A PRIMER ON THE POLITICAL ECONOMY OF AIR QUALITY MANAGEMENT

(for Engineers and Others with Low Tolerance for Mushy Data)

[This work was supported by the Environment and Man Program of Utah State University]

John Baden

March 3, 1973

TABLE OF CONTENTS

Preface . . . . . .

Introduction

A Few Comments on the Philosophy of Science I-1-9

Private Rationality, Public Rationality, Government, And Clean Air 11-1-36

The Increasing Value and Importance of Environmental Quality and Management III-T-17

On the Politics of Hot Air IV-1-21

On the Political Economy of Glamour, Sex Convenience, And Air Pollution V-l-11

Appendix

On the Difficulty of Being Environmentally Moral in the Absence of Pricing VI-1-4

PREFACE

These essays were written for Professor Bob Gearheart's "Air Quality Management" course in the Environmental Engineering Program at U.S.I). They were written from January 22 to February 18 of 1973. In no sense does this material constitute either research or even a review of the literature. This was essentially a sit-down~and-write-it-out effort. Further, I have made no systematic effort to learn about air pollution and its control. Hence, the following material is presented in a rather casual and perhaps cavalier manner. Ms. Virginia Ream's editing of my first drafts has cleaned up my residual illiteracy.

I have attempted to take the perspective of a political economist and examine a set of problems. If this effort is useful for engineers and others I would be willing to put the material into a more conventional form. I will, of course, be grateful to those who point out errors and/or make suggestions.

John Baden
February 20, 1973
Preliminary Draft

INTRODUCTION

A FEW COMMENTS ON THE PHILOSOPHY OF SCIENCE AND THE SOCIOLOGY OF ENGINEERS

(If you prefer not to read this call it an appendix)

I. Engineering and the Philosophy of Science

Engineers seem singularly uninterested in the philosophy of science. One of my relatives, a person whose Ph.D. is in engineering, explains that this is an entirely reasonable indifference for engineering tends to involve work at relatively low levels of abstraction. By degree of abstraction reference is to the length of the definitional chain from the empirical phenomena to the concepts used in analysis. I am told that in most engineering applications this chain tends to be fairly short. In addition, the rules of correspondence from the physical system being studied to the analytic system of mathematics tend to be quite clear. Further, causal linkages among the variables can be traced with clarity. Thus, one is not burdened by teleological arguments, with largely silly concerns about mind-body problems or with freewill-deterministic positions. Finally, engineers are seldom faced with the accusations that their findings are a result of the distortions produced by their personal biases. Because of these greatly oversimplified conditions, engineers have little

incentive to invest their time in the study of the philosophy of science--as long as they restrict their attention to the traditional range of engineering problems.

As engineers, such as environmental engineers, move into areas where "their" systems interact with social systems, they have reason to become concerned with the behavior of the social systems or, more strictly, with the behavior of the elements of these systems. Hence, they need to predict behavior in these systems. When they make this effort, they are dangerously close to practicing social science. This introduction is written as a cautionary note, for it is exceedingly easy to appear stupid when practicing social science. A substantial number of engineers have done so.

II. Defining the Terrain

For a number of years I have looked for a definition of science more complete and succinct than mine which states: "science is the systematic reduction of indeterminancy." This I take to be a perfectly general statement. From it, it is useful to divide sciences into two types. There are the empirical sciences such as physics, meteorology, demography, and economics; and non-empirical sciences such as mathematics and symbolic logic. The latter are systems of symbols with rules for the interrelationships among these symbols. The symbols themselves have no empirical content. Through rules of correspondence the non-empirical sciences are used as devices to analyze empirical phenomena.

In general, one looks at elements involved in a empirical system,

and through rules of correspondence, moves to a nonempirical system where symbolic manipulations are carried out and then he moves back to the physical system to make prediction. If all relevant variables are accounted for, the prediction derived from a valid theory describes some transformed state of the empirical system. If I recall correctly, this sketch also describes the structure of an examination in physics.

III. Science and Social Science

I have the general impression that many people in the natural sciences and in engineering believe that it would be useful to have "good" social science and that most believe that good social science is in short supply. The belief is correct. There are several reasons for both the preference and the belief. Having suggested the reasons for the preference in the beginning of this paper, I will attempt to account for the belief held among engineers that good social science is in short supply.

First, some engineers believe that human beings can be scientifically studied only as objects of bioengineering or as falling bodies. These people simply fail to understand science and their argument can be summarily dismissed.

Second, some believe that those practicing social science are, to put it bluntly, relatively stupid. There is some merit in this claim, but the issue is more complex than the statement suggests.

One can divide, as the Graduate Record Exams do, mental abilities into two aspects: verbal abilities and quantitative abilities. Quantitative abilities (not GRE scores on quantitative abilities but

"real" quantitative abi1ities--see how difficult it is even talk about people systematically) determine how well one can learn to manipulate symbols in the nonempirical systems, e.g., how good one is in math. It is inconceivable that one could do standard graduate level work in any field of engineering without having fairly high sophistication in some nonempirical science, i.e., some sort of mathematics. This, of course, is evidenced by the prerequisite courses in the catalog of any university with an engineering program. This requirement serves as a filter that keeps those with low quantitative abilities out of engineering fields.

In contrast with this situation is the situation found in some of the social sciences. Until recently, in many social science departments one was considered a mathematical wizard if he could do much more than count the number of students in his classes and find the room with the right number on the door. In brief, there was no filter that kept those with low quantitative abilities out of the social sciences. There simply has been little need for quantitative skills requiring mathematical sophistication. Hence, given that there is some positive correlation between quantitative aptitude and general aptitude in the most universal sense, the initial assertion that those in the social sciences are relatively stupid has some basis in fact.

The condition described above, however, will soon be largely of historical interest. There are three social sciences marked by their success, measured in terms of scientific achievement. These are economics., demography, and linguistics. Scientific work in the first

two is heavily mathematical and linguistics relies on forms of symbolic logic. Further some graduate programs in political science require roughly the same background in mathematics as do graduate programs in engineering. It remains the case, however, that today one has to strain to find a use for sophisticated mathematics in most of the social sciences. One can expect the differential abilities mentioned above to continues but at a decreasing level. I will only rarely have the pleasure of finding a faculty member from engineering sneaking over to ask a colleague in one of my departments for aid in solving a mathematical problem. One will, however, increasingly find that graduate students in a first rate social science department will have higher GRE quantitative aptitude scores than do the natural science graduate students in a third rate department.

Third, for large variety of reasons briefly mentioned here., it is exceedingly difficult to practice good social science. There are serious problems involved in formulating concepts, in obtaining data, in finding reasonably suitable rules of correspondences, in selecting the relevant variables from the vast number available, and in dealing with the philosophical questions mentioned at the beginning of this paper.

Quite apart from the above problems is the fact that many special interests, e.g., legislators, church leaders of many faiths, politically powerful people, etc., find social science quite threatening. This fear is well founded, for social science more so than any other science is highly errosive of the traditional wisdom and various ascribed sanctities which exist to some degree in *every* society. Under the general canons of

of science, no belief about empirical matters can be settled by authority, conviction, faith, tradition, or revelation. Science is played like a game of intellectual grab-ass where the regulations are set only by the scientists who play. While all science is played under the same fundamental set of rules, aside from bizarre and critical issues such as those which involved Lysyinco and Galileo, political and religious leaders have tended to be more concerned with the substance and potential political and cultural implications of social science findings than, for examples those in electrical engineering. (As an aside, however, I am convinced that the cultural and political implications which flow from electrical engineering are far more serious than those which result from the social sciences. It is difficult., however, for leaders to predict the second and higher order consequences of developments in engineering while those in the social sciences seem to be obvious.)

Fourth, engineers may have a low opinion of social science for the simple reason that the vast majority of what passes for or what is called social science is either something other than science, trivia masquerading as science, or simply bad science. I would estimate that these three categories include a substantial proportion of that which has been called social science. Clearly, there are vast differences of scientific quality among and within the various social science disciplines.

Of these three categories, I will comment briefly on one that is not science, but is often *very* useful in practical affairs and that has the potential for serving as a base for scientific work. This is the straight descriptive study that provides an account of some social system

or set of social systems. Included in this category are the ethnographic works that embellish anthropology. (In addition to being useful to engineers and others who are working in alien and "exotic" cultures, often this material also provides enjoyable reading. It also demonstrates that Cache Valley is nearer the cultural mean of the world than is most of the rest of America.) Sociology provides examples of essentially descriptive work in its many community studies. Most of the political science literature on comparative government and public administration is in the same class. Often, this material masquerades as science and those practicing it probably consider themselves scientists. Given that much of this work is at least potentially useful e.g., that of taxonomists in several fields, it probably causes little harm for practitioners to continue with both their work and their delusions. Their pretense does not diminish the value of their work.

IV. A sketch of the Scientific Process

Under II above, I defined science as the systematic reduction of indeterminancy. Earlier I stated that engineers, by and large, tended to be indifferent to the philosophy of science, and I suggested a few reasons why this might be the case, noting that as engineers become increasingly concerned with social systems, and hence, with social science, a relatively greater self-consciousness with the scientific process might be useful. In sum, both consumers and practitioners of social science need to exercise great caution. At the risk of sounding critical

when I do not wish to be, the engineer may be like the child super skiing star, i.e., he can ski well, but he is likely not to be able to explicate the process. Science is, quite literally, second nature to him.

The structure of the social science enterprise is like that of any other empirical science. Theories are constructed from' logically related empirical relationships, Theories explain behavior by connecting conditions to consequences. Inferential reasoning can be used to derive hypotheses. The antecedent conditions are either independent or intervening variables, and the consequential state is the set of dependent variables. Research generates support for (or rejection of) the predicted association among the variables predicted by the theory. In this context, explanation is structurally identical to prediction.

In social science, theory can be used to suggest associations among conditions whose consequences are viewed as having negative utility. Under alternative conditions, we can anticipate modified consequences. Hence, there is sometimes a potential for alternative possibilities through certain policy decisions. The assessment of probable outcomes is the guts of policy analysis.

The following essays provide a casual sketch of the kind of policy analysis that demands a conjunction of engineering and social science. Should you ever be occasioned to practice or use social science, be aware of its problems and limitations. More importantly, remember that structure is identical to that of the empirical science that you know best, and that the consequences of violating this structure are less obvious.

[Should you have some interest in examining literature in the philosophy of science, I suggest the following as a good beginning.

Carnap, Rudolph, Philosophical Foundations of Physics, 1966.

Bergmann, Gustav, Philosophy of Sciences, 1964.

Nagel, Stuart, The Structure of Science, 1961.

Hempel, Carl, Philosophy of Natural Science, 1966.
Fundamentals of Concept.

Madden, Edward, The Structure of Scientific Thought, 1960.

Reichenbach, Hans, The Rise of Scientific Philosophy, 1951.

Brodbeck, May, Reading In the Philosophy of Social Sciences, 1968.]

John Baden
1/30/73
Preliminary Statement

Private Rationality, Public Rationality, Government., and Clean Air

Introduction: Air pollutions like many other issues of social welfare, has precipitated a demand for governmental intervention. Good intentions, however, even when converted to public policy will not suffice. If air quality management is to successfully meet its goals, careful attention must by given to both the physical and social systems involved. Often the social context of resource administration is neglected.

Administrators' behavior is not governed, or determined by the agencies statement of purpose. Nor is the behavior determined by the arguments evidenced in Congressional debate when the founding of the agency was considered. Rather than looking toward statements of purpose for understanding the performance of bureaucracies, we can infer from the case literature that bureaucratic behavior is primarily the result of the information and incentives available to or operative upon the bureaucrats. From this perspective we can suggest that if a bureaucracy is performing "inadequately,," i.e., if it does not provide the preferred mix of goods and services efficiently, we should first examine the structure of information and the incentives in the environment of the administrators.

I. Economics and Political Science

Social morality may reasonably be considered an ordered set of

---

I thank Judd Harmon and Rick Stroup for their extremely useful comments on this essay.

preferences applied to more than one person. This directly relates to a fundamental distinction in a market organized society between the subject matter of economics and that of political science. Economics is viewed by its practioners as the science of choice in a context of scarcity. It is largely concerned with the organization of behavior under the rules of willing consent. By this I mean that economics involves the study of voluntary relationships. Presumably we will not voluntarily become party to an economic arrangement that leaves us worse off than before.

In contrast with this situation is the subject matter of political science. This discipline is concerned with the analysis of situations in which the rule of willing consent is relaxed. Briefly, political science deals with social situations in which coercion is an important component. (Obviously, there are examples of a "coercion" potential in the economic sphere. Assume that I have a corner on the potable water market in a liferaft floating in the South Pacific. Normally, however, is a market context there are substitutes for products and there are competitive suppliers.) On the basis of this differences we find that in the political context there is always a potential for particular moralities to be enforced via coercion. Our peculiarly high degree of political freedom is an historical aberration, and on a probabilistic basis is very likely to decline. Examples are all too frequent: a white may not marry (consort with, serve food to, sell a house to, etc) a black; all must salute the flag (king, peoples' spirit incarnate, etc); all must pay taxes to support the war (birth controls death control, oil interests., universities, etc). This difference in coercion between the economic sector and the political sector is, I trust, compellingly obvious.

II. Why Recourse to Political Organization

I hope that the above served to alert you to the dangerous potential inherent to reliance upon political organization. As one of the few surviving conservative anarchists, I acknowledge the necessity for relaxing the rule of willing consent. In this section I will briefly sketch the rationale for this relaxation.

You recall that the compelling advantages of market coordinated behavior are: first, that people voluntarily participate; and second, that prices serve as effective and efficient coordinating and rationing devices. I trust that it is intuitively obvious (even if you would reject all of the remainder of Friedmans' Capitalism and Freedom that a government is required for the following purposes: (1) to serve as an arbiter among parties when disagreements arise;(2) to protect the weak from the strong; (3) to prevent the market forces from being disrupted and distorted (by monopolists etc). Generally, a government is needed to enforce property rights and to maintain a context of law and order (please don't shudder at the phrase just because Nixon, et. al. have distorted its meaning by adding connotations) in which productive social relations can be undertaken. I believe that among sane men we could obtain perfect agreement that in a modernized society all of the above functions must be performed if social welfare is to be maximized. The question then becomes, to what degree should the scope of government by expanded beyond those tasks?

III. The Expansion of Action: Public Goods and Common Pool Resources

In this section I merely suggest two areas in which governmental

action is required if social costs are to be reduced and social benefits increased. Detailed treatment will be discussed later in this paper.

A public good is one which if available for anyone is available for everyone. (A similar definition applies to public bads). This suggests that the good is not packageable and hence, people cannot be excluded from its consumption. Otherwise expressed, property rights cannot be readily established for public goods. Standard examples included the benefits derived form national defense, light houses or mosquito control programs. Given that people cannot be excluded from the benefits of these programs, they do not ordinarily have an incentive to contribute to their provision of the goods. Hence, in the market context, i.e., in a situation in which willing consent is required for action, these goods will be undersupplied.

There are exceptions to these generalizations. Firsts in small groups social pressure can induce contributions for public goods, e.g., in some communal situations. Second, if there is a situation where the private benefit from providing a public good is greater than the private costs associated with providing the good, the public good will be supplied privately. An example of this situation occurs when a logging company maintains a road to a public area used by hunters, snowmobilers, and other recreationists. This, of course, is done to provide access for the company. The public good provision is a positive externality generated by the company's selfish action.

