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ORDERLINESS AND FREEDOM AS INFLUENCED BY SCIENTIFIC METHOD

"What essential things are happening to us in the foundations of our existence, now that science has become our passion?" The modern sensibility is still greatly disturbed by this question of Heidegger's. We realize well enough the great value of science and the benefits obtainable from industry and medicine. Yet there remains in our hearts a certain disquiet. What indeed are science and technology doing to us at the roots?

One of the major influences of science is the creation of orderliness—intellectual, social, environmental and so on. My aim is to explore this theme over a limited front, pointing out that the effect of scientific method is the replacement of purely personal judgments and preferences by the uniformity of objective criteria, and suggesting that the consequence, in some directions at least, is a loss of that sort of freedom which depends on richness and diversity.

I shall use optimization studies as an example, first giving a short non-technical account. The great significance of optimization

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is not yet widely known, though it underlies most of the vast activity with computers now going on, within the technologically advanced countries, in government and municipal offices, in banks and firms and nationalised industries.

Simply put, optimization is concerned with situations where there may be a choice of many different ways of doing a thing and finding out which one of these is in some sense "the best." To be sure that is what most people are trying to do much of the time. Yet optimization aims at doing it mathematically and exactly. More technically one speaks of strategies and of decision variables, and the aim is to establish which particular strategy, and which choice of its variables will result in some *objective function* reaching its highest possible value, its maximum. The objective function itself is the measure of whatever in the given situation is regarded as desirable: in short it embodies a value, a criterion. Yet not *any* value, for it must be chosen as something quantifiable, these mathematical techniques being necessarily limited in application to whatever can be expressed quantitatively. In a social context this usually requires a narrowing down of the objective to a pecuniary one. As Pigou remarked, "The one obvious instrument of measurement available in social life is money."

In brief, optimization is the means of determining which choice of strategy and which values of its associated variables will give rise to, say, a minimum of cost or a maximum of profit. As such it is finding very widespread application in establishing the "best" designs of buildings, factories, transport systems etc.; also the "best" programmes of operations, the "best" choice of personnel, and so forth. What was formerly done by intuition is now being done by this sort of analysis.

A homely example for purposes of illustration is the optimum lay-out of a supermarket or shopping centre. As a *constraint* in the problem it will often occur that the floor area available has a fixed value x. There are clearly two conflicting demands on the usage of this area: one is that goods have to be stored and displayed; the other is that customers must have easy access. Without storage and display there would be no sales; but equally without room for the customers there would again be no sales. Between these opposing requirements there is thus some optimum division and this can be discovered by the optimization

technique. This latter usually requires the setting up of a *model*—a mathematical model—based partly on working hypotheses and otherwise on such information as may already be to hand. For example, it might be "guessed" in the first place that the monetary return due to display is proportional to the area x_d so allocated; and that the return due to the area x_c given to the customers is proportional to a term containing a square, e.g. $x_c + kx_c^2$, due to an assumed stimulus of one customer by another. The testing of these hypotheses, and also the calculation of the various proportionality constants, is carried out by using data from existing shops. When a satisfactory and self-consistent model has been found, it becomes a simple matter (after bringing in the constraint $x_d + x_c = x$) to find the optimum allocation of x between the two uses.

Of course such treatments are idealized. Every real situation involves an infinitude of factors and many which are important may be non-quantitative. The taking into account of those factors only which are both significant *and* quantitative results in what is admittedly an abstraction. Yet this is a natural feature of scientific method.

The general conclusion to be drawn from these optimization studies is that they usually indicate a *single* best means of doing a thing, a *single* optimum policy. That is to say, so long as attention is given to only one criterion, such as cost or profit, there is, for the given circumstances, a uniquely "best" design of supermarket, a uniquely "best" type of factory, filling station and so on.

Since the circumstances themselves are often almost constant, it may be expected that the use of these optimised designs will become extremely widespread. We shall see them everywhere. As indeed we already see almost everywhere what is essentially the same office building, and the same school or laboratory. The *standardization of the optimum* will apply to all goods and all parts of the environment where cost or profit has a predominant influence. Gone is the time when the manager could use his flair and thereby did things a little differently from his fellows. He can now buy a whole new manufacturing plant, optimised down to the last detail, from one of the plant construction firms. And it will probably be almost the same plant (with minor alterations

due to differences of location or of sales schedule) as that firm will sell to one of his rivals.

