in Simon, 1981, The Sciences of the Artificial

SIX

SOCIAL PLANNING
Designing the Evolving Artifact

In chapter 5 I surveyed some of the modern tools of design that are used by planners and artificers. Even before most of these tools were available to them, ambitious planners often took whole societies and their environments as systems to be refashioned. Some recorded their utopias in books—Plato, Sir Thomas More, Marx. Others sought to realize their plans by social revolution in America, France, Russia, China. Many or most of the large-scale designs have centered on political and economic arrangements, but others have focused on the physical environment—river development plans, for example, reaching from ancient Egypt to the Tennessee Valley to the Indus and back to today's Nile.

As we look back on such design efforts and their implementation, and as we contemplate the tasks of design that are posed in the world today, our feelings are very mixed. We are energized by the great power our technological knowledge bestows on us. We are intimidated by the magnitude of the problems it creates or alerts us to. We are sobered by the very limited success—and sometimes disastrous failure—of past efforts to design on the scale of whole societies. We ask, "If we can go to the Moon, why can't we . . .?"—not expecting an answer, for we know that going to the Moon was a simple task indeed, compared with some others we have set for ourselves, such as creating a humane society or a peaceful world. Wherein lies the difference?

Going to the Moon was a complex matter along only one dimension: it challenged our technological capabilities. Though it was no mean accomplishment, it was achieved in an exceedlingly cooperative environment, employing a single new organization, NASA, that was charged with a single, highly operational goal. With enormous resources provided to it, and operating through well-developed market mechanisms, that organization could draw on the production capabilities and technological sophistication of our whole society. Although several potential side effects of the activity (notably its international political and military significance, and the possibility of technological spinoffs) played a major role in motivating the project, they did not have to enter much into the thoughts of the planners once the goal of placing men on the Moon had been set. Moreover these by-product benefits and costs are not what we mean when we say the project was a success. It was a success because men walked on the surface of the Moon. Nor did anyone anticipate what turned out to be one of the more important consequences of these voyages: the vivid new perspective we gained of our place in the universe when we first viewed our own pale, fragile planet from space.

Consider now a quite different example of human design. Four years ago we celebrated the 200th birthday of our nation, and in a few more years we will celebrate the 200th anniversary of the framing of its political constitution. Almost all of us in the free world regard that document as an impressive example of success in human planning. We regard it as a success because the Constitution, much modified and much interpreted, still survives as the framework for our political institutions, and because the society that operates within its framework has provided most of us with a broad range of freedoms and a high level of material comfort.

Both achievements—the voyages to the Moon and the survival of the American Constitution—are triumphs of bounded rationality. A necessary, though not a sufficient, condition of their success was that they were evaluated against limited objectives. I have already argued that point with respect to NASA. As to the founding fathers it is instructive to examine their own views of their goals, reflected in *The Federalist* and the surviving records of the constitutional convention.[1] What is striking about these documents is their practical sense and the awareness they exude of the limits of foresight about large human affairs. Most of the framers of the Constitution accepted very restricted objectives for their artifact—principally the preservation of freedom in an orderly society. Moreover they did not postulate a new man to be produced by the new institutions but accepted as one of their design constraints the psychological characteristics of men and women as they knew them, their selfishness as well as their common sense. In their own cautious words (*The Federalist*, no. 55), "As there is a degree of depravity in mankind which requires a certain degree of circumspection and distrust, so there are other qualities in human nature which justify a certain portion of esteem and confidence."

These examples illustrate some of the characteristics and complexities of designing artifacts on a societal scale. The success of planning on such a scale may call for modesty and restraint in setting the design objectives and drastic simplification of the real-world situation in representing it for purposes of the design process. Even with restraint and simplification difficult obstacles must usually be surmounted to

[1]The authors of *The Federalist* were Madison, Hamilton, and Jay, but principally the first named. My edition is that edited by P. L. Ford (New York: Holt, 1898). Madison's notes are our chief source on the proceedings of the convention.

reach the design objectives. The obstacles and some of the techniques for overcoming them provide the main subject of this chapter.

Our first topic will be problem representation; our second, ways of accommodating to the inadequacies that can be expected in data; our third, how the nature of the client affects planning; our fourth, limits on the planner's time and attention; and our fifth, the ambiguity and conflict of goals in societal planning. These topics, which can be viewed as a budget of obstacles or alternatively as a budget of planning requirements, will suggest to us some additions to the curriculum in design outlined in the last chapter.

REPRESENTING THE DESIGN PROBLEM

In the previous chapter representation was discussed mainly in the context of relatively well-structured, middle-sized tasks. Representation problems take on new dimensions where social design is involved.

Organization as Representation

In 1948 the U. S. government took a bold initiative to restore the postwar economies of the nations of western Europe, the so-called "Marshall Plan," which was implemented through the Economic Cooperation Administration (ECA).[2] An initial task in carrying out the plan was to shape the ECA organization. The answer to the organizational question depended on how one conceptualized the program. At least six different, and largely contradictory, conceptions were offered for the agency by the persons who were initially recruited to organize and manage it.