The second area where governmental action is required involves the management of common pool resources. Briefly., a common pool resource is one in which there are multiple owners (or a number of people who have rights

to use the resource) and where the use of one (or a set of users) can have adverse effects upon the interests of other users. In the situation where there is no recourse to some agency with the power to coordinate and/or to ration use, action which is individually rational can be collectively disastrous when the demand exceeds supply. To take a simple example, assume a valley airshed that has air breathing citizens and two copper smelters owned by different companies. In this situation the air is the common pool resource and the breathing citizens and the copper smelters the resource users. Given that it is costly to reduce the air pollution caused by the smelters and the damage done by the smelters is greater than the cost of cleaning the air, there is a net advantage to be gained by controlling pollution. Yet the copper companies cannot be expected voluntarily to reduce their despoliation. Hence., a relaxation of the rule of willing consent is necessary to reduce the pollution and increase social welfare.

An alternative example involves the over exploitation of a common pool resource. If we consider whales or salmon a common pool resource with independent harvesters, each harvester has an incentive to maximize his take. In the absence of collective management and rationing of the resource, we can expect the take to go beyond sustained yield. After it is understood that the resource is being depleted, we often find over investment in harvesting technology as each resource user tries to sustain his take in the face of a diminishing resource.

Thus, in the absence of clear property right to the resource and of a coordinating arrangement based on some rule other than that of

willing consent, the resource will be unnecessarily depleted. Further, a socially inefficient investment will be made in the requisite capital to harvest the resource. Imagine if you can the dynamics we would find in the national forests if suddenly all of the timber were put up for grabs on a cutout and get out basis with no provision for ownership and hence storage of the stumpage. In addition to assuring a speedy removal of the forests, it is likely that there would be great over investments in logging machinery. While many find this example nearly mind boggling, it is directly analogous to the behavioral patterns found in the exploitation of common pool resources in the absence of institutions geared to manage and ration the resource and to adjudicate conflicts among the competing users.

IV. The Difficulties with Private Solutions to These Problems

The above section has argued that there are situations in which significant social advantages may be gained by establishing agencies and bureaucracies and assigning them responsibilities and granting them powers. In principles it would be possible to accomplish the same ends via voluntary agreements among the parties with a stake in the matter. In applications however, we will always encounter a number of factors that preclude this solution except by small groups, i.e., groups small enough to coordinate and enforce behavior on a face-to-face basis. It is obvious that with increasing population density and with increasing interdependence among ever more distant persons, the range of problems that can be handled on a face-to-face basis contracts appreciably. In this Section I sketched several rationales for the insufficiency of voluntary arguments.

A common pool resource is managed or a public good provided because these actions are projected to leave people better off, i.e., net social welfare is then increased. If this can be demonstrated to the satisfaction of all parties involved., why must one resort to governmental action, why will this action not be undertaken voluntarily?

A. Free Rider Problem

The first reason is the free rider problem. Assume we know from energy cycling studies that by investing 200 units in nutrient enrichment, fish production will be increased by 1000 units in a fishery resource harvested *by* 400 commercial fishermen. Also assume that there are no relevant enternalities involved in the nutrient enrichment program. Clearly there are great advantages to such a program. In this situations however, each fisherman has an incentive to avoid contributing his share of the 200 units, i.e., half a unit. If he doesn't contribute and others do, he will be far ahead, having withheld his contributions from the enrichment program to invest his half unit in more effective harvesting tools. [This is true if we assume within the range given here, a linear relationship between enrichment and production. Obviously, if we were dealing with a step function whose first threshold was encountered between the 199.5 unit and the 200 unit of investments then the marginal contribution of the last fisherman would be enhanced. Such possibilities should not detract from the thrust of the example offered here]. Alternatively, under the above assumptions no fisherman would contribute his share. The marginal improvement of any one contribution would be spread over the 400 fishermen. Hence, unless each fisherman knows that he can collect

a share of the marginal improvement generated by the contribution of each of the other 399 fishermen, it is to his advantage not to invest in the program and to be a free rider on the backs of those who do contribute.

Because of the behavior generated by this structure of incentives and opportunities, it is necessary to relax the rule of willing consent and rely upon the potential for coercion (governmental action) if the resource is to be rationally managed. A similar logic is involved in efforts to protect or improve the quality of an airshed or a body of water. In each case, reliance upon voluntary agreement yields a less than optimal resource base. The normative question then involved the degree to which freedom is to be sacrificed via the replacement of the rule of willing consent by one of coercion in order to protect or enhance an environmental resource. It is compellingly obvious that one of the most substantial costs of an increasing population is precisely the sacrifice in freedom necessitated by the need for maximizing ration management when confronted with increasing interdependence and increasing demands on the resource base. In generals the world is taking on an ever greater resemblance to a common pool. [As an aside, one example which I find especially fascinating is the management of beaver streams adopted by the Crow Indians when the fur companies of the Missouri River trade entered their area. Apparently the Crows were the only Indians with sufficient organization to keep "their" streams from being trapped out.]

B. Decision Making or Bargaining Costs

In the absence of enforceable property rights to a resource or service,

it is extremely difficult to reach voluntary agreements regarding its management or provision. If we restrict our consideration to situations where property rights present few problems, we still encounter serious problems which preclude successful voluntary agreements among the parties involved. Clearly, two neighbors can often agree to construct and maintain a lane serving their contiquous holdings. Because the marginal costs of additional usage tends to be quite low, each has an incentive to come to an agreement with the other. In principle this could be extended to N parties.

However, it is obvious that there are at least two sets of costs involved in building the road. First is the actual cost of construction and maintenance. Second is the opportunity costs associated with the time spent in agreeing how to finance and administer the road. Given that the number of roads is quite large and that there is a finite probability of my wanting to use any road physically accessible to me, and that this probability increases as the proximity of the road to my holdings increase, two aspects become apparent. Firsts I have an interest or potential interest in a very large number of roads. Seconds if I attended negotiations for each road in which I have an interest, I would not have time for anything else. Hence, the opportunity costs of voluntary agreement become grossly unreasonable.

From the above discussion of the free rider problem and the problem of opportunity or bargaining costs associated with voluntary agreements we can develop a general statement describing the role of governmental action. From this perspective, government is nothing more than a prosaic

instrument designed to coordinate human behavior via potential resort to coercion when the costs associated with reliance upon voluntary agreement are considered to be excessively high by a group of people possessing sufficient power to set and enforce the rules under which rules are made. That sentence contains the rationale for beginning government and it is the definitive rejection of anarchy--both I find saddening.

V. Dangers Inherent to Reliance Upon Bureaucracies

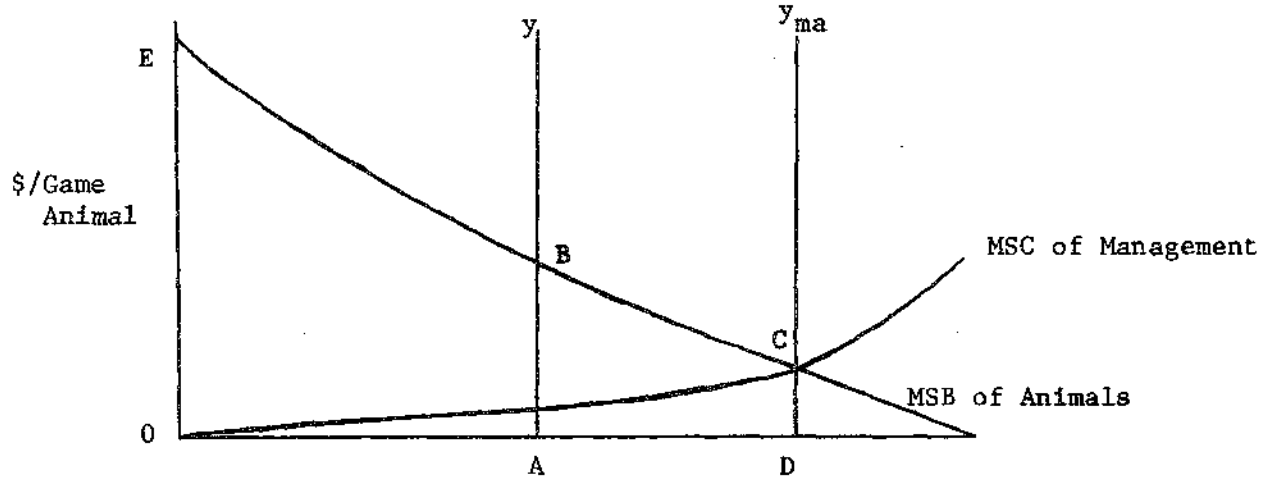
In the previous sections I have tried to explain why there are situations in which net welfare can be enhanced by relaxing the rule of willing consent and permitting coercion for the coordination of human affairs. This, however, was not to suggest that the assignment of decision making capabilities on other than a voluntary basis and the establishment of bureaus and agencies to provide goods and services will necessarily result in welfare gains. Unless careful attention is given to the information and incentives with which bureaucrats are confronted, the projected outcome which provided the rationale for establishing the agency will occur only rarely—probably with less than random frequency. This section provides an explication of this problem of bureaucratic performance. Hopefully, if the problem is stated carefully, ameliorations will be less than usually evasive.

A. The Potential for Bureaucratic Performance in a Common Pool Situation Examples

1. Consider an airshed with a capacity for assimilating Xi MT of industrial stack emissions, Xa MT of auto pollutants and Xn MT of natural pollutants (aerosols from conifer forests., etc.) with a *very* low environmental

cost. Assume that dispersion rates are fixed and that Xn is accepted as optimal. Assume no interactions among the pollutants and accepting natural pollution as optimal, concern is with the impact of Xi + Xa and with the cost of controlling each. Current pollution productions however, is running at 4Xi and 2Xa with an environment cost, converted to dollars for comparability (sorry, but it's the best we have in our tool kit) of $16u. For an expenditure of $1.3u the cost of the pollution damage could be reduced to $3.7u. Thus, there is a net gain of $12.3u (minus administrative costs) to be realized by constituting an agency to compel rather modest investments in pollutions control in order to realize very substantial gains in environmental quality. [From a social efficiency perspective, we would want to stop investing in pollution control when the marginal benefit of the improvement equaled the marginal cost of additional control. This point is discussed later.]

2. Assume a game herd with a sustained yield potential of y, if in an unmanaged habitat, and $y+m^a$, if in a managed habitat (D).

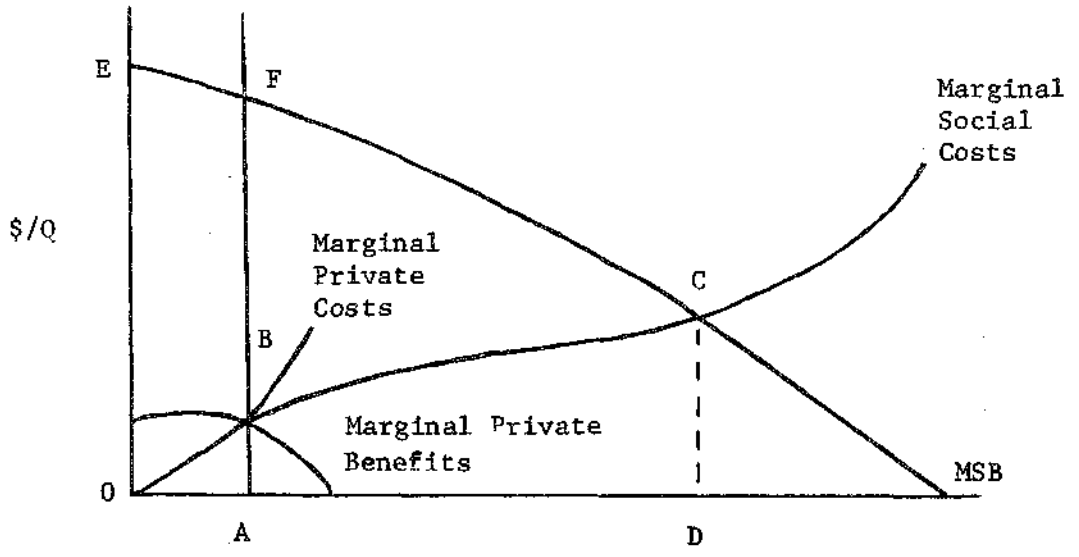


Note that with no rationing (via pricing, lottery, etc.) and no management, at zero "price" the demand for the game animal will be greater than the sustained yield. Hence, after a short period of time the herd will be hunted beyond the level necessary for replacement and will vanish from the habitat in question. Under assumptions of no habitat management this will result in a net social loss of OEBA each year into the indefinite future. Were the habitat to be managed at level yma but not rationed, the net loss each year would be (EOCD) - (OCD) for the indefinite future. It is this amount, (EOCD) - (OCD) that is the potential to be gained by establishing an agency to regulate and manage this resource. The cost of not doing so is the value of the lost resource less administrative costs discounted into the indefinite future. Again, there is a compelling argument for establishing a bureaucracy to manage this resource if the resource is to remain public.

B. The Potential for Bureaucratic Performance in Providing Public Goods and Services

Within a prescribed territory the provision of law and order has important aspects of a public good. Assume, for example, that it is found that during the evening hour when a man walks his brace of German shepherd dogs around and around a block in New York City, crime on that block is reduced to 10 percent of its normal nighttime level. This man, by the strictly private action of exercising his dogs is providing a public good. But public goods, when provided privately, tend to be undersupplied. The man, for example, doesn't walk his dogs when it is raining, and he doesn't

walk them all night. The provision of this public good is of no moment to the man. It is merely a positive externality generated by a strictly private action. If graphed, the values take the following form:



Quantity of Law and Order

In this case there is OA quantity of law and order provided privately with a value of OAEF. The optimum amount of L & 0 to be provided is C~D with a net value of (OECD) - (ABCD). Again there is a compelling reason to establish an agency with the power to tax and to use this revenue to provide a public good.

There is an important distinction between the common pool and the public good situation. The cost of failure in the former is the loss, perhaps permanent loss, of a valued resource. In contrasts failure in the public good situation results merely in an undersupply of some good or service. Presumably this good or service could be provided at some later time while if we "blow it" now we may never again have a chance with the polar bears, leopards, or the great whales.

C. Actual Bureaucratic Performance

One can solve or *very* substantially ameliorate any common pool or public good situation if he assumes the conjunction of well-intended and intelligent and informed bureaucrats and the appropriate technology. Under these assumptions, the bureaucracy will perform to the level where the marginal social benefit intersects the marginal social cost curve. At this level of production, social welfare will be maximized for the resource or good in question. Unfortunately, however, this is rarely the case.

Several of the factors which preclude this occurrence are intuitively obvious and will be summarily dismissed with a brief discussion. First, we have very poor estimates of the value of the social benefits which flow from various actions. Because these benefits are not packaged and sold, we simply do not know with precision what they are worth to people. It is especially difficult to define or otherwise determine the option demand for some resources. In additions various competing parties have strong motivations to give highly distorted estimates of the values.

Second, we lack an adequate level of scientific information about most of the processes with which we are concerned. We simply do not know what impact submicroscooic air pollution has on human health or upon natural systems. Hence, we cannot estimate costs (or perhaps even benefits) of this type of pollution.

Given the above considerations, even the best intended and most intelligent agency would not know at what level to produce.