This general notion of optimization, concerned with the logic of satisfying a criterion, is applied not only to the design of goods and structures, but also to the operations by which they are made. This is the field of systems engineering and operational research; for instance in *critical path analysis* the aim is to analyse whatever network of parallel and sequential processes is involved in an overall plan; and thereby to determine which particular path through the network will result in the plan being realised in the shortest time or at the least expense.

So also in games theory and decision theory, concerned with the logic of situations where there is an element of chance, of the unforeseeable, and where also there may be opposing interests. This is the systematization of risk and competition, as in business and international affairs, where each player is assumed to aim at maximising his *utility* or his *pay-off*.

Of course there are many areas where the codifying influence of science is still in its infancy. One of them is sport—the training of athletes, tennis champions and so on. Even so, the effect of scientific method, i.e. the application of methodical study, has been to show the existence of optimum techniques—temperament giving way to efficiency! Another is personnel selection—selection for business and industry, for entry to secondary and tertiary education, and so on. Quite sophisticated methods have developed and it is now many years since W.H. Whyte made gentle fun of the sort of Personality Profile required by certain companies for their executives. Of course this is not to say that selection methods are reliable, even for their limited purposes. All I am concerned with here is the significance of the attempt.

What will be seen in all these examples is a movement towards greater orderliness and regularity. The aim of optimization is the uniquely most profitable design or method of operation and the ideal of personnel selection is putting people in the best possible slots, the perfect sorting process. And indeed if the results of these exercises (some of which I have been engaged in myself) do, in fact, show what is "the best" it seems there is little more to be said.

ONE OR MANY CRITERIA?

However an important objection must now be raised. For the method to be applicable there must be only one objective function, only one criterion. As well as being quantifiable, this criterion must therefore also be *single* for there is no meaningful sense in the optimization of a multiple set. Take for example the profit and the safety of an industrial process and suppose that measurability of the latter factor had somehow been achieved. There would still be no sense in supposing that we could optimize simultaneously for *both* factors. The choice of the variables which would give rise to a maximum of the one would not, except fortuitously, give rise to a maximum of the other. The only possibility is to combine them in a single variable by assigning weighting factors to each (whereby they are reduced effectively to the same measure) but the choice of weighting factors would remain largely subjective.[1] However this is not often done. Attention is usually concentrated on some one criterion regarded as being the best measure of "efficiency." As has been remarked, this usually means a monetary measure.

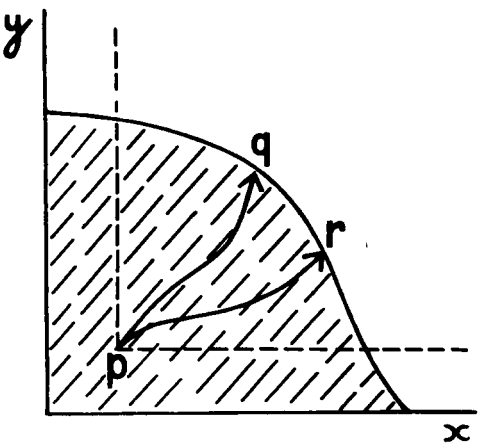

Fig. 1

[1] This is not to say that the choice must necessarily be left to a single person for the relative weights can be determined as an average over many individual rankings. (Provided however that no inconsistencies occur, as indeed they may according to K.J. Arrow's Impossibility Theorem).

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Perhaps this objection needs to be qualified a little. When there are multiple objectives, vector representation can often give clarity to the problem—though without resolving it. Think of a situation where there are two objectives and both are measurable. These are represented by x and y in Figure 1. The curved boundary of the *attainable region*, which is shaded, describes the largest simultaneous values of these objectives permitted by the existence of certain constraining factors (e.g. the availability of resources). This means that, as far as these two objectives alone

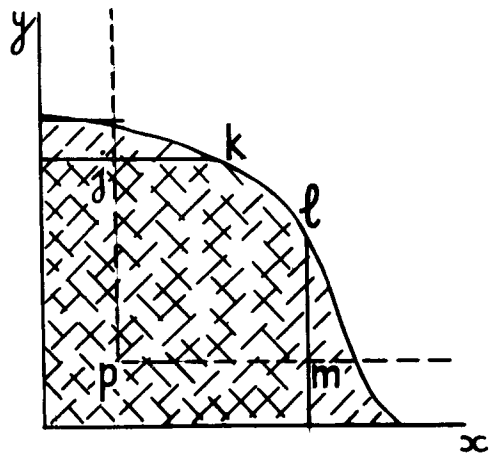

Fig. 2

are concerned, any process starting from a point p and moving north-eastwards—i.e. in the direction in which x and y are both increasing—will certainly be useful. (Movements in other directions, i.e. outside the dotted quadrant, may be useful but not with certainty). Also it may be mentioned that non-quantifiable factors can often be usefully regarded as *constraints*, i.e. as delimiting a *permissible region* within the attainable region already mentioned. This is indicated in Figure 2 as the doubly shaded area and it follows that vectors which are now both certainly useful and permissible are restricted to those moving north-eastwards from p and terminating at the boundaries, jk, kl and lm.