Congress had appropriated $5.3 billion for the first year's operations. Some thought that the task was to screen shopping lists proposed by the European nations to make sure

[2] I have told this story in more detail in "The Birth of an Organization," chapter 16 in *Administrative Behavior,* 3rd ed. (New York: The Free Press, 1976).

the lists contained what was really "needed" (commodity screening approach). Others thought the task was to determine the "dollar gap" in each nation's balance of payments and to authorize funds to close that gap (balance of trade approach). Others thought that the main task was to build up a strong deliberative institution in Europe, so that the recipient nations could make their own plans for use of the funds and thereby strengthen their collaboration (European cooperation approach). Others thought that decisions should be made primarily through bilateral agreements between the United States and each of the recipient nations (bilateral pledge approach). Others thought that at least the portion of the appropriation that was earmarked for loans ($1 billion) should be handled on a project basis, each project being evaluated for its soundness as an investment (investment bank approach). Others thought that the ECA should have a policy organ for making broad decisions, then a number of administrative organs for implementing them (policy and administration approach). Each of these representations had some basis in the congressional legislation establishing the ECA.

With a little reflection it is easy to see that very different assistance plans would result from implementing these different approaches, with very different economic and political consequences for the European nations and the United States. Conceptualizing the problem in a particular way implied organizing the agency in a manner consistent with that conceptualization. And different organizations would lead inevitably to the implementation of quite different programs, emphasizing certain goals and subordinating others, even if all the alternative policies were in some general sense consistent with the congressional intent.

As matters worked out, although vestigial organs representing each of the six approaches were still visible in the ECA after a year of operation, the balance of trade and European cooperation approaches generally prevailed, creating a measure of European economic stability and laying the groundwork for what later became the Common

Market. While each of the six approaches to the organization of ECA had some rational basis, trying to implement all of them simultaneously could (and almost did) create thorough confusion in the agency and among its clients. What was needed was not so much a "correct" conceptualization as one that could be understood by all the participants and that would facilitate action rather than paralyze it. The organization of ECA, as it evolved, provided a common problem representation within which all could work.

Finding the Limiting Resource

A second example illustrates the importance, in choosing a representation for a design problem, of identifying correctly the limiting resource or resources. A few years ago, the State Department was troubled by the congestion that affected its incoming communication lines whenever there was a crisis abroad. The teletypes, unable to output messages as rapidly as they were received, would fall many hours behind. Important messages to Washington were seriously delayed in transmission.

Since printing capacity was identified as the limiting factor, it was proposed to remedy the situation by substituting line printers for the teletypes, thereby increasing output by several orders of magnitude. No one asked about the next link in the chain: the capacity of officers at the country desks to process the messages that would come off the line printers. A deeper analysis would have shown that the real bottleneck in the process was the time and attention of the human decision makers who had to use the incoming information. Identification of the bottleneck would have generated in turn a more sophisticated design problem: How can incoming messages during a crisis be filtered in such a way that important information will have priority and will come to the attention of the decision makers, while unimportant information will be shunted aside until the crisis is past? Stated in this way, the design problem is not an easy one, but if a solution is found, even a partial one, it will at least tend to alleviate the real problem instead of aggravating it.

This is not an isolated example. The first generation of management information systems installed in large American companies were largely judged to have failed because their designers aimed at providing more information to managers, instead of protecting managers from irrelevant distractions of their attention.[3] A design representation suitable to a world in which the scarce factor is information may be exactly the wrong one for a world in which the scarce factor is attention.

Representations without Numbers

Many of the formal planning tools available to us call for representation of the design problem in quantitative form. Bayesian decision analysis, for example, requires that numerical utilities and "prior" probabilities be assigned to the possible decision outcomes and that "posterior" probabilities then be calculated for them on the basis of the estimated probability distributions of external events. With the assigned utilities and estimated probabilities in hand, the expected utility of each alternative can be computed and the best chosen.

Design problems often involve setting one or more parameters at values that will be neither too high nor too low. Such problems can often be conceptualized in economic terms as requiring the balancing of marginal benefits against marginal costs. Consider, for example, the task of regulating atuomobile emission standards.[4] The problem can be represented rationally as follows: (1) the quantity of emissions is a function of the number of cars, how far they

[3]See H. A. Simon, *The New Science of Management Decision* (Englewood Cliffs, N. J.: Prentice-Hall, 1977), chapter 4.

[4]Coordinating Committee on Air Quality Studies, National Academy of Sciences and National Academy of Engineering, *Air Quality and Automobile Emission Control,* Vols. 1–4, no. 93-23 (Washington: Government Printing Office, 1974).

are driven, and their design (hence cost); (2) the quality of air is a function of the level of emissions and of various geographical and meteorological parameters; (3) effects on human health depend on the quality of the air and the population exposed to it. An appropriate juxtaposition of these three functions produces a relation in which health is the dependent variable and the cost of automobiles the independent variable. If a dollar value is now assigned to health effects, all the ingredients will be present for a straightforward cost-benefit analysis of emission standards.

It is only necessary to state the problem in this way to show the preposterousness of attempting such calculations. Nevertheless, when this problem was presented to the National Academy of Sciences—not because it was solvable, but because the Congress had to make a decision about emission standards—the conceptual scheme for cost-benefit analysis proved to be an excellent representation for organizing the subcommittees of experts who were asked to contribute their advice. One subcommittee, mainly of engineers, examined the cost of redesigning cars to reduce emissions. A second committee, experts in atmospheric chemistry and meteorology, analysed the relations between emissions and air quality. A whole set of committees of medical experts reviewed the evidence on the health effects of the principal pollutants. Yet another committee, staffed by economists, undertook to make estimates of the values that should be assigned to health effects.