D. The Political Environment of Bureaucracies

Aside from these points there are structural features which militate against socially efficient behavior. For some bizarre and absolutely unfathomable (to me) reason there has been a long-standing belief (at least among academics) that people in the private sector are primarily greedy and self-interested, while those in the public sector tend to be primarily concerned with the public good and professional norms. If I work for Boise Cascade I am self-interested, and if I leave that job for one with the U.S. Forest Service, I become a public servant. If I leave the Forest Service and join Anaconda Forest Products, I am again operating for private greed. Leaving Anaconda for a position at a state university I again become public spirited. If I were under analysis, even my analyst couldn't keep up with shifts of this magnitude. As a general rule, bureaucrats, like real people, tend to be predominately self-interested. From this we can infer that unless the incentives within the bureaucracy counter this tendency, there is a strong probability that bureaucracies will be run primarily for the benefit of the bureaucrats and for the strongest of the bureaucracy's clientele groups.

An Agency that is assigned responsibility for the management of some environmental resource is placed in the position of constraining one or several of the competing uses. This is involved whether the resource is an air or watershed that has been used as a sink, or some biotic community that has been exploited while developing the resource to increase its social utility as measured in the market. It is exceedingly difficult to get people to change or to modify their established, patterned relation-

ships to a resource when the people involved have found their established utilization patterns beneficial at the individual level. Hence, the primary users have strong incentives to encourage the agencies to administer in a manner that protects their interests. For this reason we often find agencies becoming captives of the industries whose behavior they are to regulate. Given that the principal users have a direct and concentrated interest in the resource, and that the public at large has only a diffuse interest (although in aggregate often a much larger interest), those primarily involved with the resource can more readily organize and expend resources in the political arena to influence the bureaucracy.

The first rule of bureaucratic behavior is survival and the second is a budget increase. To survive, an agency must not only generate an improvement in net welfare for some group, but it must build a political support base that will sustain its existence. Thus, given the above mentioned political advantage of the large resource users (and their concentrated interest as contrasted with the nebulous, oft disinterested public), there is a "natural" symbiotic relationship between the agency and those who use the resource most heavily.

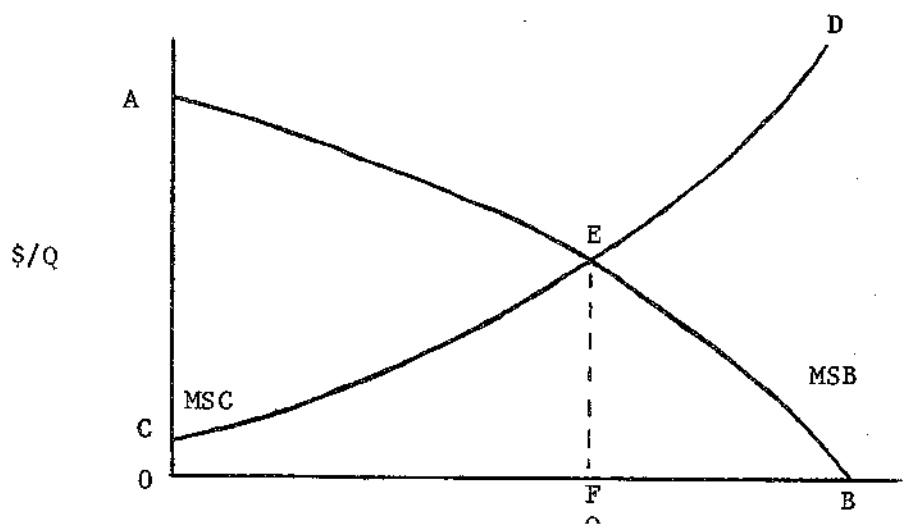
If the public captures an agency, however, this by no means eliminates the problems. If, for example, an energy regulating commission is captured by industry, prices are likely to be set at a level that produces quasi-monopoly pricing. In contrast, if it is captured by the "public", prices may be set at unreasonably low levels. The low energy prices would result in inefficient utilization of the resource (e.g./using more fuel and less insulation) and premature exhaustion of the resource. [Although

I know nothing of the topic, the above explanation is consistent with the current natural gas situation].

E. The Political Economy of Bureaucracies

Quite apart from the above considerations there is a more subtle and more pervasive problem inherent to the bureaucratic order. This involves a bias toward growth beyond the point where marginal cost equals marginal benefits. Nearly every bureaucracy is a more comfortable and rewarding place when it is expanding at a moderately rapid rate than when it is stationary or declining in size. When experiencing a 6 to 10 percent rate of growths promotions are relatively frequent and can come from inside the agency. Under these conditions of growths, imcompetent or marginally competent personnel can be hidden or their efforts ignored. In sum, people are secure, their futures relatively bright, and morale tends to be high. This was the picture of the universities in the late 1950's and the 1960's. The contrast between those times and the wail ings of doom that one now hears is very striking indeed. Both no growth and growth are very costly—but the implications of each is quite different.

Assume that line A-B is the social benefit function generated by an agency's actions and that line C-D is the marginal social cost, (i.e., what society has to give up in taxes) for producing that benefit.



Under these circumstances social welfare will be maximized if the bureaucracy produces F quantity of its good or service. Beyond F, society has to give up more to expand the bureaucratic output than it gets in return for the additional expenditure. Hence, production and budgeting should stop at F, leaving society with a net gain of (OAEF)-(OCEF) or the area in CAE.

When producing items that are consumed pubiically, it is very difficult to determine when "enough" has been reached. Firms can judge with fairly tight tolerances when they have produced enough Edsels, golf balls or shear pins for snowmobile drive trains. Determining when we have "enough" national defense is a problem of higher magnitude. One item that compounds the problem is the fact that preferences for varying amounts of national defense must be summed and in some way averaged. Obviously some people would wish to "buy" more national defense than they not obtain while others believe that they are already "buying" too much and would prefer lower taxes or greater medicare coverage. It is, of course, incumbent upon the military bureaucrats to identify those segments of the public who want more national defense and provide them information useful for lobbying on behalf of increased military appropriations.

In contrast with the defense situations weather forecasting (or even environmental monitoring) is relatively simple. Even here, however, it takes moderately sophisticated mathematics applied in the form of sensitivity analysis to even roughly determine the socially efficient investment in obtaining information. Nearly all high level bureaucrats seem to believe

that their program is indeed vital, critical, imperative, necessary, essential etc, to national well-being and that the relevant clientele would be well advised to increase the agency's budget. It just happens that what is best for the country (or district, or whatever units) also makes the particular agency a more comfortable place. Hence, bureaucrats carry on a continuous struggle to increase their budgets. From this perspective the most "successful" bureaucrat is the one who can claim responsibility for obtaining the largest budget increase.

Referring again to the above diagram, the tendency is for bureaucracies to push beyond the F level toward B. Niskanan, a former RAND scientist now teaching in Berkeley, has a fairly involved mathematical argument that, in effect, states that a bureaucracy will expand its performance beyond F to the point where the entire net social benefit (ACE, if stopped at F) is. consumed by the deviation of the increasing marginal social cost curve C-D from the marginal social benefit curve A-B. Thus,, in a mature bureaucracy the area in DEB has increased as production moved to the right (toward B) until, it is equal to area in ACE. At that point, of course, society is no better off with the bureaucracy than it would have been without it. An analogy is the purchase of a hunting dog and the discovery that not only is he a nuisance, but he also eats enough to outweigh the extra game he brings in.

VI. Alternatives to the Dismal Analysis Offered Above

Unfortunately there are no cost free solutions. Without relaxing the rule of willing consent and establishing bureaus and agencies, public

goods will be undersupplied and common pool resources will be abused, destroyed and under-productive over the long run. With the creation of bureaus and agencies some freedom is lost and the bureaucracies will tend to expand far beyond the point of optimum supply. Were these the only possibilities, our future would look bleak indeed. But the study of social relations, like that of organic chemistry, leaves ample room for creativity.

A. The Base for Seeking Alternatives

A reasonable search for alternatives involves three steps. The first of these is to select some normative base of what values should be sought. This step, while not entirely casual and while bound by canons of logic, is clearly not scientific. Concern is with the "ought" rather than with the "is". In this area reasonable and intelligent people have grounds for disagreement. I, for example, believe that more resources should be employed to preserve the existing remnants of wilderness communities while others believe that it is morally negligent to "lock up" this land if doing so deprives people of exploitable resources. It should be obvious that there is no body of scientific findings that has the potential for resolving this conflict. In brief, selection of normative standards is an ethical and intellectual exercise.

The second step involves the development of positive theories about the behavior of institutions under various circumstances. This step is morally vacuous. It has no normative content and is comprised merely of empirical statements whose verity is, at least in principle, demonstrable by recourse to scientific procedures. When completed, this step is comprised of true empirical generalizations that are connected via logical

relations into a theory or set of theories. Such theories, which are exceedingly rare in the social sciences, are "proved" neither by the "reasonableness" of their assumptions nor by their internal logic (which is a necessary, but not a sufficient condition), but rather by the degree to which the conditional predictions which flow from the theory are consistent with the empirical evidence.

In evaluating alternatives, the third step involves a comparison of the probable results of the alternative with the optimal conditions as stated in step one. Given that one is always confronted with trade-offs and that one cannot maximize all values concurrently, the finding that a proposed alternative cannot generate the "optimal" outcome is not a sufficient reason to reject the alternatives for the proposed alternative may be superior to other alternatives.

Thus, when evaluating the alternatives presented here, one would:

(1) identify his normative preferences

(2) evaluate the truth of the positive theory by forming a refuteable hypothesis and attempting to find evidence which is inconsistent with it, and then

(3) predict the impact of the alternative upon the optimal conditions identified above.

B. Competition Among Bureaus

When the primary task is to protect a common pool resources it is important that the area of coordination be as large in scope as the area to be protected. In other words, the area subject to eternalities should be included in the jurisdiction of the institution with responsibility.

When managing the Los Angeles airshed, for example, it would make little sense to include only the city of Los Angeles in the plan. In contrast with the above situation is one in which public goods are to be provided. In the latter case there are *very* good reasons to believe that the encouragement of competition among suppliers would foster improvements in welfare. [This is a major argument advanced by Niskanan.] When existing as a protected monopoly, there is very little incentive for bureaucrats to strive for efficient production. A sound argument for monopoly supply at the national level would usually require a demonstration that there are significant economies of scale to be obtained beyond the regional level. This is seldom done.

In spite of a long series of "reforms" designed to eliminate competition among bureaus, their drive for larger budgets generates a natural competition among the various agencies. A reasonable policy goal would be to harness this competition to provide a more optimal supply of public goods and to do so in a more efficient manner. Given that bureaus tend to develop close working relations with congressional committees whose membership is commonly dominated by representatives who speak for (and in a sense answer to) interests with high demands for the good or service, competition among the suppliers would lead toward end runs around the committee by one or several of the competing bureaus. Hence, the monopoly power of the congressional committee charged with program review would be weakened.

A bureaucratic system marked by competition would be less "orderly" than the hierarchical charts pushed by reformers, but it would be similar to the "disorder" of the market which is fairly effective in giving

people what they want. This, of course, does not address the problem of people (other people to be sure) wanting the "wrong things". But changing preferences depends on a changing culture and that is not the subject of this paper.

C. Changing the Incentive Structure of Bureaucracies

I firmly believe that incentive structures and information are far more important determinants of behavior in bureaucracies (just as elsewhere) than is ideology, good intent, or any of the recurrent varieties of a conspiracy--theory. I am led to this belief not because of a cynical or misanthropic view of man but rather because this perspective seems to account for (explain) more behavior than do the alternatives to which I have been exposed. I would, of course, be quite happy to reject this generalization for one more consistent with observed behavior.

Bureaucratic organizations contain for their members an incentive structure that is gravational in its pull toward power and growth via organization and misplaced efficiency.

Bureaucratic success of this sort, however., yields high opportunity costs. The artful explication of these costs clearly has a high potential social utility and it generates personal rewards. It is not that bureaucrats fail to produce, but rather, in Reich's view as expressed in his Greening of America, that they produce with a single value devotion. And in his terms, to have a single value is to be a machine.

When considering the environmental implications of this mechanized society, the problem is that the machine produces too much of a wrong product mix.

There are several possible solutions to the environmental problems created by the corporate state. Reich argues that a basic value transformation is required and impending. For a variety of reasons contingent primarily upon scarcity of resources and preferential positions, it is difficult to sustain optimism regarding the fulfillment of this transformation. Thus, we might explore an alternative solution.

I suggest that if a scholar so sage as Reich consistently finds bureaucratic performance ruthlessly and singlemindedly effective we should secure changed outputs by taking the bureaucratic values as given and then proceed to manipulate the incentive structure in the organization and thus the goals of the bureaucrats. Although Reich denies a separation between the public and the private sectors in the corporate state, for my purpose I will examine a small segment of the public sector and suggest an opportunity for reform. Note that unlike Reich I do not need to assume a fundamental shift in personal values. People can continue to be self-seeking and narrow. A change toward public spirited values, however, would only make the proposed solution easier to implement.

Within the mainstream of American political experience we lack the twin myths of divine imposition of a political charter and of a single sovereign. This absence, coupled with the presence of a federal system of organization and with rapid growth and developments has necessitated protracted constitutional and governmental experimentation. Within this context it is reasonable to view a constitution as the existing body of fundamental and general rules used as parameters for the making of subordinate rules.

The above perspective assumes that we are enmeshed in the contigent universe. Further, it is implied that our political forms lack an ascriptive sanctity. Thus, they may be changed to meet new problems. The formal structure is designed to constrain certain behavior and to promote other behavior, i.e., it is designed to foster certain values. Within any system not all values can be maximized concurrently. We recognize that any structure of government promotes some values at the expense of others. Thus, it is clear that designing a government involves balancing tradeoffs among competing values. If we temporarily accept the above perspective we might gain leverage when considering the problem of a new design for the structure of government. This opportunity to design--which essentially involves the balancing of various tradeoffs of values—is relatively rare.

While American constitutions have served well as instruments fostering opportunities for individuals to gain by promoting growth and development, some feel that there should be a change in the priorities of values fostered. Specifically, given that the Earth provides man's only known niche, it is argued that the maintenance of its life support system should receive increased weight. Some of the more radical elements (or possibly more conservatives depending on one's time span) have even suggested that this biochemical energy system by at least partially restored to a former condition of stability.

I view organization as the mobilization of bias. . In the following paragraphs a simplified version of an altered governmental organization is proposed. I expect that such a change will influence the bias and hence the tradeoffs among competing values.

Contrary to contemporary dropout and dissident intellectual folklore, it remains true that: (1) the overwhelming proportion of people in every society prefer to be "better off" and that, (2) "better off" is predominantly measured in terms of material and power. There is good reason for expecting people to be both materialistic and status (or position) sensitive. In brief, it is silly to expect revolutions of culture and life style to produce those fundamental transformations in human behavior that will yield salvation from forthcoming environmental reality checks. If we are to modify the design of government to foster environmental quality, it is prudent to assume that by-and-large people will remain narrowly self-interested. Our task is to produce a set of structures that will make self-interest congruent with high environmental quality and hence with social benefit over the long run.

The individual pay-offs from growth and development are compellingly obvious within both the private and public sectors. This is especially true in areas marked by technological innovations but it applies to development generally. While the first order objectives of development are often beneficial, the second order consequences may well be injurious. And it is clearly in the interest of the promoter to minimize nublizing these negative consequences. Currently there is no strong, no well organized and well funded countervailing force to the promoters of development.

---

*A very thoughtful and provocative statement on this set of issues has recently been presented by Don Kash, Director of the Science and Public Policy Program at the University of Oklahoma. In his "testimony on Technology Assessment" before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, Kash calls for the establishment of "counter-bureaucracies" designed to research and explicate the second order consequences of proposed technologies. I am convinced that his well crafted statement proposes one of the few solutions to this growing matrix of ever more severe problems.

