservation control costs for some of the industries suggested in Chart #5.

F. TYPICAL OF INDUSTRIAL POLLUTION PROBLEMS, THERE ARE FEW COST OFFSETS IN THE FORM OF USEABLE BY-PRODUCTS.

G. CONTROL OF PLANT LOCATIONS THROUGH ZONING.

H. REDUCTION OF OTHER SOURCES OF CONTAMINANTS TO REDUCE OVERALL POLLUTION.

I. DIRECT GOVERNMENT SUBSIDY OF CAPITAL COSTS.

J. LEGAL PENALTIES WOULD FORCE FOUNDRIES OUT OF BUSINESS WHERE ENFORCED.

K. WITHOUT INITIAL CAPITAL FOR INVESTMENT, INCOME TAX PROVISION FOR CAPITAL RECOVERY DOES NOT OPERATE.

VII. Our demand for electric power requires combustion of coal to produce steam to turn the turbine which runs the generators. Coal supplies more than 50 per cent of our thermoelectric capacity and electric power represents 50 per cent of the market for coal.

A. The Oak Creek Plant in Milwaukee is presently rated at 1.7 million kilowats and will eventually produce 2 million kilowats as the largest power plant in Wisconsin. The coal is brought in on Lake Michigan and its tall stacks are designed to disperse its exhausts over the lake with the aid of prevailing westerlies. It consumes 7,000 tons of coal each day in a pulverized coal process which is one of the most efficient in the world. They feature efficient dust collecting devices which make it possible to burn coal with little discharge of chimney soot and smoke. The cost to control this ash was about 12 million dollars or 6 per cent of the total cost of construction.

B. But the problem is that the burning of coal releases huge volumes of sulphur dioxide, one of the most serious of the air pollutants. Combining with atmospheric moisture it means that a release of 18 tons of sulphuric acid and other sulphur gases occurs per hour! If 50 per cent of these gases were processed to make commercially saleable acid, the market for acid would be broken with the glut.

C. Until now, the basic approach has been to build tall chimneys to disperse these gases into the breezes well above ground level by increased air travel and engineering considerations hold stack heights to about 600 feet. Moreover, there is increasing evidence that as the concentration of sulphur dioxide increased with increased power production, down wind communities experience excessive concentration of SO_2 in certain weather conditions.

D. One solution is a washing process but this simply switches the solution to a water problem because of the tremendous number of gallons of water involved.

E. Another proposal has been to use low sulphur content coal, but these coals are in the west while the coal burning power plants are in the east and moreover would quickly be in short supply. There is the peripheral problem of changing to non-coal fuels such as atomic power but this would be a long-term process of conversion and would magnify economic dislocations.

VIII. Industry and business is simply a special subdivision of the social process concerned with converting natural resources to the products required by the society in which it operates. Conversion means applied energy and energy requires some form of combustion. Even atomic energy produces exhausts which have great potential harm.

A. If society wants the benefits of fire, it produces the wastes of combustion and our ecology is rapidly losing its tolerance for absorption of these wastes in the atmosphere.

B. If society intercepts combustion waste by dissolving them in water, then the water pollution problem is aggravated to the critical point of survival.

C. If society forces industry to use existing, chemical and mechanical techniques for pollution control, there would need to be restructuring of our price system for resource allocation and provision made for the majority of existing business enterprises which would fail financially in the short-run since they lack the resources to survive to a new point of equilibrium in the long-run.

D. Even if industry abuse of our natural environment is drastically curtailed, the environment will continue to deteriorate due to the auto and the single family home. Consumer abuse will rise with population growth, development of under-developed areas, and expansion of our own standard of living.

E. The exciting prospect of industry is that in the next 35 years, in this country alone, we must house an additional 140 million people in cities at the same time that we develop new production systems, transportation systems, energy systems for systematic conservation of a liveable environment.