None of these committees was able to arrive at estimates that were believable in more than an order-of-magnitude sense, unless they were the estimates of auto costs which might have been accurate within a factor of two. In general the medical committees were unwilling or unable to make any marginal estimates at all, confining themselves to finding threshold levels of air quality at which the health effects of pollutants were detectable. Given these kinds of findings and assessments, there was no way in which the hypothetical cost-benefit analysis scheme could be applied literally. Nevertheless the scheme provided a conceptual

framework in which the findings could be related to each other, and in which the coordinating committee that had to assemble the pieces of the puzzle could judge the reasonableness of proposed standards. Even in this complex setting reasonable men could set upper and lower bounds on emission levels that, if not dictated by the evidence, at least were consistent with it. If optimizing was out of the question, the framework allowed the committee to arrive at a satisficing decision that was not outrageous or indefensible.

One may regard "defensibility" as a weak standard for a decision on a matter as consequential as automobile emissions. But it is probably the strictest standard we can generally satisfy with real-world problems of this complexity. Even in situations of this kind (perhaps it would be better to say "especially in situations of this kind") an appropriate representation of the problem may be essential to organizing efforts toward solution and to achieving some kind of clarity about how proposed solutions are to be judged. Numbers are not the name of this game but rather representational structures that permit functional reasoning, however qualitative it may be.

DATA FOR PLANNING

If, given a good problem representation, rational analysis can sometimes be carried out even in the absence of most of the relevant numbers, still we should not make a virtue of this necessity. The quality of design is likely to depend heavily on the quality of the data available. The task is not to design without data but to incorporate assessments of the quality of the data, or its lack of quality, in the design process itself. Setting automobile emission standards may call for a different approach to data than calculating the optimal profile for an airplane wing.

What paths are open to us when we must plan in the face of extremely poor data? One minimal strategy, which scientists have generally followed for several hundred years but planners sometimes ignore, is to associate with every estimated quantity a measure of its precision. Labeling estimates in this way does not make them more reliable, but it does remind us how hard or soft they are and hence how much trust to place in them.

Prediction

Data about the future—predictions—are commonly the weakest points in our armor of fact. Good predictions have two requisites that are often hard to come by. First, they require either a theoretical understanding of the phenomena to be predicted, as a basis for the prediction model, or phenomena that are sufficiently regular that they can simply be extrapolated. Since the latter condition is seldom satisfied by data about human affairs (or even about the weather), our predictions will generally be only as good as our theories.

The second requisite for prediction is having reliable data about the initial conditions—the starting point from which the extrapolation is to be made. Systems vary in the extent to which their paths are sensitive to small changes in initial conditions. Weather prediction is difficult in good part because the course of meteorological events is highly sensitive to the details of initial conditions. We have every reason to think that social phenomena are similarly sensitive.

Since the consequences of design lie in the future, it would seem that forecasting is an unavoidable part of every design process. If that is true, it is cause for pessimism about design, for the record in forecasting even such "simple" variables as population is dismal. If there is any way to design without forecasts, we should seize on it.

Consider the much-discussed Club of Rome report, which predicted a twenty-first century doomsday of overpopulation, resource exhaustion, and famine.[5] Since the specifics of the model used to make the Club of Rome predictions have already been much criticized, I don't have to examine those

[5]Donella Meadows et al., *The Limits to Growth* (N. Y.: Universe Books, 1972).

specifics here. My point is a broader one. The Club of Rome report predicted both too much and too little. It predicted too *much,* because its specific doomsday dates are not believable, and if believable, would not be important. We do not want to know when disaster is going to strike but how to avoid it. Without any specific predictions we know that a system with exponential population growth and limited resources will sooner or later come to some bad end. For planning purposes we wish only to have some sense of the time scale of events, to know at least whether we are talking about years, decades, generations, or centuries. For most design purposes that is as much prediction as we need.

The Club of Rome report predicted too *little* because it emphasized a single possible time path rather than focusing upon alternative futures. The heart of the data problem for design is not forecasting but constructing alternative scenarios for the future and analyzing their sensitivity to errors in the theory and data.

How can we go about designing an acceptable future for the energy and environmental needs of a society? First, we select some planning horizons: perhaps five years for short-term plans, a generation for middle-term plans, and a century or two for long-term plans. There is no need to construct detailed forecasts for each of these time perspectives. Instead we can concentrate our analytic resources on examining alternative target states for the system for the short, middle, and long run. By a target state I mean upper bounds on the quantities of energy used and pollutants produced. Having chosen a desirable (or acceptable) target state, and having satisfied ourselves that its realizability is not unduly sensitive to unpredictables, we can then turn our attention to constructing paths that lead from the present to that desired future.

Design for distant futures would be wholly impossible if remote events had to be envisioned in detail. What makes such design even conceivable is that we need to know or guess about the future only enough to guide the commitments we must make today. Future contingencies that have no implications for present commitment have no relevance to design. I will have more to say on this point presently.

Feedback

Few of the adaptive systems that have been forged by evolution or shaped by man depend on prediction as their main means for coping with the future. Two complementary mechanisms for dealing with changes in the external environment are often far more effective than prediction: homeostatic mechanisms that make the system relatively insensitive to the environment and retrospective feedback adjustment to the environment's variation.

Thus a stock of inventories permits a factory to operate without concern for very short-run fluctuations in product orders. Energy storage in the tissues of a predator enables it to cope with uncertainties in the availability of prey. A modest excess of capacity in electric generating plants avoids the need for precise estimation of peak loads. Homeostatic mechanisms are especially useful for handling short-range fluctuations in the environment, hence for making short-range prediction unnecessary.