There is no organization whose members receive rewards for explication of the second order consequences of development. And this absence can impose high costs to the public. Timber management practices in the Bitterroot National Forest provide an obvious example.

The specific proposal is for the development of an autonomous Office of Technological and Developmental Assessment (OTDA) as a government department. The focus of this agency would be upon research regarding the costs and benefits of proposed developmental activities affecting the environment. Obviously it is essential that this agency be independent of elective officials and well insulated from their intervention.

The organizational structure of the proposed OTDA is critical to its success. In our current bureaucratic and technological society there are immediate and direct sanctions (but few rewards) that fall upon those who engage in developmental assessment. The proposed structure would reverse the above incentive schedule within this organization. Advocating the obvious alternative to this proposal, narrow gauge pollution etc. control boards, is politically naive only if environmental quality is desired as more than a ritualized slogan. It is a near ironclad rule. that regulatory commissions come to be dominated by those who were to be regulated. For examples in 1970 a majority of the state pollution control boards were partially comprised of individuals who were officers in the firms primarily responsible for pollution. Hopefully we are beyond replicating this sort of simplistic fraud. What is needed is an organization that provides the same payoffs for focusing on second order consequences that are now conventionally received for promoting other technology and development.

Our experience suggests that while it is relatively easy to establish organizations, it is quite difficult to make them perform as desired. Usually the formal goals of the organization are subverted by the informal opportunities and incentives available within it. To overcome this obstacles we begin with the assumptions that: (1) the primary motivating goal of an organization is survival and growth, and (2) the individuals who comprise the agency will be primarily interested in advancing their own careers. By setting the problem up in this manner, by making the lease charitable assumption, deviations from expectations (e.g., altruistic or socially responsible behavior) will only serve to make the solution easier. Here, then, deviation from the norm of self-interest will not be subversive of goals.

The formal goal of this organization will be the avoidance of adventures that overall impose net social costs upon the public. By advertising and carefully documenting the second order consequences of developmental projects and hence by alerting the public, the organization would demonstrate its utility and importance. Funded for a period of time and refunded by popular referendum and by research contracts from the Federal Government, environmental activitists groups, manufacturers or pollution control devices and others who stand to benefit, the members of this organization will have *every* incentive to investigate those projects, proposals and practices whose net benefit is negative. Further, for *every* government project that is demonstrated to impose higher costs than benefits, the OTDA would receive 1 percent of the proposed funds plus the projected overrun for that agencies projects. Thus, for stopping the SST on the Trans-Florida barg canal,

the agency would earn an increased budget, bigger staff, etc. In short the organization should serve as a reality check on stupidity and should promote the public interest while advancing their own organization and careers.

Note that this alternative is consistent with increased technological development and that it leads to an enhanced role for scientific research. It does in fact demand that the operational scone of science and engineering be expanded to include a more thorough consideration of the multiple implications of proposed projects. Although it is probably less fashionable to reject science and technology than it was a year or two ago, a generalized public infatuation with science is likely to be mainly of historical interest. In the absence of glamour, it would be useful for those in scientific enterprise to have continual demonstrations of the capacity of science to protect the public from costly second and higher order consequences.

VII. Market Alternatives to Bureaucratic Organizations

One of the mechanisms least appreciated as a coordinating device is the market. The market is one of the very few social institutions that fosters rationality in a context of overwhelming ignorance. When a market is functioning freely and when full prices are charged, i.e., when the costs of externalities are included in the market price, a society can come closest to meeting the demands of its citizens. [Of course, people may want the wrong things, but that is usually an elitist argument. I recall meeting a Yale professor who was outraged that our system would permit more Moody Blues records to be sold than Metropolitan Opera records.

Obviously he felt that his taste was superior and that his should do the controlling.]

As I attempted to demonstrate in the early sections of this paper, however, the willing consent-market arrangements paradigm is inappropriate (if welfare is the criterion) for providing public goods and managing common pool resources. Due to the ability of bureaucracies to expand their activities because they are protected monopolists, we find bureaucracies providing goods and services that could be supplied privately. [According to Milton Friedman the post office enjoys a monopoly on first class mail because the Pony Express was so effective that the government's trans-continental mail service could not compete. This failure resulted in the law forbidding anyone else to carry mail. And, today the Adams Express Company is an investment trust rather than competing with the U.S. post officials in providing a service of ever descending quality. Note the great success of the private United Parcel Service and the impact that competition in this area has upon the U.S. Post Office.]

I define a bureaucracy as an organization with two characteristics: (1) the managers do not receive any part of the difference between costs and revenues as personal income, and (2) a portion of the revenue is from grants. Because of (1) those in the bureaucracy have very little incentive to operate efficiently or to economize. Often in fact, there is a disincentive for economy, e.g., "We must use it all UP or we won't get as much next year when we may really need it" is a statement very common in universities as well as in military units. Generally, the tendency is toward maximization of revenues rather than toward the minimization of expenses.

Because of the above tendencies, the utilization of private sources to supply public services is quite valuable. The greatest benefit from having private suppliers of public services is the reduction of the monopoly power of the bureaucracy by providing competing services at a known price. The clearest example of this that I know of comes from the Scottsdale, Arizona area which has a privates operated for profits fire department.

Scottsdale's Rural/Metro Fire Protection Company was begun about 25 years ago when a citizen discovered that his new suburban home was outside the city limits and thus had no fire protection. When a fire broke out outside the limits, the city's policy was to man a fire line at the city boundary. This fact, of course, was reflected in insurance rates. Hence, if protection could be provided, fire insurance rates would decline. Any difference between the cost of fire insurance without protection and the cost with protection is a potential gain to be captured by an intrepreneur be he either a politician who can run for office on a fire protection platform or a profit seeking citizen (who, in addition to being no less greedy than the politician, is honest in that he is openly in the business to advance his own interests).

Due largely to its stress on innovation, the drive for efficiency sparked by self interests and the high investments in research, the firm provided fire protection at a prorated fee of $4.50 per household. This figure is less than one half the national average for tax-funded fire protection. The revenue of the firm comes from contracting to provide services to political units and selling individual subscriptions

to those who live in areas where there is no fire department. If a non-subscriber has a fire the firm puts it out and bills him for the services if the building is saved.

Apart from the efficiency of the profit motivated firm, Rural/Metro is noted primarily for its technological advances in a sector of the public economy notorious for its reluctance to innovate and employ existing research findings.

In many of the "socialist" Scandinavian countries, public services are contracted. Western Canada has a number of cities and towns where police service is contracted to private firms. Although these cases cover a statistically trivial proportion of the populations they are important far beyond their numbers as competitive examples which reduce the monopoly power of bureaucracies.

VIII Conclusion

The reader is likely to conclude that I am unreasonably enamored with the market system or that I am needlessly paranoid regarding government in genera] and bureaucracies in particular. Because I have spent a large part of my life in public bureaucracies that latter inference may be well-founded and I am not about to argue the state of my mental health.

The formal organization of bureaucracies is highly seductive to those of us who may have orderly minds and who have a public purpose which we wish to advance. It usually seems obvious that an intelligent and well intended bureaucracy can do much to foster that purpose which we believe should be serviced. If bureaucracies were comprised of people

like me (you), the state of the world would be much improved. Thus we must set up tight rules to make bureaucracies actually perform as you or I would perform were we in the agencies. It is precisely this line of reasoning that I argue should be strongly resisted. The track record and the actual behavior of agencies are, for the reasons 1 have indicated throughout the paper, not promising. Hence, unless great care is exercised in establishing the incentives and information under which improvements in public welfare are to be advanced, we can reasonably predict unsatisfactory results.

One generalization which seems to have the verity (if not the elegance) of the laws of Newtonian physics is that any randomly selected persons will be more responsible to his interest than to yours. There are a variety of self-evident reasons for this and many major religious movements have tried to reduce this disparity. None, however, has made a very substantial dent in the problem.

The market system assumes self-interested people bound by agreed-upon rules of behavior coercively enforced. Under its assumptions, individual freedom is maximized and a minimum of resources must be devoted to planning. In the common pool and public goods situations, however, the rule of self-interest leads to destructive dynamics where behavior that is individually rational is collectively costly or even disastrous. These are the cases of market failure and are situations where the market rule of willing consent must be relaxed in the interests of social welfare.

Rather than being enamored of the market, I view it merely as a coordinating tool that permits and even fosters a great deal of behavior that

I find personally objectionable. It permits people to exercise "bad taste" and impose its consequences on me in the form of billboards, snowmobiles, plastics, and throw-away containers. Yet it is a tool for giving people what they want in a highly effective and efficient manner. Hence, given that people's tastes seem to be improving slightly (i.e., they are becoming more like mine and those of my friends), I urge that market and quasi-market mechanisms by employed to a greater degree and that less reliance be placed on bureaucracies as presently constituted.

Having made this suggestion I should warn you of the situations in which market failure can be expected. The goal of social science is to predict behavior and our predictions can be far better than random. The confidence level, however, is less than one.

I will state the set of circumstances under which the market will function with optimal efficiency, i.e., will function to provide the greatest units of satisfaction with a given set of inputs. Aside from cases in which the marginal cost of addition use is zero (e.g., a bridge whose life span is a function of weakness caused by time rather than use), when there is perfect information and when both information and negotiation costs are zero, efficiency problems will be solved in private markets when all positively or negatively valued items carry full property rights and are exchanged in competitive markets. These assumptions, like those of mechanics are never perfectly realized, but for many items the approximation is sufficiently close to permit good predictions. In issues relating to matters of environmental quality, issues which many of us find extremely

important, very few of these assumptions are either met or closely approxi-- mated. The assumptions are violated most severely in the areas of public goods and common pool resources. While it is intuitively clear that the degree of deviation from these assumptions is related to the degree that a society (whose goal was welfare maximizing) will depart from reliance upon market coordination, the explication of this relationship is complex and goes far beyond the scope of this paper.

John Baden
February 27, 1973
Preliminary Draft

THE INCREASING VALUE AND IMPORTANCE OF ENVIRONMENTAL QUALITY AND MANAGEMENT

I. Introduction: Bias Toward Growth

It is clear that private enterprise has a bias toward economic growth and development. In general, economic growth has involved the conversion of the world's natural state into a man-made state. Most economists have viewed this growth as an expansion of the opportunity set available to individuals. They commonly fail to acknowledge, however, Mishan's point: "as the carpet of 'increased choice' is being unrolled before us by the foot, it is simultaneously being ruled up behind us by the yard."

This impact of "private" economic growth is perceived by anyone who considers the effect of stripping to bedrock the deciduous forests of Kentucky in order to obtain coal, disassembling mountains for mineral wealth, or of using the Great Lakes as an energy and residual sink. These events are accepted by many as tradeoffs necessary for growth. For many years such tradeoffs made sense in terms of social welfare. The conversion processes mentioned above are carried out due to a desire for profits gained by meeting peoples wants. At the risk of appearing trite, these outcomes seem embedded in man's very nature.

In this paper, I argue that a set of drives identical to the profit forces are also evidenced in the public, governmental sector of all

representative governments. As numerous studies (and casual reports in such popular magazines as Time) have indicated, the argument can be extended to nondemocratic political systems as well. The explication of the argument in the care of representative governments is described below.

II. Special Interest Effect in Representative Governments

Perhaps the most strongly supported finding in political behavior research is that voters are overwhelmingly ignorant about both candidates and issues. This ignorance is "rational" because the opportunity costs of acquiring information are high, and because the information necessary for "wise decisions" concerning public affairs has important attributes of a public good. And public goods, if supplied privately, tend to be under-supplied. Hence, the average citizen tends to obtain little information about public affairs and, therefore, he is rationally ignorant of them.

This is a simplistic example of linking empirical generalizations about human behavior to yield an explanation or a prediction. The example, of course, is a *very* loose indeed, being based on mere tendency statements. In principle, we could obtain measures to any degree of accuracy and employ rules of correspondence to gain the leverage of mathematical analysis. In application, the burden of building an explanation of human behavior includes the liabilities of working with statistical generalizations and probabilistic models rather than deterministic statements and dealing with discontinuous functions. In brief, if we take it seriously, doing social science is a bitch. It is, however, quite easy to fake it if we have high verbal skills. As potential consumers of social science research, it is incumbant upon you to identify the frauds. The game is science and the same rules apply everywhere.

Clearly, issues vary in their importance to voters. It is also clear that not all voters are equally interested in each issue. In terms of "interest", there is a variance among both voters and issues. In general, however, voters are most concerned about those issues that they expect to affect their welfare. This is not to deny the existence of such high interest-low welfare issues as amnesty for those who left the U.S. to avoid serving in Vietnam.

For our purposes it is useful to divide issues into three types and then quickly dispose of the first two. Major issues are those such as war, socialized medicine, or a general rationing of consumer goods which have a substantial impact on nearly all citizens. These, of course, are the issues that generate a great deal of "press" and nearly everyone has some opinion about them.

The second type are the Offsetting special interest issues. Generally,, these are of little importance, but they receive great attention from two groups, strong supports and those who are strongly opposed. Because policy changes change the distribution of costs and benefits in society., unanimity or concensus is only very rarely found in the collective decision making process. In these offsetting issues, most voters are indifferent but those who anticipate gains or losses feel strongly and act politically to foster their interests. Thus, when a legislator takes a position on issues of this type, he is trading off an appeal to one set of voters for appeal to the other set.

When considering these circumstances, remember that a legislative body is a perfect example of a controlled population in which there is

usually strong competition (or potential competition) for each niche (remember Wayne Aspinall of Colorado?). In this environment;, only the politically strong survive. They survive by coming down on the "right" (strongest) side of issues with off-setting interests.

For our purposes, the most important issues are non-offsetting special interest issues. On such issues there is a strong, well organized interest group on only one side. In this case, a minority of voters are strongly concerned, and they are willing to invest their resources to gain a favorable outcome. These are the situations that often result in a rolling up of opportunities by the yard. Given that amenity factors such as clean air are valued, it is this situation that can lead to an inefficient allocation of societies resources via legislative (or administra-- tive) allocations.

II. Environmental Amenities and Non-Offsetting Special Interest Issues

From the perspective of a legislator or a candidate, the ideal policy is one that has clearly identifiable beneficiaries, each of whom is substantially helped by an indirect and small cost extracted from a large number of persons. A good example would be a bill gaining or protecting a legal right to use an airshed as a residual displacement system (a dump).

In this example, a large loss can be avoided by legislative or administrative action. Hence, those affiliated with the industries have a high stake in effecting the decision. The legislator's position on the issue is identified and he is advised that if votes and campaign contributions are to be expected from those especially concerned, he should vote to foster their interests. In contrast, each member of the

general public will suffer only a small cost or almost none if he is located upwind, which is where expensive subdivisions are usually built by virtue of the legislator's action. The average voter is, in fact, unlikely to ever know that the issue arose and he is extremely unlikely to know how his legislator voted.

In situations of this sort the loss to society of depreciated amenities may far outweigh the benefits gained from cheaper production. When we find highly concentrated benefits and widely dispersed costs, legislators or administrators have strong incentives to support the decisions benefiting special interests even when the social costs exceed the social benefits. This is especially likely when the issue is complex or made complex by the legislators. Often, of course,, the special interests actually draft the legislation. By acting on behalf of special interests,, legislators can obtain campaign contributions which are then used to market the legislator's image to the general public during election campaigns.

A similar logic applies with the various elected commissions. During the 1972 elections in Montana, for example, one candidate for the Public Service Commissions the commission that "regulates" power companies and "protects" the public, declared campaign expenses that were more than twice the total salary for the job (only a percentage of all contributions and expenses are normally declared). The bulk of the declared sum was said to have come from the Montana Power Company, the largest utility in the state.