F. The problem of sustaining life on the moon or in space travel is neither as complex a problem or one that will require as much capital for its solution as the manufacture of an environment which will make it possible for us to survive at even our present standard of living here on earth.

CHART #5

TYPICAL COSTS OF BASIC AND CONTROL EQUIPMENT
INSTALLED IN LOS ANGELES COUNTY

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment	% of control to basic cost
Airblown asphalt system	500 bbls./batch	$ 10,500	Afterburner	$ 3,000	29%
Bulk gasoline loading rack	667,000 gals./day	88,000	Vapor control	50,000	57%
Carbon black plant	2,000 gals./day	5,000	Baghouse	5,000	100%
Coffee roaster	3 tons/hr.	35,000	Cyclone and afterburner	8,000	23%
Crucible furnace, yellow brass	4 furnaces @ 850 lbs. each/heat	10,000	Baghouse	17,000	170%
Cupola, gray iron	48" ID	40,000	Baghouse and quench tank	67,000	168%
Fiberboard production	32,000 lbs./hr.	10,000	Electric precipitator	15,000	150%
Fluid catalytic cracking unit	40,000 bbls./day	7,460,000	Afterburner and precipitator	3,469,000	47%

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Commerce, Industry, Public Utilities

James A. Grasskamp

Business is not the natural enemy of conservation nor of civilization. I think historically we can show that civilization has evolved with industrial technology and that the standard of living we enjoy is based on industrial technology. So, with hindsight industry is condemned by citizens for its lack of foresight, even though its industrial managers have the same cultural pattern as the citizens condemning it. Certainly, industry can stand indicted for waste of natural resources, contamination of the air supply, pollution of our water sources, and desecreation of the natural landscape with industrial hardware of all kinds. But I think that we should abandon immediately the view that this is an ethical question--that industry is naturally inclined toward exploitation and destruction of the environment. This is nonsense. Accusing the pilot of the airliner of reckless disregard for the passengers' safety does not seem to make too much sense when one realizes that it is the nose of the airplane that will hit the mountain first.

I think,,rather than taking the easy answer that industrial management is without social ethic, we should examine the basic constraints on the individual firm which has to serve many masters and which, like the politician, has first the problem of surviving and then advancing and progressing. Therefore, the economics of advancing environmental control and quality should be examined, if only briefly.

First of all, the environmental economics of society are quite different than the economics of the individual farmer. Slide Society can invest its resources in environmental control up to an amount which equals the benefits being derived.

A triangle can illustrate this principle. The left side measures the total cost; the bottom represents the total benefits to be derived out of a commitment of society's resources to some aspect of conservation, the right side represents environmental control. and soon. Now obviously, there are two statements which are rather large assumptions, but the economists never seem to falter in making them. The first one is that we can measure the benefits. What is the cost of something such as dust in the air? We can't put a dollar value on it. We know it is not good, but we don't know how bad it is. And, by the same token, we can't really measure the cost of controlling a simple thing such as the soot which is emitted from all of the various chimneys in the land. We do have some processes which would be 99 per cent effective in eliminating soot but which can be installed only at considerable cost. However, the rather apparent contamination element of soot is the least important of the emissions from smokestacks.

Therefore, we cannot accurately measure in dollar terms the benefits to society of a given conservation program nor its cost. However, we can say that to the degree that the harmful effects of a given condition are reduced, we are justified in allocating some of society's resources for that purpose. A benefit-cost relationship is involved, which means that we will invest as much as is justified by the return in benefits to society. But no such benefit-cost relationship exists for the individual firm. With some exceptions, technological advances on environmental control provide no direct benefit to the individual firm. They are only a cost and a burden--a re-allocation of that firm's own resources and capacities toward environmental control. If it cannot shift the additional costs back to the consumer of its product, then it must absorb these costs, relocate to some other area without such controls on the businessman, or go broke. And I submit that survival of the individual business firm is an essential element in the fabric of the society.