Feedback mechanisms, on the other hand, by continually responding to discrepancies between a system's actual and desired states, adapt it to long-range fluctuations in the environment without forecasting. In whatever directions the environment changes, the feedback adjustment tracks it, with of course some delay.

In domains where some reasonable degree of prediction is possible, a system's adaptation to its environment can usually be improved by combining predictive control with homeostatic and feedback methods. It is well known in control theory, however, that active, feedforward control, using predictions, can throw a system into undamped oscillation unless the control responses are carefully designed to maintain stability. Because of the possible destabilizing effects of taking inaccurate predictive data too seriously, it is sometimes advantageous to omit prediction entirely, relying

wholly on feedback, unless the quality of the predictions is high.[6]

WHO IS THE CLIENT?

It may seem peculiar to ask, "Who is the client?" when speaking of the design of large social systems. The question need not be raised about smaller-scale design tasks, since the answer is built into the definitions of the professional roles of designers. At microsocial levels of design it is tacitly assumed that the professional architect, attorney, civil engineer, or physician works for a specified client and that the needs and wishes of the client determine the goals of the professional's work. In this model of professional activity the architect designs a house that meets the living requirements of his client, while the physician plans a course of treatment for his patient's ailments. Although in practice matters are not so simple, this definition of the professional role greatly facilitates the development of technologies for each of the professions, for it means that consequences going beyond the client's goals don't have to enter into the design calculations. The architect need not decide if the funds his client wants to spend for a house would be better spent, from society's standpoint, on housing for low-income families. The physician need not ask whether society would be better off if his patient were dead.

Thus the traditional definition of the professional's role is highly compatible with bounded rationality, which is most comfortable with problems having clear-cut and limited goals. But as knowledge grows, the role of the professional comes under questioning. Developments in technology give professionals the power to produce larger and broader effects

[6]The design of dynamic programming schemes that use a combination of prediction and feedback to control factory systems is discussed in Holt, Modigliani, Muth, and Simon, *Planning, Production, Inventories, and Work Force* (Englewood Cliffs, N.J., Prentice-Hall, 1960).

at the same time that they become more clearly aware of the remote consequences of their prescriptions.

In part this complication in the professional's role comes about simply as a direct by-product of the growth of knowledge. Whether through the modification of professional norms or through direct intervention of government, new obligations are placed on the professional to take account of the external effects—**the consequences beyond the client's concern**—that are produced by the designs.

These same developments cause the professional to redefine the concept of the client. The psychiatrist working with an individual patient becomes a family counselor. The engineer begins to take into account the environmental impact of new products. Finally, as the society and its central government take on a wider range of responsibilities, more and more professionals find they no longer serve individual clients but are employed directly by agencies of the state. Almost all of the professions today are undergoing self-examination as they experience the pressures generated by these complications in their roles. Architecture, medicine, and engineering all exhibit the stresses engendered by this process.

Professional-Client Relations

Architects are especially conflicted for several reasons. First, they have always assigned themselves the dual role of artist and professional, two roles that often make inconsistent demands. As artists they wish to realize esthetic goals that may be quite independent of clients' expressed or understood desires. If a client comports himself as an (idealized) Renaissance patron, there may be no difficulty, for the patron does not impose his views of beauty on the artist. But if the client's approach to building takes a more utilitarian bent, and he is not willing to sacrifice what he conceives as usefulness for what the architect conceives as beauty, then the relation between them may be tainted with mistrust and deception. At best, the architect becomes

teacher and advocate, not simple executor of his client's purposes.

I once asked Mies van der Rohe, then my faculty colleague at Illinois Institute of Technology, how he got the opportunity to build the Tugendhat house—a startlingly modern design at the time of its construction. The prospective owner had come to Mies after seeing some of the quite conventional houses he had earlier designed in the Netherlands when he was still an apprentice. "Wasn't the client shocked," I asked, "when you put before him your glass and metal design?" "Yes," said Mies, viewing the tip of his cigar reflectively, "he wasn't very happy at first. But then we smoked some good cigars, . . . and we drank some glasses of a good Rhein wine, . . . and then he began to like it very much."

A second and increasingly acute problem for architects is that, when they take on the task of designing whole complexes or areas instead of single buildings, their professional training does not provide them with clear design criteria. In city planning, for example, the boundary between the design of physical structures and the design of social systems dissolves almost completely. Since there is little in the knowledge base or portfolio of techniques of architecture that qualifies the professional to plan such social systems, the approach to the design tends to be highly idiosyncratic, reflecting little that can be described as professional consensus, and even less that can be described as empirically based analytic technique.

In the medical profession the stresses take slightly different forms. The first arises from the resource allocation problem—balancing the cost of medical care against its quality. Traditionally patients got such care as they could afford, or as the doctor could afford to provide for them—one can look at it either way. Today with indirect channels of payment for most medical services, budget constraints are harder to define and monitor, and ethical choices have to be made explicitly that formerly were made tacitly.

The second stress in the design of medical care and treat-

The client is [illegible] simply the person [illegible] but also [illegible] — [illegible], government regulations, ments derives from the advance of medical technology, which gives the physician a degree of control over life and death that is vastly greater than in the past. And so the traditional view, which opts unconditionally for life, no longer remains unquestioned. Even harder questions arise with new technical means for modifying genetic processes and for manipulating the mind. In the traditional professional-client relation, the client's needs and wants are given. The environment (including the functioning of the body) is to be adapted to the client's goals, not the goals to the environment. Yet much utopian thought has conceived of change in both directions. Society was to be made more fit for human habitation, but the human inhabitants were also to be modified to make them more fit for society. Today we are deeply conflicted about how far we should go in "improving" human beings involuntarily. The movie *The Clockwork Orange* states the conflict dramatically by asking whether we are justified in destroying the capability for willful action even to prevent viciousness.