The central point is that those who supply benefits, including the avoidance of costs, via the political process often have the opportunity to gain by supporting special interest legislation even when the net social costs of the legislation far exceed the benefits. The strategy

of the political entrepreneur is to: (1) support the special interest, (2) keep these interests advised on his support, (3) obtain campaign and other funds, and (4) mask the issues through the use of complexity and jargon to keep the average voter ignorant of the implications of the special policies.

It is at this point that many people are tempted to object and suggest that what is needed is greater public concern and more public spirited political entrepreneurs. Obviously a conjunction of public concern and public spirit would have advantages in overcoming the special interest problems discussed here. But, both virtue and diligence on behalf of the public interest have always been in short supply. This shortage is coupled with the fact that a politician who fails to support special interest positions, when that support would yield electoral gains, increases the probability of being replaced by more astute, less virtuous entrepreneurs who will respond to special interests. This leads to Baden's 5th Law of Politics, the Law of Political Erosion: beyond the short run currents of self-interest erode virtues from the political process. Note that however well intended and publically motivated a politician is, if there is some other candidate who wants to compete in an election, the incentive to support special interests at the expense of general welfare remains a force to consider. The workings of this process is highly visible in the depreciations of environmental amenities.

III. An Example of Special Interest Legislation

In 1970, Walter J. Mead, an economist currently with Resources for the Future, presented a paper analyzing the impact of one piece of special interest policy, the oil import quota. The quota on foreign oil went into

effect in 1959. The justification for the quota **was,** in the words of President Eisenhower, "in the certified requirements of our national security which makes it necessary that we preserve to the greatest extent possible a vigorous, healthy petroleum industry in the U.S." Under the Trade Agreement Extension Act passed by Congress in 1955, the President is directed to take the action he deems necessary to adjust imports so they will not threaten the national security. It is likely that neither you nor many other citizens have ever heard of this act. Of those who have heard of it, and have even read it, few would be likely to predict the impact it would have on the oil interests, on natural amenities such as the Santa Barbara Channel, or upon the price that we pay for oil products.

Our theory of special interest accounts for the policy of restricting foreign oil and encouraging the consumption of domestic supplies. To import oil, a fee of $1.25 to $2.00 per barrel must be payed. Imports are further restricted by a quota system that divides the U.S. into 4 districts. It number limits imports into the area east of the Rocky Mountains to 12.2 percent of domestic production in this district. Formulas for the other districts are more complex. In their public announcements, the oil industry's concern was with national welfare and security. A major goal of the industry in arguing for import quotas may be assumed to be the same as that of any industry that wants competition restricted, i.e., it wants to be able to obtain a higher price for its products in the domestic market. This, of course, was not the argument that the oil companies used. They claimed that the licensing-import system would prevent the U.S. from reliance upon foreign oil.

This policy greatly encourages rapid domestic extraction of oil. Further, the oil depletion allowance of 20.5 percent of gross income, plus the ordinary depreciation on capital investment, also serves to encourage a *very* high domestic oil consumption rate.

The beneficiary of these policies is the oil industry. In terms of dollars, these policies cost consumers about 5×10^9 dollars per year in terms of higher prices on petroleum products and products that use petroleum inputs. These costs, however, are very indirect and widely spread among a latent majority. The subsidy system is complex and meshed with national security justifications. In contrast with the general public, the beneficiaries are highly concentrated, organized, and identifiable. Hence, our theory of special interest is consistent with the actual outcome.

In addition to the financial rip-off, there is a set of other costs imposed on the general public by this special interest action. This involves the depreciation of environmental amenities. If the oil industry can hasten a shortage of energy by restricting trade, they can then push, in the public interest of course, for the extraction of oil in high risk areas such as coastal zones and for premature (from a social welfare perspective) extraction and transportation of oil from and around areas of extreme ecological sensitivity such as those on vent of the Alaskan pipe line. When school children in Iowas and Tennessee are without heated classrooms, and when factories in Dayton are shut down due to an "energy crisis", the relative importance of an Arctic ecosystem has suddenly diminished.

When estimating the net social costs of this special interest legislation, we must consider the potential loss of environmental amenities

and add the sum to the five billion dollar rip-off.

It is important to realize that the special interest effect sketched above is extremely common, although it is only seldom found at this scale. It is reasonable to conceptualize rip-offs of this sort as transfer payments from the general public to special interests. The various Federally subsidized water development and "improvement" projects demonstrate the same dynamics. Citizens who have a special interest in developed water join forces with political entrepreneurs, of both the elected and bureaucratic variety, to gain a transfer payment from the Federal purse to "develop and improve" a drainage. The physical process is to change its condition from one that is relatively natural to one distinctly man made. In accomplishing this mission, natural amenities are usually sacrificed. Hence, not only is a special interest group bilking the public of funds, in the process it is also destroying amenities whose use and option values are increasing rapidly.

The above discussion is an effort to explain why we should expect the destruction of environmental amenities to result from government action as well as private enterprise. It is my casual judgement that a great proportion of the government sponsored amenity destruction would not take place if the government were not in the business of subsidizing those who appear to least need the subsidy . This is merely another example of governmental intervention leaving all but special interests, politicians, and bureaucrats worse off.

IV. The Increased Importance of Evaluating the Production Tradeoffs

A. Social Systems

All societies are systems and include subsystems. This merely states

that there are patterned interactions rather than random disturbances among the elements. The test for inclusion in a system is dependence or interdependence of elements.

A human society is a system of human interactions considered at the most general level. It is the aggregation of religions, kinships, bureaucratic and other sets of human interactions. These interactions occur in a context of natural physical systems. The human interactions are influenced by the natural systems and in turn influence some of the natural systems.

Although there are tremendous variations of subsystems among societies, there are also common elements among them. A fundamental question of social science is: what variables account for these variations and commonalities? While the number of variables involved is for all practical purposes, infinite, these variables differ in their partial loadings. It is my belief that the greatest single determinate of the patterning of the subsystems is the ratio of inanimate to animate energy in the societies examined, i.e., the ratio of nonmuscle to muscle power in the society. With known changes in this ratio, we can predict, with modest confidence, changes in political systems, recruitment to the various roles in society, family structures, religion, and the degree to which members of the society value various traits or conditions. Technology and science have a thoroughly pervasive impact on social organization.

B. Culture and Values

Most simply, values are the selectors and regulators of behavior. To discuss values is to run the risk of entering an intellectual quagmire. And while some may enjoy rooting around in mental swamps, this effort would be

a diversion from the main effort. Thus, I merely ask that you temporarily accept that values select and regulate behavior and then consider the implications of this statement for environmental management.

When a society experiences an increase in the ratio of inanimate to animate power, the amount of goods and services available in the society also increases. [Note that the latter increase could also result from increased efficiencies.] The increase in production leads to the expansion of opportunities mentioned at the beginning of this paper.

In 1800 the $\frac{\text{Animate}}{\text{Inanimate}}$ power index of America was very low. This index which is named the modernization index of society has increased by several orders of magnitude since then. It is this index change that largely accounts for the expanded opportunity set available to Americans over the past 170 years. Unfortunately there is a tradeoff involved in enlarging this opportunity set, i.e., natural amenities are given up as the price of a larger set of goods and services. At this point in the development of North America, the tradeoff is likely to reduce welfare. This is explained in terms of marginal utility or marginality.

Just after economics became something other than "political arithematic," the concept of marginalism entered economic theory. This occurred when economists employed differential calculus to formulate problems of benefit maximization. A common problem was one of finding the level of production, that would maximize net gain (where gain = benefits - costs). As the level of production increases, both costs and benefits normally increase. Beyond some level of productions costs increase faster than benefits. At the optimum point of production;, the marginal cost of adding another unit equals the marginal benefit derived from the production. At this point,

further production costs more than it is worth, while a decrease in activity would reduce benefits more than it would reduce costs. Although economists usually think in terms of dollar benefits and costs, the same logic can be applied when the cost of an activity depreciates natural amenities.

Since 1800, the modernized nations have produced a fantastic volume of goods. Since World War II, the accumulation of these goods among the middle class of North America has been so extensive that the marginal utility of material "stuff" has undoubtedly declined. Hence, we find the development of Reich's Consciousness III among the young and higher expenditures for recreational time among their parents. Since all data on the subject is highly suspect, I will accept Field and Stream's recent announcement as a further evidence for this claim: for the first time our country's expenditures for recreation (how defined?) exceeds that for national defense.

Concurrent with this increase in material stuff, such amenities as clean air and water, wilderness, and peace and quiet have become more scarce and more valuable. Demand for wilderness, for example, has been increasing at the rate of 11 percent for the past several years. Any engineer armed with a log table will quickly calculate that this rate of increase leads to a doubling of demand in 6.3 years. (In general, to find the doubling time for other resource demands set current rate and Po. We then have:

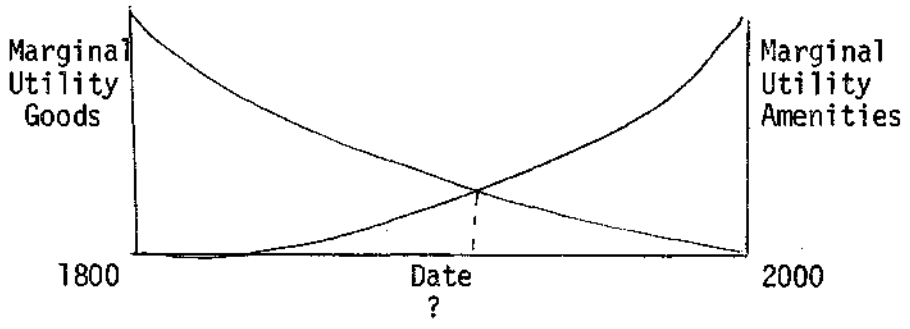
$$2Po = Po\ e^{rk} \text{ or } 2 = e^{rk}$$

$$K = \frac{\log_e 2}{r} = \frac{.6931}{r}.$$

The quick and dirty approximation $= \frac{70}{100r}$)

As these amenities became more scarce they have increasing utility values. This is quite apart from an ongoing cultural shift that may place a higher value on a wilderness (or clean air) experience due to a changing sense of values. At the minimum, these changes in marginal utilities (material "stuff" going down, amenities going up) reflect changes in the availability of these two categories of goods.

When America was being settled, natural amenities were all too plentiful. As Nash and others have pointed out, wilderness had a negative value, i.e., the marginal utility of natural amenities zero. During this period manufactured goods were very scarce. A glance through my great grandfather's account books (and he was a moderately prosperous man) clearly demonstrate relative poverty in terms of goods. In this period the scarcity of goods gave them high marginal utilities. Scarcity encouraged the production of mere goods at the cost of amenities which had only a very low marginal utility. Today the situation is recovering. This is diagramed below.



C. Equity and Technology

There is no society in which wealth and political power are randomly related. In part, this is due to the fact that the characteristics (skills and aptitudes) that enable a person to acquire wealth (or political influence) tend to be the same characteristics that enable that person to acquire

wealth (or political influence) tend to be the same characteristics that enable that person to acquire political influence (or wealth). These, then, are attributes that agglutinate.

I have suggested above that for a substantial proportion of the relatively affluent, amenities have a higher marginal utility than do material goods. Given that the relatively affluent and the wealthy have disproportional political influence, and that the political system largely determines the rules of the game in which economic transactions are conducted, there is a strong potential for the relatively wealthy to impose environmental constraints that are economically disadvantagous to the working class. For many workers pollution leads to jobs and economic well being. Political action that causes marginal industry to shut down or reduce production is considered a serious threat. Current examples involve the East Helena smelter (built in the late 1800's), proposals to declare tracks of merchantable timber as wilderness areas, and efforts to preclude mining in certain areas. For the workers for whom material goods have high marginal utilities, actions such as these are considered as special interest politics. From their perspective the impact of these policies is to disadvantage the workers to benefit those in the upper middle class. In the industry I know best, timber, this reaction is especially pronounced. Loggers and others in the timber industry perceive much of the environmental action affecting them as unfair acts supported by physicians, engineers, professors, attorneys (and their hippy children) for largely selfish reasons. Of course, the loggers are correct, and at the operational level they evidence a better understanding of the political system than do those whose self-

interests are masked by sanctimony. Proposed environmental action will also have short and medium run second order adverse effects on workers outside the immediately affected industry, i.e., these people who must pay higher prices for timber products. Given the spending patterns in America, this second order consequence will tend to be income regressive. Hence, we must confront the issue of equity.

It is extremely easy for those of us who are committed to actions which we feel will enhance the quality of the environment to state that the workers want the "wrong" things. This elitist position has a tremendous potential for the development of a pietistic belief that we are trying to set the world more in accord with God's plan. Variations of this sentiment are relatively common among those in the environmental movement. The argument is run that because we are in possession of a "superior vision," the moral implications of our political action are "right" and should take precidence over the crass and inferior preferences of others. It is all too easy to be seduced into this position. And this position contains the seeds of tyranny. I, for one, resort to it with some discomforts believing (with some measure of doubt) that the preferences of future generations will be more nearly in accord with my own.

The impact of technology and science upon increases in social equity has suffered from a relative lack of attention. Most social critics (and many otherwise responsible social scientists) have tended to stress the cold, brutal, depersonalizing, and "dehumanizing" (whatever the hell that means) impacts of technology. Not considered is the fact that as technology develops in a society (as a society's modernization index increases), the mean, mode, and median incomes tend to converge. More simply, technology

and economic equity covary. This principle has application to the range of equity problems discussed above.

Our opportunity set for environmental management seems to be made up of some mix of the following possibilities. First we could continue the ultimately self-destructive course of environmental degredation. Second, we could cut back on the production of those goods with heavy environmental impacts and, in effect, freeze the current material have-nots in their present position (or perhaps reduce their present position). Third, we could increase our investment in the technology and science of residual management.

As Commoner has attempted to demonstrates an incomplete technology, a technology focused only on first order consequences, is largely responsible for current environmental problems. With a modified social accounting scheme now being part of many peoples mental baggage, these second and higher order consequences are no longer lightly dismissed. Hence, the first of the above options is ruled out. The second option is disequitable for those who find material goods to have a high marginal utility, i.e., it hurts the relatively poor.

From the above perspective I conclude that substantial increases in technology and science provide the option that is consistent with both a livable environment and a relatively equitable social order.

This is not to suggest that any likely investment in technology will provide a Utopia. In this situation, like most others, there simply is no cost-free solution. In practice, we will probably select from each of the three options in response to varying political pressures. It is not

unreasonable to believe that we are living substantially above our environmental budget. If this is the case, a forced movement back toward our environmental limits, however disruptive it may be, will be made with greatest surity and least discomfort only with a strong emphasis on the technology of residual management. [P.S. Note that human babies may be conceptualized as the residual product of sex for pleasure.]

February 14, 1973

ON THE POLITICS OF HOT AIR

All sciences have a bias toward "hard" data. This preference partially accounts for the fact that substantial research dealing with the design of efficients consistent and reliable policies for resolving environmental problems has only begun since 1960. Economists in particular tended to consider environmental problems as nuisances or anomalies of little importance to society. The generation of residuals was viewed as merely the "unpriced" price of progress. Without the firm data of market price, there were obvious problems involved in focusing research on such issues. The seminal articles of economic enlightenment were Boulding's "spaceship earth" paradigm published in 1965 and the analytical integration of input-output with material balance by Ayres and Kneese in 1969. The thrust of this material was the implication that over the long run materials input must equal waste residuals and that this relationship possess a "reality check" on any society.