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Vector studies of this kind, based on the computer solution of differential equations, will probably be heard of a good deal more, especially in economics.[2] But it remains true, of course, that out of the infinity of still remaining vectors the one which is finally decided on as "best" can be singled out only by the use of weighting factors which represent personal judgments.

These qualifications have been largely a digression. The important point is that optimization requires that the value factors in a situation are capable of being reduced to a single overriding criterion. Without this there would be no unique basis for comparing one state or condition with another.

Diversity, on the other hand, is a consequence of using multiple criteria which may be in conflict. For these criteria can then be satisfied only partially, and in a multiplicity of different ways, according to individual taste or judgment. Traditionally each man solved his problem in his own way (resulting in the immense variety of our inherited environment) and in a manner entirely opposed in spirit to that which has been described.

I have thus been discussing optimization as a paradigm of one of the important influences of scientific method. Science as a whole, it may be said, is the advance of orderliness—and orderliness means smallness of deviation from a norm, smallness of "spread," i.e. the closeness with which anything actual conforms to a criterion.[3]

Must it be concluded therefore that a consequence of science acting on society is a loss of richness and diversity? In one

[2] I am much indebted to Professor R. Aris for drawing my attention to these researches.

[3] This definition of "orderliness" is as applicable in physics, and I would think also in biology, as it is in the present context. P.B. Medawar (*Encounter*, September 1963) has criticised the view that the physicists' and the biologists' conceptions of order are the same; in my view however the same notion of orderliness can be used consistently in many fields *provided* it is not confused with the concept of "organization." The two terms are used almost interchangeably by many biologists, yet there would be a gain in our understanding of living systems if they were kept separate. To be sure orderliness and organization often go together, but sometimes they do not. This can be seen by comparing a crystal with a living cell; the former is *more* orderly but *less* highly organized than the cell. Similarly a primitive society made rigid by taboo may be said, on that account, to have greater orderliness than a modern industrial society and yet to be less highly organised. I hope to show the significance of this distinction in more detail elsewhere.

important sense the reverse is the case: science brings new factors into existence; new products, new materials, new facilities for travel and leisure; also, by creating material wealth, it opens out to people greater opportunities in work, study and enjoyment.

All this is true; and yet in a more profound sense the scientific attitude of mind is radically opposed to diversity. Science, it has been said, is a *convergent* activity; it believes in single, not multiple criteria; it expects a unique answer to every problem; as Bronowski puts it,[4] "Science arrived like an Old Testament prophet, with a puritan and obsessed vision of single-minded coherence, ...". In short, its ethos is entirely contrary to solutions which are personal or idiosyncratic.

No doubt distinction must be made between different forms of "orderliness"—intellectual, environmental, social and others. The value of the striving for intellectual orderliness can hardly be gainsaid and it is the origin, deeper than curiosity, of the urge to science and scholarship in general. And in other directions as well our desire is not for less orderliness, but rather for a great deal more: in international affairs, for example, and also concerning traffic in cities. Yet in other areas there are signs that industrial civilization may be moving towards a condition of having an actual excess. Particularly those areas where economic factors tend to dominate. However this important question must be set aside for the moment.

ORDERLINESS & FREEDOM

To speak of a possible excess is to imply that orderliness—or at least certain forms of it—itself has an optimum. And that indeed is the hypothesis I am leading up to. Yet this notion of an optimum raises a certain difficulty. Complete orderliness has been identified as perfect conformity with a criterion. If orderliness should preferably *not* be complete, how is this "preferably" to be defined, other than by using some further criterion? (Which would again mean complete orderliness relative to *this* criterion).