If the firm does incur additional cost for some element contributing to environmental improvement--the control of smokestacks or water pollutant elements--this increase in its cost requires an increase in price to the consumer if the firm was at an equilibrium point to begin with. Now, if the price increases and the demand for the product is elastic, there must be a decline in the number of units which will be purchased. If the number of units purchased decreases, so will the number of units produced. Next, the fixed costs of operation must be distributed over a smaller product line, increasing the total cost of the product per unit by more than the incremental cost of environmental control. Thus, the cost of conservation must increase the total cost of the products being produced and sold by a multiple of the conservation expenditure, which will affect the entire revenue flow of the firm. In making a decision to implement one conservation procedure or another the firm must make decisions which consider the impact on a great number of persons with a vested interest in that firm.

First, the price and quantity requirements of the consumer must be considered: how much he needs, how much he can afford to pay, the level of quality he can afford to pay for in the product. The second consideration must be the return of capital required by the lender. The more capital that is necessary to go into the business and the longer it takes to repay that capital, the higher the interest rate on it will be and the less that can be invested in other projects, resulting in the delay of projects, with less priority.

A third point involved is the profit required by the equity investor of the firm. The businessman must also consider the employment stability in his region and the growth required by the community. If one firm is subject to restraints in terms of what it can or cannot do from an environmental standpoint, this means that it will not grow or expand in this area. It will either move to some area with less control or perhaps shut down entirely. Since the community is encouraging industrial expansion so that it may continue to employ its younger citizens, some kind of balance must be struck between the economic base of the community, the expansion of that base, and the constraints under which the firm must expand in that community.

The next consideration is the tax revenue by society. For example, if a firm is encouraged to invest in sewage treatment facilities of one sort or another, it may be given certain tax incentives or be allowed to depreciate the facilities more rapidly than other investments, thus decreasing the contribution toward the social treasury in the form of income taxes. Only so many favors can be given a business before there are no income taxes to support the other activities of society. So a balance must be struck between tax incentives and the tax revenue needs of the community. The final consideration is an equitable distribution of the cost of the conservation element in order to affect an efficient allocation of resources. A market economy presumes that, by having each firm operate to achieve its most optimal equilibrium point--the natural resources, labor, capital and management talents of that society will eventually be allocated to the most efficient degree possible. However, once the investment of capital is rearranged by imposing certain environmental restraints on the firm, obviously there will be a re-allocation of the entire society's resources.

Industry is a prime target for those who would reduce smog or water pollution, simply because industry offers both visible and dramatic targets, such as the black smudges coming from its tall smokestacks and the oil slicks on the water. However, I would suggest that you look at the record of communities such as Los Angeles, where very severe restrictions have been placed on the companies which contribute the most dramatic air contaminents of all, such as the oil refineries. Although industry has spent a tremendous fortune adjusting to these controls, the smog and other air pollutants continue to rise. It has been found that the primary contributor to the pollution problem in Los Angeles is the odorless and colorless carbon monoxides, carbon dioxides, and sulfer dioxides from the family auto and oil burner. Water pollution was found to be primarily the result of untreated sewage from communities where the citizens wanted to maintain their low property taxes. Therefore, industry should not be the sole whipping boy. Indeed, it remains to be proven whether the majority of what we call the pollutants of our environment are actually emitted by industry or produced by the consumer in enjoying the standard of living that industry has provided.

In this lecture we obviously can only suggest how some conservation factors affect the decision-making processes of the individual firms. First I would like to cite cases in which it is to the benefit of industry to follow good environmental practices. The principal problem of industry is adjusting to those conservation problems which impose only a capital cost, allocation of management, or a technological process which may be beyond their abilities to install and to operate. However, in some areas industry would benefit if it would only pursue conservation programs. An example is the regeneration of natural resources, which includes tree farms and fish farms. All sorts of natural resources can be regenerated as they are used, and, of course, companies using them have extensive programs for a natural cycle of replacement. If they did not, obviously the raw materials of their whole operation would be lost and, as the supply dwindled relative to the demand, the price of the materials they need for their business would become exhorbitant. Therefore, it is to their economic advantage to pursue a policy of conservation and regeneration.