Although economists elected to largely ignore this issue, general citizens, legislators, planners, and political activists have long recognized that spillovers or externalities are central features of industrial society. This general realization is reflected in common and statute laws, zoning ordinances and recurrent efforts at land use planning. Few of these efforts, however, have been successful at solving the problem addressed and many of them have generated serious negative

consequences. Zoning is a particular case in point. "Recently, however, economists have developed techniques that utilize existing data to access not only the costs of pollution but also the socially most efficient control level of the pollution, By applying this technology, the kinds of socially costly consequences that have resulted from zoning can be very substantially solved."

I. Welfare Implications of Pollution

Some degree of pollution is both inevitable and desirable. The first question then becomes, given any specified set of values held by members of a society, what level of pollution is consistent with the highest welfare. Because we are dealing with a common pool resource where private action is socially inefficient the second phase question is what impact does the political system have on the attainment of the desired level of pollution?

To explicate the situation we will consider a simplistic example. Assume an airshed where all objectionable pollution is caused by industry. (Because this case is treated in more detail later, it is only outlined here.) Assume that the damage and irritation caused by pollution is 100U. An expenditure of 5U would reduce this cost to 10% of its former level. Thus, there would be a net gain of 85U. In this example society would be better off by 85U if the industries would control their pollution. Obviously, if tastes change and people come to place a higher value on a clean environment, then the same amount of pollution will have a negative value (disutility) greater than 100U and the benefits from pollution

control would increase. Given this situations what is the likelihood that the efficient level of pollution will be reached via the political process. It is, in brief, damn slim.

II. The Political Dynamics of Pollution Control

There is a disparity between the ease of political mobilization enjoyed by the industries and the difficulties faced by those organizing the direct consumers of air. This difference is primarily the result of the nature of the benefits sought and the size of the groups.

The industrialists have been using the airshed as a receptacle for their waste products. They have done so not out of malice or intent to damage (for they must, to some degree,, suffer the consequences of polluted air) but rather, because it is a convenient, cheap and traditional way of removing waste from the site. The vast bulk of the costs generated by the pollution is passed on to third parties. In this sense environmental degradation and externalities associated with pollution provide another example of a common failure of modern social institutions to deal with involuntary private transfers.

The industries, then, are receiving a public subsidy in the form of implicit permission to pollute. And subsidies of this magnitude are *very* rarely given up voluntarily. Hence, the industries have a strong incentive to act in the political system in a manner to maximize the probability of this subsidy being retained or preferably even expanded.

Clean air may be considered a public good. If available to anyone, it is available to everyone. (An exception to this, of course, is the

bottled air, air that has been packaged. Bottled Air is provided to traffic policement in Tokyo.) In contrast with the industrialists, those who desire the provision of cleaner air as a public good have far weaker incentives to organize. Because air is not normally packaged, people can not be excluded from its benefits. The effective demand created by any one person's investment in either time or money is likely to be *very* small indeed. From the perspective of any individual, the rationale for not participating is as follows:

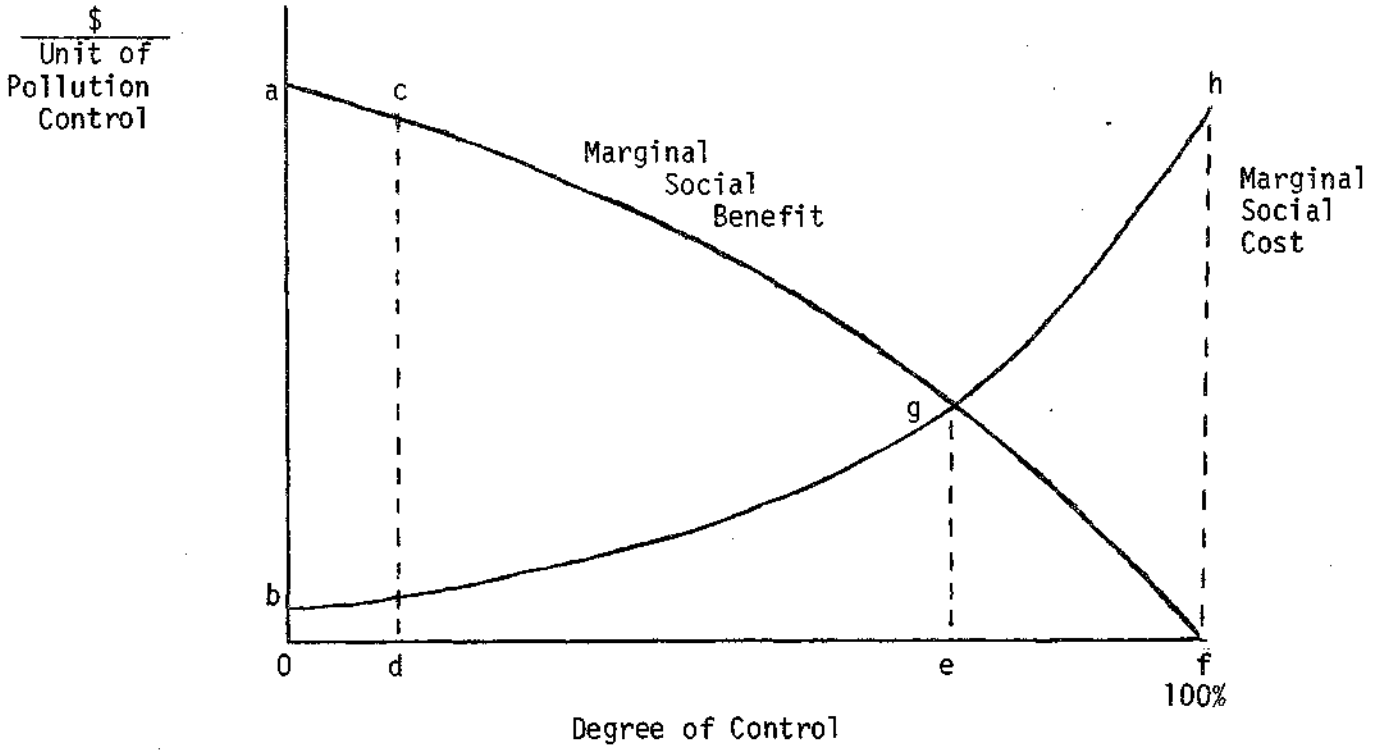
> If I withold my investment in time and money, the contributions of the Sierra Club and rich environmentalists may gain the action anyway. Therefore, I will not contribute, If the action is unsuccessful my investment goes down the drain, If the action succeeds, I gain the benefits of clean air anyway. Thus, I will opt for a free ride on the backs of contributors.

This disincentive for organizing to bring about pollution control is strengthed on the cost side by the size of the group subjected to the pollution. From a political action viewpoint, there are many concerned citizens, but no one has a sufficiently large stake in the issue to warrent bearing the costs of the action. Thus, there is a potential citizen base for a political lobby group but it is only a "latent" group.

In sum there are two structural factors working against those who prefer cleaner air. When a group subjected to a negative externalities is large and when each individual in this group experiences relatively small loss, it will generally not be in the interest of any of the individuals to invest much effort toward influencing the outcome. In contrast, if a small group (firms) expect large losses (even when their <u>total</u> projected loss is smaller than the current <u>total</u> loss of the general public as in our example), each member (firm) has a concentrated

incentive to work toward a favorable decision. Thus, the basic forces that produce special interest legislation elsewhere are operative in air pollution decisions.

When diagramed the example would take the following form:



The local benefit of 99.9% control would be (approximately) the area under the curve a-f. The social benefit would be the area (o a f)-(o b h t). (Note that this could be a negative value at f, i.e., there is a potential disutility from too much control.) From the perspective of social welfare, the optimum level of control is at e, the point where the SMC = SMB. At level e, SMB = (o a g e)-(o b g e) or, the area in (a b g). Hence, society is better off by imposing pollution control at level e. The associated costs of control however, are born in a concentrated manner by the firms and ultimately their customers, while the benefits are diffused among the public.

III. The Probable Results of Voting to Establish Pollution Control Levels

On the basis of both the historical record and personal experiences, we are accustomed to thinking of the public as being victimized by the industries which impose social costs. Because these costs are becoming greater as industry and population grow, and because a growing number of people are reluctant to tradeoff a depreciated environment for more material goods, the political environment in which industries impose costs has changed significantly. This change is evidenced by the results of public referendum conducted at both the state and local levels. It seems clear that industry will continue efforts to impose externalities on society but that this imposition of this social cost will require greater skill and more rationalizations than in the past. This change, however, should not suggest that the "optimal" level of pollution will be reached.

Consider again the example discussed and graphed above. In this situation each citizen realizes that any actual payment that he might make to the firm to "bribe" it to reduce pollution would have a trivial effect on the pollution level. Thus, although the aggregate damage suffered by the public is *very* much greater than the cost of reducing the pollution, no private bargains will be made. The potential for the citizens to band together to form a bargaining coalition does exist but it is precluded from operating by the freerider problem discussed above. Thus, nothing is done privately and the rule of willing consent is relaxed to permit solutions by governmental means.

Under these governmental means, each individual can vote on the

issue of the pollution emission, Because the government employs coersion to require people to carry out the decision reached, no individual has a motive to conceal his preferences when voting. Hence, it seems reasonable to anticipate that this problem would be handled better by government action than by free market activity.

The line of reasoning ignores the problem of information, The decision as to how much the pollution should be restricted (recall that level e is optimal), or what method should be used to restrict it; for example, a tax on smoke emission is a technical problem. Will the individual voter invest the effort to become informed on these matters?

The same line of reasoning used above to indicate desirability of governmental action clearly indicates that the voters will not both to become informed. The individual citizen finds that if he makes a payment to the factory owner to reduce pollution, most of the benefit of this payment accrues to other people and *very* little to himself. In exactly the same manner any improvement in his information mainly benefits other people.

In any actual situation the above case is very strong indeed. If the number of citizens is 100 or greater the following propositions would be true. First, if the individual improved his information and hence changed the way he would vote, it is very unlikely that this change would have any effect on the outcome.' Under the circumstances the payoff to improving information is so low that we expect the individual would not bother to seek out information. The most consistent finding in

political behavior research is that voters are overwhelmingly ignorant. The free rider problem returns in another form. In the market with externalities the individual is a free rider because he does not make payments. In governmental dealing with externalities, the individual is a free rider in the sense that he acquires no information, and hence his decisions are badly informed.

Most individuals seem to have at least some slight preference for low, rather than high levels of pollution, Thus, pollution levels could be established via democratic processes and the preferred level implemented by some administrative means. It would not be necessary for the citizen to concern himself with technological matters.

From the standpoint of social welfare, the question is not whether people object to pollution, but rather how strongly they feel about this preference. How many resources are people willing to give up in order to reduce the pollution? Some of us might give up a great deal and others only a small amount, but no one would sacrifice everything to provide clean air. There are simply too many other values. Otherwise expressed, pure air does not have infinite value. If the optimum amount of control were to be selected, each voter would have to decide how much he would be willing to sacrifice for increased air purity. Some sort of average would then be taken,

Obtaining the optimum level of pollution from the above process seems to be the least likely of possibilities. When confronted with a referendum (and if he thinks about the matter at all) the voter will not ve concerned with the problem of obtaining an optimum allocation of

resources. Rather, since the costs of this improvement will be borne largely by others the referendum will probably be viewed as an opportunity to improve one's well-being by moving toward an airshed of pristine quality.

Anyone living in Missoula, Montana and whose job did not depend on the pulp mill would be very likely to vote for 99+% control regardless of what such control costs. Any of you who have visited Missoula will understand this prediction.

In terms of the graph presented above, under democratic procedures we expect the citizen whose welfare was not closely linked to the firm producing the objectionable pollution to vote for a level of pollution control in excess of e. From the perspective of social efficiency, however, each unit of investment in pollution control beyond e costs more than it brings in benefits, i.e., beyond e the area under (b-h) increases more rapidly than that under (a-f).

In general, voters will tend to be largely ignorant in their voting with respect to reducing social costs. When they consider the issues, primary attention will be on wealth transferred to themselves rather than social efficiency. Hence, one would not expect democratic procedures to be *very* effective in reducing social costs.

IV. The Single Standard Approach to Air Quality Measurement

In the previous sections I attempted to demonstrate why there are very serious problems inherent to both market and democratic means of determining air quality standards. Another obvious possibility is to set a standard at the national level and enforce them over the entire nation.

The social costs of pollution are largely dependent upon types of emissions, emission levels, delivery mechanism,, and location of receptors. The cost of controlling the social costs of pollution vary with level of technology available, resource availability, and the level of pollution producing activity. The socially optimal level of air pollution (0*) is that which minimizes the sum of damage and control costs. In an example taken from Richard Stroup's study of the Tacoma copper smelter, "Common Pool Resource Problems: The Role and Utilization of Information," we find 0* = f(W, S, H, E, R, N, P) where W is the wind velocity vector, S is atmospheric stability, H is stack height, R is damage per household per unit of $S0_2$, N is control expenditure, and P is a vector of population size and distribution.

If you will assume that this statement captures the bulk of the variables which determine the socially optimum level of pollution (0*), several conclusions are immediately obvious. First, the variables do as a matter of fact vary throughout the nation. Wind velocity vectors are not the same on the Montana Highline as they are in the Tennessee Valley or the Los Angeles Basin. Clearly there is tremendous variance in P between Chicago and East Helena, Montana. In sum, it is inconceivable that we could optimize 0* by establishing a single level of pollution emission for the entire nation.

A single standard, however, has one compelling advantage for the bureaucrats who would be responsible for administering air quality; it is easy to administer. There is a rule to consider when predicting the responses of large, centralized bureaucracies to problems with diffuse

sources. The rule is that it is exceedingly difficult for a large, centralized bureaucracy to take time, place, and situational variables into account when making decisions. Control by standardization is one hallmark of bureaucracies that not only disturbs people subjected to it, but also, in the example given, leads to a great waste of resources.

V. Science, Knowledge, and a Rational Strategy of Air Quality Measurement

[This section is taken from (pirated from) a paper written by Richard Stroup, an economist with a background In engineering and meteorology, for a collection of papers on common pool resources edited by John Baden.]

In a world of complete information most of the inefficiencies caused by pollution could be quickly solved. If those damaged by pollution (by lessened health, crop damage, or extra car washes) had their damage estimated and their polluters identified, then receptors can, under the common law of nuisance, collect damages via the courts and hence cause the polluters to act in a socially responsive manner.

Complete information, however, is neither obtainable nor worth its price. Thus, with information being "costly," maximum satisfaction of multiple goals can be achieved only by adherence to the equimarginal principle, i.e., if the worth of resources is measured in dollars, equal units of satisfaction per dollar spent must be obtained by spending in any direction.

We face situations in which varying negative externalities are imposed on the public and in which information regarding those externalities is expensive. Those responsible for administering air quality, then, must strike a balance between permitting a socially inefficient

degree of pollution or requiring social inefficiencies over investments in pollution control. Rational decisions then are dependent upon good information. In the absence of good information, it is also easier for pressure groups to gain influence in the political context within which administrative decisions are made.

The method suggested by Stroup is a technique for working with available data to expose the most critical areas of empirical ignorance, to indicate the payoffs to better data on each parameter value, to examine the stability of a solution under alternative estimates of parameters, and to provide guidance to decision makers who must take action before further data can be obtained. One feature of this analysis is its encouragement (to both resource managers and their critics) of disagreement on an objective plane where the issues are proper estimates of specific parameters.