There is clearly some risk of arguing in a circle. The question

[4] *Encounter,* November 1965.

which is being raised is not the same as in conventional optimization studies where there is often a kind of endless recession, like the kings in *Macbeth*, in which one first adopts a simple criterion, then seeks to make it more comprehensive, and so on almost indefinitely. It is rather a question of getting beyond any such man-made criteria and asking if there may not be entirely *empirical* grounds for believing in the existence of an optimum. That is to say, enquiring if it is not in a sense "natural" that humans should flourish most when there is an optimum admixture of orderliness with its opposite, of regularity with diversity. Or indeed, in a sense, of science with anti-science!

This can be led up to by way of an analogy. In nature one finds various points of balance established between opposing principles of orderliness and of mobility. This balance determines, for example whether a particular chemical substance is a solid, a liquid or a gas. The influence towards orderliness, arising from attractive forces, tends to make the molecules arrange themselves in a regular three-dimensional pattern, such as actually occurs in those substances which are crystalline. The influence of the opposing factor, kinetic energy of motion, is to dislodge the molecules from their orderly positions and set them moving in random directions. This tendency becomes more and more significant the higher is the temperature and causes each substance to pass successively through solid, liquid and gaseous states in which orderliness diminishes and mobility increases.[5]

Consider the importance to living creatures of the intermediate liquid state. It is now well known that immensely complicated molecules having coded structures are necessary to the ordinary working of organisms, as well as to their inheritance. In this respect there could be no life without orderliness. Yet the supreme examples of orderly structures, the crystalline substances, are useless to life, being too regular and therefore too rigid to allow mobility and free development. Gases, at the other extreme, are equally useless since they can retain no permanent form. One could not conceive a gaseous organism. It is therefore no accident

[5] What is discussed here is, of course, related to the Second Law of Thermodynamics but has been expressed in molecular terms. The full relationship of "orderliness" (or rather of its converse) to entropy requires the consideration of quantum states and not of configurational factors only.

that life, like Venus, was born in the sea and that living creatures are largely made up of liquids and jelly-like substances. It is this intermediate state of matter, permitting motility for the unicellular organisms and also diffusion within the cell interiors where the coded molecules are accommodated, which makes life possible.

Here then is a clear indication of a condition of optimum orderliness at the biological level. What will now be suggested is that similar considerations apply at the social level. Just as life has greatest freedom for physical development under the conditions of the liquid state, so also its freedom in a psychological sense (as this refers to the highest animals) will be at a maximum when there is an appropriate balance in the social communities between orderliness and variety. Such at least is the hypothesis.

But first concerning my usage of the word "freedom"—a term which is here regarded as being in no respect the opposite of "orderliness" but rather as denoting a quality which is, so to say, orthogonal to orderliness, a different social dimension.

Is it not the case that the meaning of "freedom" is like that of a transitive verb, requiring a statement of what it is from which a person claims to be free? Maurice Cranston[6] has argued this point very clearly:—"Whereas 'I am hungry' has one meaning, 'I am free' might have any one of a vast range of possible meanings. If we are to know which of those innumerable possibilities is intended, we must know what it is that a man who says he is free, is free from. He must name a constraint, impediment or burden."

By way of illustrating two different sorts of constraints, Cranston gives as examples the *Progressive* and *Romantic* theories of freedom: the former referring to "freedom from the constraints of nature, freedom from disease and hunger and insecurity and ignorance and superstitition;" the latter, as it was put forward by Rousseau, giving emphasis to freedom from the constraints imposed by advanced political institutions, and obtainable, in his view, only by returning to more primitive and natural ways of living.

But clearly there are many other forms of liberty. "Freedom as a whole" must evidently be understood in an additive sense,

[6] *Freedom, A New Analysis* (Longmans, Green & Co. 1953).

i.e. as being a kind of weighted summation over all free choices.[7] No doubt some part of this total depends on man-made criteria, and its component items will be weighted rather differently at different periods of history. Yet the rest—and I would think the major part—corresponds to natural psychological requirements, just as food and air are natural requirements of the body. Perhaps Auden had this in mind when he said: "Liberty is not a value, but the ground of value."

To come to the point, let us think of this additive "freedom" plotted as a function, in multi-dimensional space, of the various distinguishable forms of "orderliness." Such a plot defines a surface—a multi-dimensional surface—whose slope at any point is essentially the upwards or downwards movement of "freedom" relative to the other variables. My hypothesis is that the highest point of the surface, where "freedom" has its maximum, is likely to occur at values of one or more of the "orderliness" variables less than 100%.