There next is the problem of having marginal supplies of scarce resources, such as the iron ore in Wisconsin and Minnesota. Having exhausted the richest veins of these ores, businesses are now faced with either finding new sources of iron far more remote from productive blast furnaces or utlizing the more marginal sources of the raw materials, such as the taconite process which condenses and concentrates iron ores before shipment.

A third area, perhaps less apparent has to do with the loss of resources due to natural disasters and includes such things as fire prevention. The example of the Yates-American plant suggests where good aesthetics mean good economics (slide). The Yates-American plant on I-90 near Beloit, Wisconsin, is very attractive, with a very elaborate mosaic pattern on the plant and a large lagoon in front containing a fountain on which colored lights can be used. Now, while this is certainly an enlightened view of the factory building in the natural landscape, the lagoon also serves as a natural emergency water supply for the plants sprinkler system which is used to prevent fire. The sprinklers themselves reduce fire losses to the point where the fire insurance rate reduction will pay for the sprinklers and the lagoon in a very short period of time. Moreover, the fountain aerates the water, preventing algae from forming and clogging the pumps in case the fire system should have to be used. Also, because this is a rural plant without a municipal sewer system, the pond is used as a secondary treatment facility for the sewage plant, serving as a sedimentation and aeration pond for the effluent from plant sewers. Therefore, the natural landscaping--the fountain, the pond--are all supported and justified by the economics of a rural plant location.

Another manufacturing business produces suburban residential sites. Formerly Suburbia was the familiar grid plan going on ad infinitum. However, it is much cheaper for the manufacturer if he has a little smaller lot, and allocates the land he saves to a common greenery area. (slide) By trimming a little off the back and the sides of lots, the area related to that green area can be saved. (slide) By clustering lots in a circular pattern, the extent of streets necessary to serve it can be reduced, as can the length of the utility runs for sewer, water, and electricity.

As a result of producing a subdivision of homes made up of cluster patterns, we avoid the extensive utility investments of the conventional plan, and the construction costs caused by working with difficult slopes, ravines, and other areas which otherwise must be plowed down by the bulldozer and the earth grader. Much of the sterility of the grid plan is also avoided, and the result is a lower-cost product which has conserved the natural contours and attractive features that make suburban life worthwhile. (slide)

A comparison of the two types of subdivision layouts would show that all of the open space is used in a conventional pattern--even that which is difficult to subdivide. (slide) The cluster plan would have the same number of lots, but by reducing them only slightly in size the wooded, hilly, and ravine areas would be released to common use and enjoyment. Since these areas are difficult to build on, the result is a more attractive neighborhood at less cost.

Good aesthetics can also be good economics when the building, such as an architectural landmark of one sort or another, both advertises the firm's product and also serves to create an image of enlightened management. This can be carried through in the design of the individual products. But unfortunately for industry as well as society, these types of situations are in the minority. Instead the problem is how to cope with pollution (air or water). When consideration of environmental control is of no immediate benefit to the firm except that it is necessary in order to survive with society. When any economic system does not itself justify the cost involved, it is necessary to shift the social cost of disregard for these factors back to the individual producer by creating some type of economic, legal, or legislative penalty for failure to consider them.

For example, when the industrial revolution first began, factory personnel had a large number of accidents. There was a strict law of liability which would place the cost of these accidents upon the employer if it could be shown that he was negligent. But recovery was slow and uncertain. Charities, welfare agencies, and society in general had to carry the burden of the accidents. Finally, the issue of fault was removed, and employers were required to carry workman's compensation insurance to provide full medical benefits, lost wages, and rehabilitation to those who were injured, their survivors, and family. The premium for this mandatory insurance was based in part on the company's individual loss experience, and thus was made a function of the company's care and regard for its employees. The cost of this insurance induced the employers to undertake accident prevention and safety programs of various kinds in order to reduce their premium and the result was a conservation of human resources.