The case of the engineer presents yet another aspect of the problems that growing technical power and growing awareness of remote consequences bring. Most engineering is done within the context of business and governmental organizations. In this environment there is continuing potential for conflict between the decision criteria defined by the profession and those enforced by the organization. In the hypothetical business firms of the pure theory of competition, discussed in chapter 2, organizational criteria would prevail. In the more complex world in which we actually live, the professional engineers possess substantial discretion to give professional considerations priority over the goals of the organization. If they choose to exercise that discretion, they must decide who the client is. In particular **they must decide which of the positive and negative externalities to which the artifacts they are designing will give rise should be incorporated in the design criteria.**

Society as the Client

It may seem obvious that all ambiguities should be resolved by identifying the client with the whole society. That would be a clear-cut solution in a world without conflict of interest or uncertainty in professional judgment. But when conflict and uncertainty are present, it is a solution that abdicates organized social control over the professional and leaves it to him to define social goals and priorities. If some measure of control is to be maintained, the institutions of the society must share with the professional the redefinition of the goals of design.

The client seeks to control professionals not only by defining their goals of design but also by reacting to the plans they propose. It is well known that physicians' patients fail to take much of the medicine that is prescribed for them. **Society as client is no more docile than are medical patients.** In any planning whose implementation involves a pattern of human behavior, that behavior must be motivated. Knowledge that "it is for your own good" seldom provides adequate motivation.

The members of an organization or a society for whom plans are made are not passive instruments, but are themselves designers who are seeking to use the system to further their own goals. Organization theory deals with this motivational question by examining organizations in terms of the balance between the inducements that are provided to members to perform their organizational roles and the contributions that the members thereby provide to the achievement of organizational goals.[7]

A not dissimilar representation of the social planning process views it as a game between the planners and those whose behavior they seek to influence. The planners make their move (i.e., implement their design), and those who are

[7]The notion of organizational survival and equilibrium depending on the balance of inducements and contributions is due to Chester I. Barnard, *The Functions of the Executive* (Cambridge: Harvard University Press, 1938).

affected by it then alter their own behavior to achieve their goals in the changed environment. The gaming aspects of social planning are particularly evident in the domain of economic stabilization policies, where the adaptive response of firms and consumers to monetary and fiscal policies may largely neutralize or negate those policies. The claims of monetarists, and especially of the "rational expectations" theorists, that government is helpless to influence employment levels by using the standard Keynesian tools of monetary and fiscal policy and that attempts to reduce unemployment can only cause inflation, are based on the assumption that public responses to these measures will be strongly and rapidly adaptive.

Except for economics it is still relatively rare for social planning and policy discussions to include in any systematic way the possible "gaming" responses to plans. For example, until quite recently it was common to design new urban transit facilities without envisioning the possible relocations of population within the urban area that would be produced by the new facilities themselves. Yet such effects have been known and observed for half a century. Social planning techniques need to be expanded to encompass them routinely.

TIME AND SPACE HORIZONS FOR DESIGN

Each of us sits in a long dark hall within a circle of light cast by a small lamp. The lamplight penetrates a few feet up and down the hall, then rapidly attenuates, diluted by the vast darkness of future and past that surrounds it.

We are curious about that darkness. We consult soothsayers and forecasters of the economy and the weather, but we also search backward for our "roots." Some years ago I conducted such a search in the Rheinland villages near Mainz where my paternal ancestors had lived. I found records of grandparents readily enough, and even of great-grandparents and beyond. But before I had gone far—scarcely back to the 18th century—I came to the edge of the

circle of light. Darkness closed in again in the little towns of Ebersheim, Woerstadt, and Partenheim, and I could see no farther back.

History, archaeology, geology, and astronomy provide us with narrow beams that penetrate immense distances down the hallway of the past but illuminate it only fitfully—a statesman or philosopher here, a battle there, some hominoid bones buried with pieces of chipped stone, fossils embedded in ancient rock, rumors of a great explosion. We read about the past with immense interest. A few spots caught by the beams take on a vividness and immediacy that capture, for a moment, our attention and our hearts—some Greek warriors camped before Troy, a man on a cross, the painted figure of a deer glimpsed by flickering torchlight on the wall of a limestone cave. But mostly the figures are shadowy, and our attention shifts back to the present.

The light dims even more rapidly in the opposite direction, toward the future. Although we are titillated by Sunday Supplement descriptions of a cooling Sun, it is our own mortality, just a few years away, and not the Earth's, with which we are preoccupied. We can empathize with parents and grandparents whom we have known, or of whom we have had first-hand accounts, and in the opposite direction with children and grandchildren. But beyond that circle our concern is more curious and intellectual than emotional. We even find it difficult to define which distant events are the triumphs and which the catastrophes, who the heroes and who the villains.

Discounting the Future

Thus the events and prospective events that enter into our value systems are all dated, and the importance we attach to them generally drops off sharply with their distance in time. For the creatures of bounded rationality that we are, this is fortunate. If our decisions depended equally upon their remote and their proximate consequences, we could never act but would be forever lost in thought. By applying a heavy discount factor to events, attenuating them with their remoteness in time and space, we reduce our problems of choice to a size commensurate with our limited computing capabilities. We guarantee that, when we integrate outcomes over the future and the world, the integral will converge.