Putting it more simply, let us think of "freedom" in relation to only one such variable. The latter might be defined, for example, by the criterion that the growth rate of the national economy shall remain constant at some chosen value. Poor conformity with this criterion, i.e. low orderliness in this particular sense, might result in low freedom due to consequential adverse effects on the economic part of the total. Conversely very high conformity, i.e. almost complete orderliness, might again result in low freedom since the maintenance of the chosen growth rate might require restrictive legislation, increased unemployment etc. Thus the balance of effects is likely to be a maximum of overall freedom at some intermediate value of the orderliness variable, as is indicated diagrammatically in Figure 3.

More generally it may be suggested that too little orderliness of a social and economic sort would be inimical to high material standards, preventing the attainment of industrialism and the particular forms of freedom which industrialism brings. Too much

[7] The notion of a "freedom function," taken as a summation over all possible preferences, each weighted according to its utility, has been developed mathematically by Dennis and André Gabor. (*Journal of the Roya! Statistical Society*, Series A, Vol. 117, 1954, pg. 31; *Cahiers de l'Institut de Science Economique Appliquée*, No. 2, 1958, pg. 13).

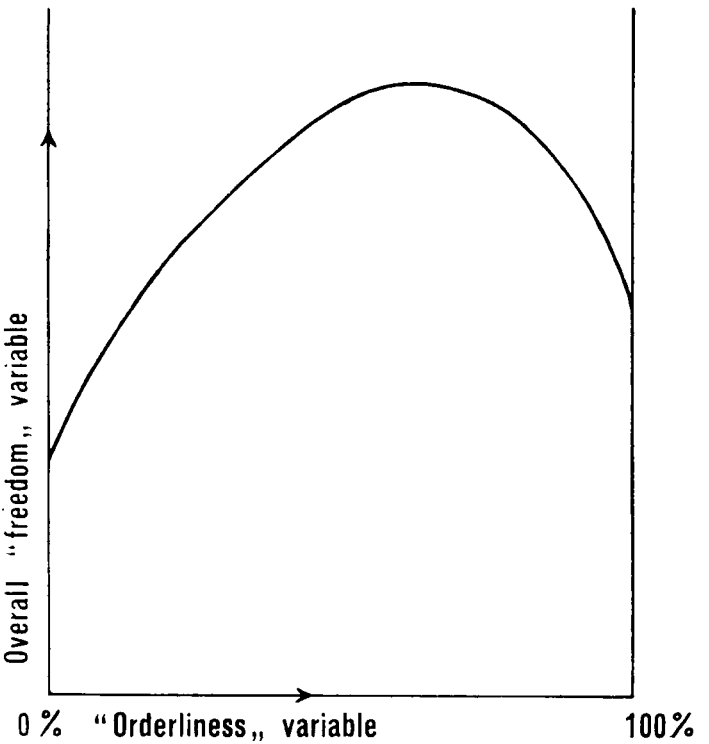

Fig. 3

however would lead to constraints in quite a different direction: lack of variety in the environment, conformism of behaviour and outlook, the suppression of personal judgment and taste, and the putting of each man in his right slot in the system; in short, psychological constraints of a most serious kind.

The reader will appreciate that what has been said in the last few paragraphs, for purposes of illustration, is highly schematic. Obviously we are unable to express social or economic forms of orderliness on a percentage scale, still less to plot "freedom" as their function. However this does not affect the substance of the principle I have been asserting, ... i.e. that the psychological and social sides of existence, just as much as the physical, require

a balance between order and disorder. Scientific method is an expression of our efforts towards regularity and system, and such indeed is the general aim of the rational outlook. Yet, though we strive for order, we find our stimulus in its opposite—i.e. in the world's variety and unexpectedness which all the time we are eating into.

ECONOMICISM

As regards the world of nature, it may be that its diversity is inexhaustible,[8] and if so my concern is needless. Not so however regarding man's own artificial world. Already many primitive societies have disappeared[9] and others have become Westernized. Over the whole globe a single way of life is being rapidly accepted as the desired standard. Will it occur that man eventually establishes a milieu where everything becomes so systematic and methodical, so much done by rule, that he loses the sense of surprise and interest on which his creative powers depend? Will reductionism, taken as far as it can go, lead to a state of civilization where all things are done rationally and with maximum efficiency—and yet will be one of unparalleled boredom and dullness, one in which the incentive to research itself will terminate?

Of course it is not science itself which is the driving force behind these seemingly adverse processes. That force is rather the relentless application of a particular criterion, the economic, which uses scientific method as its instrument. Yet if it is not science directly it is science indirectly. For this criterion itself has been one of the products of the quantitative attitude of mind.