We are now trying to find ways to internalize the cost of environmental control in a way which is both fair to the manufacturer and provides and incentive for him to find the most efficient way of doing it. One way is to create legal penalties for failure to follow specified conservation practices. But ~~once~~ unless these penalties are set high enough, it simply becomes a way of licensing abuse of what otherwise might be conservation procedure. Another way is to create special incentives in the form of subsidy, tax relief, or special priveleges for the firms which do whatever desired conservation element is in question. Another way is to create rather intangible standards of approved social behavior to bring about the desired response to environmental conservation.

Water and air pollution are perhaps the dominant subjects in the debate on envrionmental control today. To see what lessons can be drawn about the reaction of the individual firm to these problems, we will look at the paper and steel industries and then the problems of an electric power plant.

The first problem of the paper industry is that of spent sulfite liquor. The paper making process is a cooking process, whereby logs are reduced to pulp in a pressure cooker, and it involves tremendous volumes of water. Spent sulfite liquor is not toxic or harmful and consists basically of about 50 per cent of the log products dissolved in the water. To understand the cooking process, look at the cellulose in logs as bricks, and the lignin in the logs as the mortar which holds the cellulose bricks together. The cooking process divorces the cellulose and the lignin reducing much of the cellulose to sugars. The lignin goes into solution as a result of the sulfination of the fluid, and what is left of the cellulose becomes the paper element. A very rich effluent results from paper production--the spent sulfite liquor which comes in tremendous volumes and is rich in some potentially useful organic material. For every ton of paper produced more than a ton and a half of this fluid is produced. The first problem then, is simply one of disposing of two and a quarter million tons of sulfite without putting it back in the river or lake from which the water came.

During the late 1930's in Wisconsin, the paper industry was asked to do something about the Fox River, which was being overburdened with sulfite liquor. Although the sulfite liquor itself was not the contaminant, it did require much of the oxygen capacity of the river, leaving little oxygen for reduction of the sewage elements and other pollutants being introduced into it. In orfer to relieve the river of this burden, the paper companies were asked to find another way of handling the sulfite liquor. Therefore, for the last 26 years they have financed the research themselves on a voluntary basis and they now have implemented some system at each plant for disposing and perhaps utilizing the sulfite liquor.

At first the problem of disposing of this tremendous volume led to solutions such as sedimentation ponds, where the fluid was simply pumped in and allowed to evaporate. Another solution was timing discharges of the fluid from storage tanks, so that it would be disposed of only at points of high flow of the river and thus would not become the dominant fluid in the river. A very low cost utilization of these products was spraying them on gravel roads to keep the dust down, since they are an excellent road binder. Some of them were used as fuel, by distilling and extracting the solids from the liquor and then injecting these solids into the furnace.

But all of these uses were simply ways to dispose of large volumes of the fluid, and the economic benedit bore no resemblance to the total cost of disposing of the fluids.

More recently chemistry has made it possible to reduce these wastes to what we would call high-value products, such as adhesives and yeasts. The paper plant at Rhinelander converts almost all of its sulfite products to yeast. However, the volume of yeast which could be produced from sulfite liquor exceeds the total demand for yeast in the country. Therefore, one solution alone is not enough to solve the problem.