Sociobiologists, in their analyses of egoism and altruism, undertake to explain how the forces of evolution would necessarily produce organisms more protective of their offspring and their kin than of unrelated creatures. This evolutionary account does not explain, however, why the concern tends to be so myopic with respect to the future. At least one part of the explanation is that we are unable to think coherently about the remote future, and particularly about the distant consequences of our actions. Our myopia is not adaptive, but symptomatic of the limits of our adaptability. It is one of the constraints on adaptation belonging to the inner environment.

The economist expresses this discounting of the future by a rate of interest. To find the present value of a future dollar, he applies, backwards, a compound discount rate that shrinks the dollar by a fixed percentage for each step from the present. Even a moderate rate of interest can make the dollars of the next century look quite inconsequential for our present decisions. There is a vast literature seeking to explain, none too convincingly, what determines the time rate of discount used by savers. (In modern times it has hovered remarkably steadily around 3 percent per annum, after appropriate adjustment for risk and inflation.) There is also a considerable literature seeking to determine what the social rate of interest *should* be—what the rate of exchange should be between the welfare of this generation and the welfare of its descendants.

The rate of interest should not be confused with another factor that discounts the importance of the future with respect to the present. Even if we are aware of certain unfavorable events that will occur in the distant future, there may be nothing to be done about them today. If we knew that the wheat harvest was going to fail in the year 2000, we

would be ill-advised to store wheat now. Our unconcern with a distant future is not merely a failure of empathy but a recognition that (1) we shall probably not be able to foresee and calculate the consequences of our actions for more than short distances into the future and (2) those consequences will in any case be diffuse rather than specific.

The important decisions we make about the future are primarily the decisions about spending and saving—about how we shall allocate our production between present and future satisfactions. And in saving, we count flexibility among the important attributes of the objects of our investment, because flexibility insures the value of those investments against the events that will surely occur but which we cannot predict. It will (or should) bias our investments in the direction of structures that can be shifted from one use to another, and to knowledge that is fundamental enough not soon to be outmoded—knowledge that may itself provide a basis for continuing adaptation to the changing environment.

The Change in Time Perspective

One of the noteworthy characteristics of our century is the shift that appears to be taking place, especially in the industrialized world, in our time perspectives. For example, embedded in the energy-environment problem that confronts us today, we can see three almost independent aspects. The first is our immediate dependence on petroleum, which we must reduce to protect ourselves from political blackmail and to achieve a balance of international payments. The second is the prospect of the exhaustion of oil and gas supplies, a problem that must be solved within about a generation, mostly by the use of coal and nuclear energy. The third is the joint problem of the exhaustion of fossil fuels and the impact of their combustion on the climate. The time scale of this third problem is a century or so.

What is remarkable in our age, and relatively novel I believe, is the amount of attention we pay to the third problem. Perhaps it is just that we have all three confused in our minds and have not sorted them out to the point where we can think about the more pressing ones without concern for the other. But I do not think that is the reason. I believe there has been a genuine downward shift in the social interest rate we apply to discount events that are remote in time and space.

There are some obvious reasons for our new concern with matters that are remote in time and space. Among these are the relatively new facts of instantaneous worldwide communication and rapid air transportation. Consequent on these is the continually increasing economic and military interdependence of all the nations. More subtle than either of these causes is the progress of human knowledge, especially of science. I have already commented on the way in which archaeology, geology, anthropology, and cosmology have lengthened our perspectives. But in addition new laboratory technologies have vastly increased our ability to detect and assess small and indirect effects of our actions. Oscar Wilde once claimed that there were no fogs on the River Thames until Turner, by painting them, revealed them to the residents of London. In the same way our atmosphere contained no noxious substances in quantities of a few parts per million until chromatography and other sensitive analytic techniques showed their presence and measured them. DDT was an entirely beneficent insecticide until we detected its presence in falcons' eggs and in fish. If eating the apple revealed to us the nature of good and evil, modern analytic tools have taught us how to detect good and evil in minute amounts and at immense distances in time and space.

It may be objected that there has been no such lengthening of social time perspectives as I have claimed. What perspective can be longer than the eternity of life after death that is so central to Christian thought, or longer than the repeated reincarnations of Eastern religions? But the attitudes toward the future engendered by those beliefs are very different from the ones I have been discussing. The future with which the Christian is concerned is his own future

in the light of his current conduct. There is nothing in the belief in an afterlife or a reincarnation that calls attention to the future consequences for this world of one's present actions. Nor do I find in those religious beliefs anything resembling the contemporary concern for the fragility of the environment on which human life depends or for the power of human actions to make that environment more or less habitable in the future. It does appear therefore that there has been a genuine shift in our orientation to time and a significant lengthening in time perspectives.

Defining Progress

As the web of cause and effect is woven tighter, we put severe loads upon our planning and decision-making procedures to deal with these remote effects. There is a continuing race between the part of our new science and knowledge that enables us to see more distant views and the part that enables us to deal with what we see. And if we live in a time that is sometimes pessimistic about technology, it is because we have learned to look farther than our arms can reach.