The value of added information (or the cost of continued ignorance) depends on the gains from better decisions made possible by the information added. Here, added information is taken to mean reduction of the size of the interval assumed to contain the value of a parameter at a given level of confidence.[1] Use of the technique presently considered--hereinafter called sensitivity analysis--involves two basic steps: (1) construction and solution of an optimization model using the "best," "most acceptable," or "most likely" parameter values available; and (2) examining the effects on the solution variables and expected benefits when alternative data estimates or sets of estimates are used.

[1]Respecifying the relevant parameters or functional relationships could also result from added information. Such possibilities could logically be treated in the same way as alternative estimates of parameter values.

When probabilities can be attached to the occurrence of all possible values of every parameter, techniques of statistical decision theory seem capable of handling both optimization and the question of evaluating precisely the value of added information.[2] In the more prevalent case, where less is known about the parameter values, the less rigorously defined method of sensitivity analysis is a useful way of exploiting all available information.

Before proceeding with the empirical example demonstrating sensitivity analysis, it seems desirable to comment briefly on the study whose results are summarized in the example. The original study attempted to evaluate both the pollution effects and the control costs associated with all emission levels greater than zero, up to the omission level prevailing with little or no control. The pollutant considered was sulfur dioxide from the stack of a copper smelter near Tacoma, Washington.

The argument is often made, of course, that economic analysis, however elegant, is useless in such a problem with so little solid data. Certainly usable output from the analysis does require specified data. This in fact is a great strength: assumptions about tastes, production possibilities, etc. must be explicitly stated before "answers" or "optimal solutions" can be reached. In the absence of unique, accurate numbers, however, unique optima are difficult to express with confidence. The purpose here is to show that sensitivity testing can in fact allow economic analysis to use efficiently the

---

[2]For a solved example of an analogous problem, see H. Wagner, (4) pp. 655-658.

existing data, and thus to be very helpful not only in evaluating alternative policy choices, but also in helping to direct research into areas of empirical uncertainty.

Pollution damages were estimated from property value data, processed to control for other value determinants and to isolate the effects of sulfur dioxide pollution which caused people (for a variety of reasons including aesthetics and material damage) to pay less for houses in more polluted locations than for otherwise identical houses in less polluted locations. Data presented below are for only the four emission levels least costly to attain according to technical and cost data furnished by the National Air Pollution Control Administration.[3]

Pollution damages are dependent on the delivery mechanism (air movements), emission levels, and the location of receptors relative to the emission source. Control costs depend on technology, resource availability, and the level of the pollution producing activity. The most efficient level of emission (E*) is that which minimizes the sum of damage and control costs. More specifically, in this case:

$$E^* = f(W,S,H,R,N,P)$$

where W is the wind velocity vector, S is atmospheric stability, H is stack height, R is damage per household per unit SO_2, N is control expenditure, and L is a vector of population size and

---

[3]Data sources and methodology are detailed, and further data given, in Stroup. (4).

geographic distribution.[4]

Table I shows the various costs associated with each of the four levels of control considered, under various sets of assumptions about parameter values. Assumption set No. 1 involves parameter estimates selected by the author as "most likely" after examining the actual data, reviewing various literatures and consulting experts in several fields of study. Obviously, much personal judgment is involved in this, the first step of sensitivity analysis. At this point no two people working independently are likely to reach exactly the same conclusions. Still, even in such a highly uncertain state, decisions must be made, at least regarding research strategies and priorities, and probably regarding control policy. Assumptions must be made and an explicit statement of these assumptions (as in the original source of these numbers) encourages hard thinking and use of defensible assumptions.[5] Accepting this basic set of assumptions implies that 96 percent control is efficient, saving almost half of the $6.2 million cost of no control.

---

[4] Efficiency is the only criterion considered here. It is assumed that once efficiency is attained--or at least efficient strategy determined—equity or who pays and who is compensated, can be arranged separately, the latter must clearly be done carefully if the former is also to be accomplished. Note also that any level of pollution may be shown to be efficient, given the "proper" estimates of true pollution damages and control costs. Validity of any model's outputs are, of course, dependent on the validity of data inputs.

[5] At this point, where dollar figures have been introduced, it is well to remember that dollars in themselves do not count for much,, and that prices are simply condensed information about opportunities, relative scarcities, and preferences. When net evaluations of alternative actions must be made and compared, a common denominator is required. Economists have long recognized that prices are the lowest of denominators, and often (but not always) objectively measurable.

Table I.

Annual Costs of Pollution and Control
(Millions of Dollars)

Sets of Assumptions	Control Level (%)	Control Costs	Pollution Costs	Total Costs	Net Cost (96%)
1. Basic	0	0.0	6.20	6.20	
	80	2.37	1.24	3.61	
	*96	3.25	.25	3.50*	0
	99.2	4.000	.05	4.05	
2. $R = 0.5R_o$	0	0	3.10	3.10	
	*80	2.37	.62	2.99*	0.38 (0.11)
	96	3.25	.12	3.37	
	99.2	4.00	.02	4.02	
3. $R = 1.5R_o$	0	0	9.30	9.30	
	80	2.37	1.86	4.23	
	*96	3.25	.37	3.62*	0 (0)
	99.2	4.00	.07	4.07	
4. $N = 1.5N_o$	0	0	6.20	6.20	
	*80	3.55	1.24	4.79*	0.33 (0.11)
	96	4.87	.25	5.12	
	99.2	6.00	.05	6.05	
5. Very Stable Atmosphere	*0	0	.34	.34*	2.92 (2.7)
	80	2.37	.07	2.44	
	96	3.25	.01	3.26	
	99.2	4.00	.003	4.00	
6. Inversion at 300 meters	0	0	7.96	7.96	
	80	2.37	1.59	3.96	
	*96	3.25	.32	3.57*	0 (0)
	99.2	4.00	.06	4.06	
7. Wind vector 2	0	0	5.45	5.45	
	*80	2.37	1.09	3.46*	0.01 (0.11)
	96	3.25	.22	3.47	
	99.2	4.00	.04	4.04	
8. Wind vector 3	0	0	5.76	5.76	
	80	2.37	1.15	3.52	
	*96	3.25	.23	3.48*	0 (0)
	99.2	4.00	.05	4.05	
9. Heated Emission Plume	0	0	4.50	4.50	
	*80	2.37	.90	3.27*	0.16 (0.11)
	96	3.25	.18	3.43	
	99.2	4.00	.04	4.04	

* Optimal control level with given assumptions

Assumptions No. 2 through 9 involve only the change specified using the basic set of assumptions for all other parameters. The last column supplies the net cost of accepting all the basic assumptions and controlling 96 percent of emissions, when in fact the alternative assumptions are correct. Following each number in the net cost column is a number in parentheses, the net cost of accepting the alternate when basic assumptions are correct. These figures not only indicate the cost of improper control strategy under the various assumptions, but they also point out the crucial areas of our ignorance and give a rough idea about the payoffs to reducing ignorance about each parameter, whose estimate is allowed to vary within what appear to-be reasonable bounds, given the current state of knowledge.

Data generated using the assumption sets No. 2 and 3 show that changing the damage per household per unity of pollution by 50 percent in each direction has a significant effect, but only if the basic estimate is too high will the error be costly, accepting other basic assumptions. Determination of whether or not the basic estimate is too high apparently might save hundreds of thousands of dollars per year. (Note that the basic estimate simply doubled household damages, on the assumption that about half of all $S0_2$ damages occur at the location where people live.)

Data for assumption set No. 5 shows that *very* stable atmospheric conditions reduce damages so much that any positive level of control involves largely wasted control costs. (The most unstable condition is even more extreme, resulting in no expected damages, so that any control cost is totally unrewarded.) Clearly, research on the relative

frequency of various atmospheric stability conditions is extremely important, since errors here may cost millions of dollars in net losses for this one pollution source alone. On the other hand, existence of an inversion just above stack height, while it raises estimated damages, does not change to appropriate strategy, so that extra information here would have a small payoff. Likewise, the next two cases show that the solution is rather insensitive to the choice of local wind rose data, when other basic assumptions are accepted, so there is little urgency to more precisely estimating the true wind rose.[6]

The last change in assumption just shows the effect of adding a stack heater which raises effective stack height by 10 meters, raising the plume and reducing ground level concentrations everywhere. Total cost estimates are reduced by $230,000 per year. Apparently such a device is socially beneficial here (in the absence of emission controls) if installed and operated for less than that amount. At the 96 percent level of control, however, it would reduce damages only by $9,200 per year.

The benefit-cost study buttressed by sensitivity analysis is, then, an important management tool. It not only can use the best available estimates of each parameter to indicate optimal management practices; it also can reveal which parameter estimates can, within their respective reasonable ranges, lead to the most costly errors, and thus can help guide the use of scarce research resources

---

[6] See Asmus and Stroup (1) for a subsequent and much more sophisticated treatment of the stability problem applied to this case as well as another smelter.

in the search for better information. Given uncertainty in the parametic estimates, the analysis can also indicate when it might pay to depart from the indicated "optimum" management plan based on "best" parameter estimates, since consequences of errors typically are not symmetrical with respect to the direction of error. The analysis is very general in that any set of assumptions and parameter estimates may be used. Of course it follows that the results are only as valid as the data inputs and model specification.

Perhaps equally as important as the technical properties of this type of analysis are the potential benefits of dissemination of pertinent information beyond the management staff to those interested, but not strongly enough interested to retain professional help in gathering the data themselves. As Niskanen has said (3, p. 23):

> Secrecy and lack of information about the nature of his operations and production process are the main tools the bureaucrat uses to maximize his [control over resources]. Because laymen and policy makers lack information, they must too often take on faith or accept at face value the assertions of bureaucrats.[7]

Use (and publication) of the kind of analysis above not only helps the bureaucracy attain its stated goals, but also aids its critics in protecting their own interests. At the same time, both defense and criticism of a given decision can be expected to revolve around more concrete and objective questions when the goals, assumptions, and parameter estimates are shown explicity for all to see. Without necessarily resolving conflicts such explicit analysis should at

---

[7]Niskanen uses "budget" in place of the bracketed phrase inserted here.

least clarify points of disagreement. In fact, opposition to the use of such explicitly stated techniques can be expected precisely because of this. Some bureaucrats and the currently powerful clients of bureaucrats naturally do not want their own power and influence diluted by the easy access to others of information previously theirs alone. Cries (corrects but largely irrelevant) will be heard that "the numbers don't tell the whole story." True! But when there are non quantifiable factors, the quantitative analysis can estimate the cost of attaining non quantifiable benefits, or the benefits to be gained from even rough estimates of unquantified costs.

REFERENCES

1) W. Leontief, "Theoretical Assumptions and Nonobserved Facts" Amer. Econ. Rev., March 1971, LXI, 1-7.

2) W. Niskanen, Bureaucracy and Representative Government, Aldine-Atherton, Chicago, 1971.

3) R. Stroup, The Economics of Air Pollution Control, University of Washington thesis, 1970; available from University Microfilms, Ann Arbor, Michigan.

4) H. Wagner, Principles of Operation Research, Prentice-Hall, New York, 1969.

John Baden
February 27, 1973
Preliminary Draft

ON THE POLITICAL ECONOMY OF GLAMOUR, SEX, CONVENIENCE, MADISON AVENUE, AND AIR POLLUTION

Introduction: Cars, Values and a Personal Confession

Americans have placed a very high value on the convenience and social status attached to private use and control over their transportation; cars are *very* important to most Americans. Los Angeles may be reasonably viewed as a monument to this value. But it is increasingly clear that this private preference generates serious social costs. An effort is being taken to ameliorate auto caused pollution, and the central problem involved in attaining this objective is, simply, that it is very difficult to get people to give up or reduce their consumption of a common pool resource, in this case an airshed.

There are probably few, if any, metropolitan areas in the U.S. that have air pollution problems not closely related to automobiles. The only charming and sexy engineering student I am fortunate enough to know has advised me that according to her figures, approximately 50 percent of the noticeable air pollution in Cache Valley results from auto and truck exhaust. And I will take her figure to be as good as any.

There is near consensus that in many regions this pollution should be significantly reduced. There is little agreement, however, as to the equitable and efficient means of accomplishing this goal. One method, however, can be quickly dismissed. A number of enviornmentally concerned (and I am sure kind and empathetic) people advance the agrument that to obtain effective solutions to environmental problems peoples' heads must be changed'. Unless

peoples' orientation toward their envirommenl. is changed, they assert, the real problem is simply not addressed. People in or on the fringes of the biological sciences and those in the humanities seem to be relatively prone toward this position.

The principle flaw in this approach is that it has *very* little to do with the problem. From the logic of this perspectives the problem seen is primarily a spiritual one. It is not that people create pollution that bothers them as much as that people do not mind causing pollution. Their position then, is that of the missionary. I believe we can state with some confidence that: (1) there will be little difference in the quantity of human waste generated by a person regardless of the quality of his spirit, and (2) the filters and organisms of a sewage treatment plant are totally indifferent to the spiritual quality of the emitter of the waste. In general, it is extraordinarily risky to rely on conscience to protect common pool resources.

> This is not to discount the importance of value shifts. It is obvious that if people place a high value on the quality of their environment, they will be willing to give up more to protect or enhance it. Further, given my values, I believe that efforts should be made to foster a general sense of environmental awareness and appreciation. A fundamental shift in this direction is underway and receives wide support. If you will forgive a personal confession, when growing up in a rural area we customarily disposed of beer bottles by throwing them out of the window of a moving vehicle. The only time I thought much about the practive was when mowing ditch banks and picking up a bottle in the sickle bar of the mower. Ten years later when driving back from work, I would stop the crewtruck if a new logger threw an empty out of the window. While this is obviously a trivial example, it is probably not especially unusual. Further, it may be reflective of the general shift in awareness and values mentioned above.

I. Strategies for Pollution Control: Direct and Indirect

A. Definitions

In discussing strategies for managing air quality it is useful to distinguish direct from indirect control. Direct controls are applied to the

emitting source with little if any discretion for making private decisions. The closing down of a plant that exceeds emission standards is one example of a direct control and banning the burning of leaves is another. Under this strategy there is a single link between the regulating agency and the polpolluter. To be effectives the cost of not complying must be extremely high. In effect the regulation states that thou shalt not emit $S0_2$ in a quantity greater than X.

In contrast to direct controls, indirect controls have multiple links between the emitter of pollution and the agency. Under this system the agency attempts to control pollution by modifying the information and incentives available to the polluter. The obvious example is that of placing a tax on waste. The firm can either pay the tax and thus pay society for damages, or it can adopt controlling technologies and lessen the damage.

B. Direct Control on Automobiles

Control of automobile emissions has been attempted by the direct means, i.e., manufacturers cannot produce a machine whose specified emissions are above a prescribed level. These standards are relatively easy to implement and enforce for only a small number of plants build engines. This Federal strategy has left the technical decisions of how to meet the standards to the manufacturer. Hence, manufacturers are developing catalytic reactors with low fixed costs but with high operating costs and high maintenance costs. One of the alternatives would be a thermal control with high fixed costs and lower maintenance costs.

Catalytic reactors will function properly only with nonleaded gasolines. Thus, more highly refined gasolines with higher natural octane ratings will be produced. Some research suggests that unleaded gasoline will

produce greater emissions of olefins and other complex hydrocarbons. Yet it is not at all clear that lead causes more damage than olefins. With the decision made for catalytic reactors, we appear to be locked into olefin production.