By the same token, the volume of adhesives which could be produced probably exceeds the industrial applications of these adhesives at this point. Therefore, technology must find multiple answers to the utilization of these products. Otherwise, the market for the various products which were created can be literally broken by oversupply. (slide)

Until recently the problem has simply been one of total disposal. Then, gradually, there was some low-value utilization. But as chemistry made possible high-value utlization of these fluids, the disposal through sedimentation, spraying on vacant land and so forth, dropped to a very small percentage of total production. Presently, we are utilizing about 35 per cent of these fluids in various types of products. However, chemists have still been unable to develop enough uses for all of this waste. The process has required a tremendous investment in capital, although most people think of capital as being hardware--the pumps, the furnaces, the machinery, the presses, and so on. But capital here meant a long-term investment, in research, market development, and education on using these products rather than what may already be on the market. Finally, once the process and the product were known, capital meant the creation of the hardware to make it commercially feasible.

One way to ameliorate the waste disposal problem is simply to find new ways of making paper with less water. This meands first of all that an unnecessary burden is not placed on our total surface water supplies. Secondly, by using less water less waste goes into solution. Thus efficient use of water means not only a change in the disposal pattern, but also a change in the entire production process in order to eliminate the initial source of wastes. By doing this there is less of an oxygen demand on the rivers, the volumes of waste are smaller, and the balance of the waste produced is brought back to the level of the productive uses for it.

An excerpt from a movie produced by Kimberly Clark shows the research they have done in waterconservation in paper processes. (Movie script follows) In the notoriously water-short area of Southern California, the problem of conserving the water supply is coupled with waste treatment and disposal. In this section of the country waste treatment is approached with the double goals of water recovery for re-use as well as fiber reclamation. This surplus water drains from the stock, through the screen to the tray collector and into the white water chest, called that because the water is white with bleached wood fibers. It is pumped from there to various other locations for dilution and a vacuum filter or save-all recovers the wood fibers and clarifies the water.

The design of the Fullerton plant allowed it to start operation using only half the amount of water normally required for a ton of production. This has since been reduced to one-third, and still further reductions now appear within reach.

The material from the save-all contains fibers formerly lost, but now recovered for profitable production. Clarified water, the other product of the save-all, is re-used in processing and also for clean-up purposes.

The giant mixing bowl or hydro-pulper prepares the pulp for the quake wadding (?) machines. The mix consists of treated wood fibers, or cellulose, and water and is thick, looking something like white cotton candy. To thin the mix dillution water is used, which already contains wood fibers and is drawn from the white water chest. Water is precious at Fullerton and none is wasted.

Part of the continuing conservation effort includes the water recovery systems at the Fullerton mill. Incoming fresh water, treated to soften it and reduce dissolved solids, is mixed with mill effluent. The mixture passes through a sedimentation and flocculation unit--a high-rate settler where particles collect and settle out. After the water goes through a final polishing filtration it is ready for re-use in the production process. With this system in operation, water is re-cycled though the plant repeatedly with the addition of only relatively small amounts of fresh or make-up water. (end of movie)

The cost of providing that type of research runs from five to ten per cent of the cost of the paper mill itself.

Let's take a look at a problem where we can get a better idea of costs. The steel industry provides probably an unlimited number of horror stories for conservationists in regard to air and water pollution. The typical blast furnace emits iron oxide, silica fumes, carbon monoxide, sulfer dioxide, oil, and coke dust. No matter how you state it, these are harmful and corrosive, and in some areas they have been known to erode the stone on the face of buildings. It will cause damage to the surface of automobiles, blight vegetation, produce uncomfortable odors, and reduce visibility. There is no way to get around that, unless we can eliminate the fumes themselves.

Firms voluntarily have tried to develop control installations, but they have experienced an unexpectedly high investment and operating cost. In Michigan the cost for a simple foundary was more than one million dollars per cupola, the vent on the top of a single blast furnace. This represented more than 25 per cent of the total construction cost of that cupola. The fans and pumps necessary to handle the air control features of these cupolas required 1,400 total electric horsepower, and the cost of operating them for three shifts a day was $100,000 a year for electricity alone. Moreover, the replacement and maintenace cost equalled a yearly expenditure of one-third the initial investment--over $300,000 each year to replace the fans and pumps, and to otherwise keep the machinery in operating order. The very things which make the fumes corrosive and undesirable to the average citizen, makes them also highly undesirable for the ordinary piece of machinery. Often fan baldes had to be replaced, as often as every two weeks. Break-downs and other disadvantages with this type of equipment meant that the cost of operating adequate control equipment on the exhaust from a single foundary cupola represented at least half the cost of the initial equipment, or more than $500,000 a year.