Defining what is meant by progress in human societies is not easy. Increasing success in meeting basic human needs for food, shelter, and health is one kind of definition that most people would agree upon. Another would be an average increase in human happiness. With the advance of productive technology, we can claim that there has been major progress by the first criterion; but what has been said in chapter 2 about changing aspiration levels would lead us to doubt whether progress is possible if we use the second criterion, human happiness, to measure it. There is no reason to suppose that a modern industrial society is more conducive to human happiness than the simpler, if more austere, societies that preceded it. On the other hand, there seems to be little empirical basis for the nostalgia that is sometimes expressed for an imagined (and imaginary) happier or more humane past.

A third way of measuring progress is in terms of intentions rather than outcomes—what might be called moral progress. Moral progress has always been associated with the capacity to respond to universal values—to grant equal weight to the needs and claims of all mankind, present and future. It can be argued that the growth of knowledge of the kinds I have been describing represents such moral progress.

But we should not be hasty in our evaluation of the consequences of lengthening perspectives in space or time. The present century is not lacking in horrible examples of man's inhumanity to man. We must be alert also to the possibility that rationality applied to a broader domain will simply be a more calculatedly rational selfishness than the impulsive selfishness of the past.

The Management of Attention

From a pragmatic standpoint we are concerned with the future because securing a satisfactory future may require actions in the present. Any interest in the future that goes beyond this call for present action has to be charged to pure curiosity. It belongs to our recreational rather than our working day. Thus our present concern for the short-run energy problem is quite different from our concern for the long-run problem or even the middle-run problem. The actions we have to take today, if we are to improve the short-run situation, are largely actions that will reduce our use of energy—there are only modest prospects of a substantial short-run increase in supply. The actions we have to take with respect to the middle-run problem are largely actions on a large scale toward the development and exploitation of some mix of technologies for the conversion of coal, mining of oil sands and shales, and safe nuclear fission or fusion. The principal actions we can take now with respect to the long-range energy problem are primarily knowledge-acquiring actions—research programs to develop nuclear fusion and solar technologies and to gain a deeper understanding of the environmental consequences of all the alternatives.

The energy problem is rather typical in this respect of large-scale design problems. In addition to the things we can do to produce immediate consequences, we must anticipate the time lags involved in developing new capital plant and the even greater time lags involved in developing the body of technology and other knowledge that we will need in the more distant future. Attention of the decision-making bodies has to be allocated correspondingly.

It is a commonplace organizational phenomenon that attending to the needs of the moment—putting out fires—takes precedence over attending to the needs for new capital investment or new knowledge. The more crowded the total agenda and the more frequently emergencies arise, the more likely it is that the middle-range and long range decisions will be neglected. In formal organizations a remedy is often sought for this condition by creating planning groups that are insulated in one way or another from the momentary pressures upon the organization. Planning units face two hazards. On the one hand, and especially if they are competently staffed, they may be consulted more and more frequently for help on immediate problems until they are sucked into the operating organization and can no longer perform their planning functions. If they are sufficiently well sealed off from the rest of the organization to prevent this from happening, then they may find the reverse channel blocked—they may be unable to influence decisions in the operating organization. There is no simple or automatic way to remove these difficulties once and for all. They require repeated attention from the organization's leadership.

DESIGNING WITHOUT FINAL GOALS

To speak of planning without goals may strike one as a contradiction in terms.[8] It seems "obvious" that the very con-

[8]This section owes much to James G. March, who has thought deeply on these lines. See his "Bounded Rationality, Ambiguity, and the Engineering of Choice," *Bell Journal of Economics* 9(1978):587–608.

cept of rationality implies goals at which thought and action are aimed. How can we evaluate a design unless we have well-defined criteria against which to judge it, and how can the design process itself proceed without such criteria to guide it?

Some answer has already been given to these questions in chapter 4, in the discussion of discovery processes. We saw there that search guided by only the most general heuristics of "interestingness" or novelty is a fully realizable activity. This kind of search, which provides the mechanism for scientific discovery, may also provide the most suitable model of the social design process.

It is generally recognized that in order to acquire new tastes in music, a good prescription is to hear more music; in painting, to look at paintings; in wine, to drink good wines. Exposure to new experiences is almost certain to change the criteria of choice, and most human beings deliberately seek out such experiences.

A paradoxical, but perhaps realistic, view of design goals is that their function is to motivate activity which in turn will generate new goals. For example, when about thirty years ago an extensive renewal program was begun in the city of Pittsburgh, a principal goal of the program was to rebuild the center of the city, the so-called Golden Triangle. Architects have had much to say, favorable and unfavorable, about the esthetic qualities of the plans that were carried out. But such evaluations are largely beside the point. The main consequence of the initial step of redevelopment was to demonstrate the possibility of creating an attractive and functional central city on this site, a demonstration that was followed by many subsequent construction activities that have changed the whole face of the city and the attitudes of its inhabitants.

It is also beside the point to ask whether the later stages of the development were consistent with the initial one—whether the original designs were realized. Each step of implementation created a new situation; and the new situation provided a starting point for fresh design activity.

Making complex designs that are implemented over a long period of time and continually modified in the course of implementation has much in common with painting in oil. In oil painting every new spot of pigment laid on the canvas creates some kind of pattern that provides a continuing source of new ideas to the painter. The painting process is a process of cyclical interaction between painter and canvas in which current goals lead to new applications of paint, while the gradually changing pattern suggests new goals.

The Starting Point

The idea of final goals is inconsistent with our limited ability to foretell or determine the future. The real result of our actions is to establish initial conditions for the next succeeding stage of action. What we call "final" goals are in fact criteria for choosing the initial conditions that we will leave to our successors.