There seem to be three generalizations that can be drawn for this sketch. First, because of their single likeages, ease of administration, and hence apparent predictability, governmental agencies will tend to prefer direct controls. Second, it is extremely difficult for a governmental agency to predict the second and higher order consequences (olefin production) of its decisions. Thus, without a large volume of high quality research, direct controls are likely to produce an entire series of costly "remedies". The recent series of decisions regarding laundry detergent is one example. Third, the firms involved in this situation (as in all others) will make *every* effort to pass on their costs to the customers. Thus, the fundamental question remains; how can the situation be structured so that those responsible for producing pollution be forced to take the costs of their action into account in a socially responsible manner?

C. The Application of Indirect Controls

When applying indirect controls to eleviate the costs of pollution, linkages between the administrative decisions and the reduction in pollution involve both human behavioral and technological assumptions. Hence, if the control strategy is to be effective in reducing pollution, the agency must not only have good technical information and accurate predictions regarding the human responses to the control strategies, but it must also know the logical relations among these sets of interacting systems.

One obvious possibility for indirect control would be a very high tax on gasoline. Since all demand curves slope downward to the right (this is the social analogue to the law of gravity), an agency may assume that people will use less gasoline at higher prices. Hence, as assumption is made that the amount of pollution will be reduced. This prediction relies upon the assumption of a technological link between volume of gas consumed and exhaust emissions and a behavioral link between price and amount demanded.

Unfortunately, the above argument does not take into account all relevant variables. In the first place, the above solution does not take into account that a large proportion of people are continuously seeking out possibilities that will make them better off. Thus, higher gasoline prices will encourage the purchase of cars with smaller displacement but higher compression ratios. [If I recall correctly, the power from an Otto cycle engine increases to the 1.4th power of its compression ratio while fuel consumption is primarily dependent on D holding RPM's constant. Hence, horsepower is a function of both D and CR. The consumer can manipulate either, depending on the cost of fuel.] It turns out, however, that engines size and the emission of hydrocarbons and carbon monoxide are not strongly positively related and are in some cases, are even inversely related. In Federal tests of 1971 automobiles, one vehicle with a displacement of 79 cubic Inches had emission rates of hydrocarbons and carbon monoxide that were 50 percent greater per mile than a vehicle with a 472 cubic inch displacement engine. [The 79 cubic inch displacement engine was probably a Harley-Davidson Sportster motorcycle rather than an

automobile, but it is unrealistic to expect large bureaucracies to make such subtle distinctions.] Thus, the substitution of small engines for larger ones, made in the interest of fuel economy, could produce a greater production of objectionable pollution.

In addition to the above possibility,, we should also consider that not only mileage but also driving patterns involving acceleration, speed, etc. have substantial impacts on the emissions of hydrocarbons, CO and NO_x. Thus higher gasoline prices (say $1.00 per gallon) would encourage drivers to drive more slowly for shorter distances with cooler engines in order to increase fuel economy. Such changes in modes of operation could actually increase objectionable emissions, and on the absence of strategic reactions by those subject to control is likely to fail in meeting its objective.

D. Costs of Control

Neither information or administration and enforcement are free. In principle, however, it would be possible for an agency to determine the socially optimum degree of automobile pollution control if it has the following sets of information. First, it must know all technologies and potentials for substitution among all resources. Second, it must account for the preferences of all citizens and those of future citizens and develop a weighing system for welfare tradeoffs among these generations. Third, resource availabilities and the environmental assimilative capabilities of the re!event ecological systems must be understood. Even if one discounts administrative and enforcement costs to zero, it is clear that

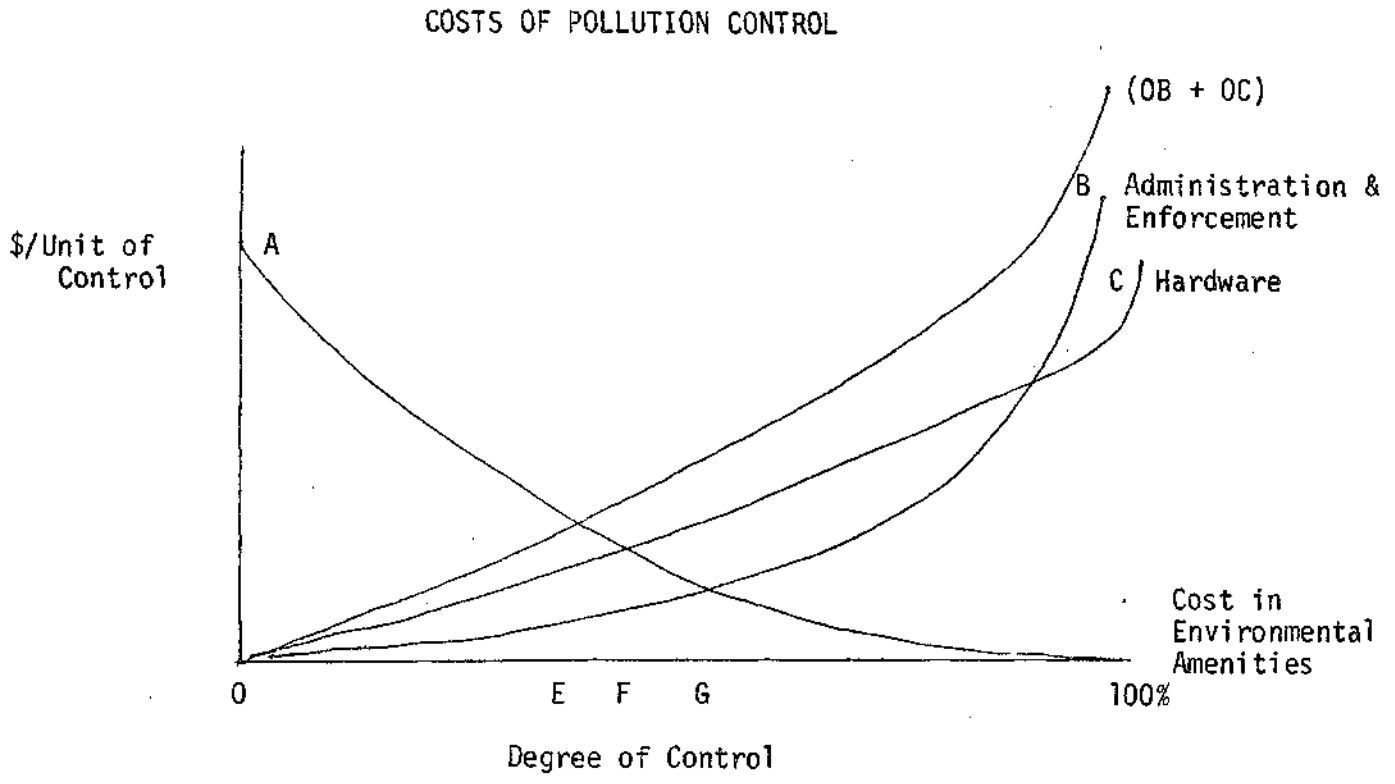
the above three sets of information are unobtainable and that even rough approximations would be extremely difficult to obtain. Hence, even the best system of direct control would entail very substantial compromises.

£. A Comparison of Direct and Indirect Controls

Please recall that both direct controls and indirect controls presuppose extensive knowledge of both the technical and the behavioral systems and of the interactions among them. Indirect controls, however, are primarily concerned with the welfare implications of pollution and leave to the final polluter the task of judging at what level he is willing to tradeoff payment to society (for damage done) against investments in pollution control. Hence, with indirect controls the agency can focus its attention on the question of damages done by pollution and then adjust the schedule of incentives and information available to the polluter, to move toward Pareto optimality.

Our concern is with two sets of costs that an agency faced with automobile pollution control must face: administration and policing costs, and information costs. When considering this set of costs, we should remember the generalization that bureaucracies find it very difficult (and hence, expensive) to make decisions that take time and place variables into account. Thus, there is an advantage to be gained from making the control decision at the level nearest the person taking the action which causes pollution. The trick, of course, comes in designing a structure of information and incentive generation which forces the pollution producer to take the social welfare implications of this action into account.

In effect we now have something close to the single standard approach to automobile pollution control. The loopholes (older cars,. olefins production) and inefficiencies (catalytic reactors, decreased fuel economy, forced over investment in control devices for low mileage drivers) are obvious.



Although the conformation of the other curves has been discussed elsewhere, OB has not. The administrative and enforcement costs of rigid direct controls imposed to *very* high levels is expected to be exceedingly high. If the level of control is considered oppressive to the industry being regulated, illegal actions and pressure will be generated in attempts to neutralize the impact of control. If social welfare is the goal, not only will vast amounts of resources have to be employed before setting controls at high rigid levels, there would also be a necessity for monitoring the controllers if the projected control were to be effective. The required degree of monitoring would be a partial function of the degree of pollution control sought and the degree of directness. Attempted efforts to thwart

the impact of control would be wasteful for the perspective of social welfare. This is discounting to zero (0) the moral implications of such efforts.

In the above sections I have attempted to identify several of the potential problems involved in efforts to gain a net social welfare by reducing the social costs of automobile pollution. In the following section an effort is made to identify a feasible method of dealing with these problems of automobile caused air pollution.

F. The Pricing of Emissions

It is indeed possible that a conjunction of changes in tastes, technology, and alternative forms of transportation will eliminate the current problems associated with automobile pollution. It would be unrealistic, however, to count on such shifts, Hence, in seeking a solution we may be well advised to start with the current state of affairs.

Individuals who drive are those who are responsible for air pollution. Of course, currently, they have few options, i.e., only a few have the talent and the resources to build methane powered steam cars. Thus, from the standpoint of both equity and social efficiency, those driving should have the responsibility and costs of "administering" their pollution control.

In dealing with a common pool situation, it is necessary to relax the rule of willing consent if the resource is to be managed rationally. Thus, ultimate reliance will be on governmental coersion to enforce the means of control suggested.

Assume that an agency is able to determine the socially efficient level of pollution. This would be accomplished by examining the preferences

of citizens and the degree to which pollution is inconsistent with the attainment of those preferences. Next, assume that a price is placed on the several emissions. Obviously, given current technology, it would be silly to continuously measure emissions from each vehicle. In contrast, given known fuel input characteristics (for lead, sulphurs, etc.), it is relatively easy to determine the average output of emissions from various engines. Thus, if mileage is known via scheduled checks of odometer readings (such as currently done for many commercial trucks) the operators could be assessed the social costs of the cars emission. Hence, referring back to the earlier example, the rider of the 79 CID Harley-Davidson would pay 50 percent more tax per mile than the driver of the 472 cubic inch machine.

Were the system implemented, operators would then constitute a market for machines with clean engines. And capitalists, I assure you, are sufficiently greedy to respond to this new demand. High mileage drivers would find it rational to make very heavy investments in pollution control devices. In contrast, those who use a car *very* infrequently would find it preferable to spend little on control. It would be socially inefficient for a little old lady who drives only to Relief Society to allocate $500 for pollution control. In a similar manner, a rancher on the High Line generates very little social cost when he drives into Haver. Hence, the emission fee on the High Line would and should be less than in Pasadena. This scheme would make explicit some of the social disutilities that result from extreme concentrations of people.

In sum, a pricing system distributes costs to those who produce or consume polluting goods. Further, detailed information about the techniques of polluting goods. Further, detailed information about the techniques of pollution reduction need not be known by the administering agency. This is consistent with administrative efficiency. Perhaps of greatest importance,

however, is the fact that the pricing scheme provides both the information and incentives that make actions that are individually rational also socially rational. And we will probably agree that one of the greatest political and moral problems of the next century will be that of preserving the commons without resorting to tyranny.

John Baden
February 18, 1973
Preliminary Draft

APPENDIX

ON THE DIFFICULTY OF BEING ENVIRONMENTALLY MORAL IN THE ABSENCE OF PRICING

After reading several of the previous essays, I am concerned that the moral implications of my analysis and suggestions be misunderstood. The consistent theme in these essays is that those whose actions have the potential for causing pollution must be provided the "proper" information and incentives if they are to act to enhance social welfare. One may object that this is a narrow and perhaps even cynical view of man. There is in this collection, little explicit attention given to the role of good intentions. This omission is largely intentional. Two brief examples may suggest why.

Several years ago I was, as usual, on a committee charged with responsibility for designing an environmental program for a university. The director of the program was a physical scientist who specialized in natural resources. His Ph.D. was granted by one of the nation's most prestigious universities. He had published in environmental problems in Science and in professional journals. He was, in brief, certified to be highly competent. Further, he had developed an "ecological conscience" long before such became fashionable.

During one of our policy meetings held at his house I was running my usual argument that if people were to behave in an environmentally responsible manner it would be necessary that they receive the correct information and incentives in the market, i.e., that prices must reflect environmental costs. This director took strong exception to my position claiming that what really must be done is to educate people to the environmental implications of their behavior. After all, he explained, he had traded in his Buick for two VW's because of his enhanced awareness. Surely others could make the same type shift. Not being noted for tact when dealing with deans and other administrators, I asked what kind of cans our beer was being served in. Aluminum throw-aways! Surely I said, given your academic specialty you must be aware of the environmental implications of aluminum throw-aways as compared with returnables. Well, yes, he admitted, but he had just never really thought about it and I should understand that he had so many important things in bis mind. I really expected better than that—even from deans. My point is simply that he wouldn't have had to think about it at all if the same beer cost a dollar more per case for throw-aways.

The second example occurred only a short while ago. I was in a shop that handles, among other things, health foods. (Just to protect my reputation for sanity. I was not in the shop buying health foods. Health foods have more to do with religion, in the broad sense of that term, than they do with health as that word is usually employed.) A young lady reeking of sincerity came in clutching the wrapper from a health food bar made in California. She spoke with the proprietor, asking him to stock the item and commenting on how wonderful and remarkable it is that people, and even companies, are now showing concern for both

their inner and their outer environments(?). I could not resist pointing out that the wrapper, which was largely a testimony to the purity of its contents, happened to be made of aluminum foil. "0h," she responded, "It stays fresh anyhow. There's a plastic coating over the aluminum." Academics concerned with policy matters should remind themselves *every* morning that half the population is below average in intelligence.

The central point in all of the above is that prices are a condensed form of information about availabilities and opportunities. If environmental components of availabilities and opportunities are not included in prices, then regardless of the purity of one's intentions, he is confronted with very serious information gathering and analyzing problems. In the absence of prices, trying to do good, rather than trying to do well, is a formitable problem--in a large part because one can not tell what others want and how intensely they want it in the absence of prices which reflect values.

I happen to prefer and buy wood, leather, wool and cotton rather than synthetics--unless the synthetics have compelling advantages. Aside from nylon, (ripstop, climbing line, boot laces and pack material) and vibrum soles (which have a high coefficient of friction when wet), and dacron thread (which does not rot out), I directly consume few synthetics. Although this is partially due to an environmental sensitivity, taste is a far more important determinant. I simply do not care for the Sears-Robuck Boutique look. If the synthetics actually do have a greater environmental impact than do the natural products, (research on this would be *very* useful) then this impact should be included in the price. If it is not, then there will be a socially inefficient over consumption of the synthetics. As an example, I was told by a person in the industry

that when the synthetic fabrics first became widely available there were approximately 10,000 woolen mills in the U.S. Today there are 600. With only this information sketch I tentatively infer that wool was largely driven off the market due to its competition being underpriced (environmental costs not included) in the market.

In sum I suggest that even the most rabid environmentalists, rather than damn the market system and rant at the crass materialism of Americans, view a price system (like a genetic system) as a means of transmitting information. This is the first step toward the inclusion of environmental information in the one area that all sane people take into account in their daily affairs.