Control equipment, therefore, is just economically out of reach of most companies because they cannot afford to pass these costs along to their customers. If the foundaries in Michigan are required to meet these standards, but the foundaries in Illinois Wisconsin, and Ohio are not, then those foundaries which have the lower costs obviously have lower prices and soon will have all of the customers. A small foundary that might invest $750,000 in a total plant, equipment, and all of its inventories would require at least an additional $300,000, for an air filtration system, The price structure for foundary products will not presently support that kind of investment.

If we wanted to change the steel-making process or the foundary process, there are several technological alternatives, but most of them will not produce the products we need in sufficient volume. In the absence of economically acceptable control procedures, industry still must continue to convert to the new oxygen furnace in order to remain competitive with both overseas producers and alternative domestic producers in areas which may not be so concerned with conservation. The current modernization of equipment will postpone replacement construction, if and when pollution control processes are discovered. Even if they were made operational tomorrow, more than 50 per cent of our steel capacity would not benefit from them for another twenty years. A change in the melting procedures might require a complete reconstruction of the steel industry, which under present replacement and depreciation processes, would take at least twenty-five years.

The fact is that no one today knows what the right control process should be. The steel industry has to continue to modernize to survive in the current competitive environment. Therefore, the dilemma is one of securing conservation controls when the technology does not exist without either setting back the industry or the standards that society has set for its products.

The problem in the steel industry applies to many others. (slide) The problem is not the performance of a known control but rather the cost. We can control plant location through zoning so that these fumes are emitted in the less desirable parts of our country, but this still contributes to the total air pollution problem which can be considered on a world-wide basis. Time magazine recently reported that the carbon dioxide-carbon monoxide build-up for the world as a whole has been 10 per cent since the turn of the century. This has created what they call a green house effect--a gradual warming of our average temperatures. If this continues another 10 per cent the polar ice caps will begin to melt. This would be one solution to much of our pollution problem, since the costal cities where industry is heaviest would be under about 50 feet of water.

There is the alternative of direct government subsidy of capital costs, but as yet our legislators have been unwilling to do this. If legal penalties were enforced, foundaries would be put out of business, and this has in fact, happened. Firms in both Milwaukee and Detroit have literally gone out of business or gone broke in the process o f installing air filtration equipment on their plant.

All of the assumptions up to now have been that firms can afford to do whatever they want, which is not so. Without initial capital for investment, all of the income tax provisions and other types of incentives simply will not operate. You cannot tell someone to spend $300,000 on a given process when he does not have $300,000, nor the profit expectations in his business such that he can attract $300,000. He has the choice of simply going out of business quickly, by graceful liquidation, or slowly, through an undignified bankruptcy.

Another type of horror story for the various firms involved here is the different types of equipment that are needed and the expense relative to their total capital investment. Those which I selected are not necessarily the worst, but they were the costs that came to hand quickly. They suggest the cost of air filtration or water pollution equipment, relative to the total cost of the plant for various types of basic industrial processes.