How do we want to leave the world for the next generation? What are good initial conditions for them? One desideratum would be a world offering as many alternatives as possible to future decision makers, avoiding irreversible commitments that they cannot undo. It is the aura of irreversibility hanging about so many of the decisions of nuclear energy deployment that makes these decisions so difficult.

A second desideratum is to leave the next generation of decision makers with a better body of knowledge and a greater capacity for experience. The aim here is to enable them not just to evaluate alternatives better but especially to experience the world in more and richer ways.

In chapter 4 I referred to Becker and Stigler's argument that considerations of the sort I have been advancing can be accommodated without giving up the idea of fixed goals. All that is required, they say, is that the utilities to be obtained from actions be defined in sufficiently abstract form. In their scheme the utility yielded by an hour's listening to music increases with one's capacity for musical enjoyment, and this capacity is a kind of capital that can be increased by a prior investment in musical listening. While I find their way of putting the matter a trifle humorless, perhaps it makes the idea of rational behavior without goals less mysterious. If we conceive human beings as having some kind of alterable capacity for enjoyment and appreciation of life, then surely it is a reasonable goal for social decision to invest in that capacity for future enjoyment.

Designing as Valued Activity

Closely related to the notion that new goals may emerge from creating and implementing designs is the idea that one goal of planning may be the design activity itself. The act of envisioning possibilities and elaborating them is itself a pleasurable and valuable experience. Just as realized plans may be a source of new experiences, so new prospects are opened up at each step in the process of design. Designing is a kind of mental window shopping. Purchases do not have to be made to get pleasure from it.

One of the charges sometimes laid against modern science and technology is that if we know *how* to do something, we cannot resist doing it. While one can think of counterexamples, the claim has some measure of truth. One can envisage a future, however, in which our main interest in both science and design will lie in what they teach us about the world and not in what they allow us to do to the world. Design like science is a tool for understanding as well as for acting.

Social Planning and Evolution

Social planning without fixed goals has much in common with the processes of biological evolution. Social planning, no less than evolution, is myopic. Looking a short distance ahead, it tries to generate a future that is a little better (read "fitter") than the present. In so doing, it creates a new situation in which the process is then repeated. In the theory of evolution there are no theorems that extract a long-run direction of development from this myopic hill climbing. In fact evolutionary biologists are extremely wary of postulating such a direction or of introducing any notion of "progress." By definition the fit are those who survive and multiply.

Whether there is a long-run direction in evolution, and whether that direction is to be considered progress are of course two different questions. We might answer the former affirmatively but the latter negatively. Let me venture a speculation about the direction of social and biological evolution, which I will develop further in the next chapter. My speculation is emphatically *not* a claim about progress.

From a reading of evolutionary history—whether biological or social—one might conjecture that there has been a long-run trend toward variety and complexity. There are more than a hundred kinds of atoms, thousands of kinds of inorganic molecules, hundreds of thousands of organic molecules, and millions of species of living organisms. Mankind has elaborated several thousand distinct languages, and modern industrial societies count their specialized occupations in the tens of thousands.

I shall emphasize in the next chapter that forms can proliferate in this way because the more complex arise out of a combinatoric play upon the simpler. The larger and richer the collection of building blocks that is available for construction, the more elaborate are the structures that can be generated.

If there is such a trend toward variety, then evolution is not to be understood as a series of tournaments for the occupation of a fixed set of environmental niches, each tournament won by the organism that is fittest for that niche. Instead evolution brings about a proliferation of niches. The environments to which most biological organisms adapt are formed mainly of other organisms, and the environments to which human beings adapt, mainly of other human beings. Each new bird or mammal provides a niche for one or more new kind of flea.

Vannevar Bush wrote of science as an "endless frontier." It can be endless, as can be the process of design and the evolution of human society, because there is no limit on diversity in the world. By combinatorics on a few primitive elements, unbounded variety can be created.

THE CURRICULUM FOR SOCIAL DESIGN

Our examination of the social planning process here suggests some extension of the curriculum for design that was proposed in the last chapter. Topic 7, the representation of design problems, must be expanded to incorporate the skills of constructing organizations as frameworks for problem representation, building representations around limiting factors, and representing non-numerical problems. Our discussion also suggests at least five new topics for the curriculum:

1. *Bounded rationality.* The meaning of rationality in situations where the complexity of the environment is immensely greater than the computational powers of the adaptive system.
2. *Data for planning.* Methods of forecasting, the use of prediction and feedback in control.
3. *Identifying the client.* Professional-client relations, society as the client, the client as player in a game.
4. *Time and space horizons.* The discounting of time, defining progress, managing attention.
5. *Designing without final goals.* Designing for future flexibility, design activity as goal, designing an evolving system.

With the exception of control theory and game theory, which are of central importance to topics 2 and 3, the design tools relevant to these additional topics are in general less formal than those we described in the previous chapter. But whether we have the formal tools we need or not, the topics are too crucial to the social design process to permit them to be ignored or omitted from the curriculum.

Our age is one in which people are not reluctant to express their pessimism and anxieties. It is true that humanity is faced with many problems. It always has been but perhaps not always with such keen awareness of them as we have today. We might be more optimistic if we recognized that we do not have to solve all of these problems. Our essential task—a big enough one to be sure—is simply to keep open the options for the future or perhaps even to broaden them a bit by creating new variety and new niches. Our grandchildren cannot ask more of us than that we offer to them the same chance for adventure, for the pursuit of new and interesting designs, that we have had.