There is also the problem of power and energy. Our demand for electric power is basic to an industrial society, and it requires energy to turn the turbines which turn the
of this energy is created by the combustion of coal. Coal
generators. Some 55 per cent of their market in electric power. (slide) suppliers find more than 50 per cent

The Oak Creek power plant in Milwaukee is rated about 1.7 million kilowatts, and it will eventually produce about two million kilowatts, to be the largest power plant in Wisconsin. It is run on a highly efficient coal system, which pulverizes coal into a very fine talcum-like dust and blows the dust into the furnace so that it burns like a gas rather than as a solid. The tall stacks are designed to disperse the fumes from this process over Lake Michigan at a height which will hopefully avoid ground-level concentrations. This, of course, allows them to disperse over the lake where the prevailing breeze is westerly so that the good people in the southern part of Milwaukee County will not be irritated often. It consumes about 7,000 tons of coal each day. The chimneys each feature electric precipitators to remove the soot and ash so that the smudges ordinarily associated with this type of plant are almost non-existant. The system is about 99.6 per cent efficient in removing soot and ash. Its site is the best that could be had under the circumstances. The cost to control that ash was about 6 per cent or $12 million of the total construction cost.

Certainly the electric company is sensitive and aware of the problem of air control. But the problem is really that burning of coal releases huge volumes of sulfer dioxide, one of our most serious air pollutants. Combined with the atmospheric moisture, it is the equivalent of 18 tons of sulferic acid per hour. If 50 per cent of these gases could be processed and converted to make commerically salable acid, the commercial market for sulferic acid would be destroyed. We simply do not have the industrial demand to utlize all of the potential products of the wastes being vented up chimneys. Until now the basic approach has been to build a tall chimney and hope that we can disperse these gases in the breeze well about ground level and the local citizenry. But now we are reaching points where beyond 600 feet these chimneys are a hazard to airplanes. Moreover, there is increasing evidence that the concentration of sulfer dioxide may not increase in Milwaukee but will increase on the lee side of Michigan. As our concentrations of these gases increase in downwind communities, we begin to have the adverse effects that we were trying to avoid with the local community where the power plant is located.

One solution is to wash the gases before venting them, as is done in England. But the problem here is that this simply changes the problem for one of air pollution to one of water pollution. What could be done with the 1.2 million gallons of water per hour needed to make the system work and from where could that much water be taken without having the aggregate effect of power plants all around the Great Lakes draining off the surface of the lakes to a point where channels, shipping, and so forth would be adversely affected.

Another proposal is to use low sulfur coal. However, these coals are largely in the western part of the United States, while most coal-burning power plants are on the eastern side of the United States. The pripheral problem then is hoq to transport the coal to where it is needed most. Indeed, if all of the electric power plants did convert to low sulfur coal, the supply would quickly be exhausted, since it represents only a small part of our available energy resources. The same problem with sulfur dioxide exists with the use of all our fossil fuels, including oil, and gas, as well as coal. As yet there has been no technological solution to this which is one of the most serious problems of our environmental control.

Industry is simply a subdivision of the social process, and it shares with the average citizen the same standards, the same willingness to choose from one advantage or another and the same willingness to incur cost without its own special benefit. Even atomic energy, for example, will produce potentially dangerous exhaust wastes. But society wants the benefits of fire, even if it produces wastes of combustion. However, our ecology is rapidly losing its tolerance to absorb these wastes in the atmosphere and if they are intercepted by dissolving them in water, our water resources will be destroyed. If society forces industry to use existing chemical and mechanical techniques for control, there would be a complete restructuring of our price system for resource allocation and for the standard of living which is presently enjoyed. This is also politically unacceptable. Even if industrial abuse of our natural environment were curtailed, the environment would still continue to deteriorate because of the auto and the single-family home.

Consumer abuse will rise with population growth, with development of our underdeveloped areas around the world, and expansion of our own standard of living. In addition, in the next 35 years industry will have to supply, house, and feed another 140 million people in cities while at the same time developing an entirely new production process which does not produce harmful environmental consequences. We must produce transportation systems which do not have unpleasant consequences for our ecology. We must have new energy systems in order to produce a livable environment.

Industry is quite aware of its responsibilities since it, too, would like to survive. The problem of sustaining lifeon the moon or in space travel is neither as complex a problem nor one that will require as much capital and private initiative for its solution as the manufacture of an environment which will make it possible for us to still have our industry and our natural environment by the year 2000.