The way in which the numerical and the quantifiable came to play such an important part in the intellectual life of the West, from the Middle Ages onwards, has been well described by J.U. Nef.[10] One of its early aspects was time measurement, based on the coming into use of clocks on a wide scale. Another was

[8] For an expression of this view by a physicist see David Bohm, *Causality and Change in Modern Physics* (Routledge & Kegan Paul, 1957).

[9] Thus Levi-Strauss (*Nature*, 1966, *209*, 10) remarks that in South America alone between 1900 and 1950 some fifteen languages ceased to be spoken: "Native cultures are disintegrating faster than radioactive bodies."

[10] *The Cultural Foundations of Industrial Civilization* (Cambridge, 1958).

the keeping of numerical records, the beginning of modern statistics. Yet a third was the first stirring of the science of economics itself. The whole movement of ideas which took physics and astronomy as its models, was based on quantification as its methodological principle.

When we speak of productivity, for example, or of the gross national product, we include in them only the measurable, the monetary, factors. If a change in a firm were to result in better relations between its employees, this would not be reckoned as a gain in "productivity," although what it had produced we should agree is valuable. Similarly what the wife does for her home, what the city councillor does for his city, and all other unpaid forms of work, are not included in the gross national product.

Thus the essence of this particular outlook—which elsewhere[11] I have called *economicism*—is to assume that all social issues are reducible to a monetary basis. The falsity of this view is generally realized. Cost and profit are *not* the only criteria—yet we allow many social judgments and changes to be made as if they were.

A widely held conception of the "standard of living" is an example of this. The view that the standard means no more than incomes and what they will purchase is narrowly economic and takes no account of a host of other factors as important as they are difficult to measure. It accounts, in part, for the brain-drain which a broader conception of the standard, if it could be brought into common acceptance, might well diminish. Similar remarks could be made concerning other aspects of our social judgments and decisions. As Joan Robinson remarks: The first essential for economists is "to combat, not foster, the ideology which pretends that values which can be measured in terms of money are the only ones that ought to count."[12]

THE PRESERVATION OF DIFFERENCES

This essay concerning the tendencies towards uniformity should not be ended without mention of the contrary influences. Fortunate it is that they exist; and it may be hoped that, if they

[11] *Science, Industry and Social Policy* (Oliver & Boyd, 1963).

[12] *Economic Philosophy* (Watts, 1962).

are sufficiently supported, they will succeed in replenishing the social and environmental diversity at least as fast as the systematizing tendencies take it away.

One of the most important of these influences is education. What nature provides towards the maintenance of variety is the random mixing of the genes. What can be further provided by artifice is the nurturing of these novel combinations of talents and qualities, virtually unique to each particular child, under the guidance of the devoted teacher. Hence the great importance, I believe, of maintaining variety within the educational system (e.g. as between different sorts of schools, colleges and universities) and also adopting methods of teacher training such as will encourage individuality in the teachers themselves.

A second is the influence of the arts and the leisure side of life. In the world of work: method; in the world of play: spontaneity and variation.

Such, for example, is the refreshing effect of fashion which brings a constant supply of new images into the everyday life. And the same, at a deeper level, is shown by the history of art itself, especially decorative art, which exhibits a profound interplay (as H. Weyl has remarked[13]) between symmetry and asymmetry, as expressions of contrary human inclinations towards orderliness and its opposite.

Is there not, in fact, a sort of natural entropy factor in human affairs—more familiarly a waywardness—which helps to create a welcome topsy-turvydom where otherwise everything would be planned and systematic? But for the existence of this natural psychological safeguard the whole idea of "planning" would be far less acceptable than it is.

Also we have a strong tradition of personal liberty which is not easily overpowered. Ours is a civilization having a certain special quality of fluidity and richness, one in which we regard it as normal that there should be the most diverse and conflicting tendencies. Although scientific method is now so natural in the West, our society remains loath to adopt its own self-planning and prefers a conception of itself as consisting of myriads of free individuals each exerting his own pulls on the social fabric. The

[13] *Symmetry* (Princeton University, 1952).

existence of this sort of tension—between the demands of method and systematization on the one side and a kind of vital ferment and commotion on the other—seems almost of the essence of modern society.

These favourable factors, which do not belong to science, will eventually find a response from within science itself. Greatly increased attention is now being given to biology and thereby to the distinctive characteristics and requirements of living systems. The life sciences are concerned with complex organization and this (as suggested already in a footnote) is something distinct from orderliness. Biology also emphasizes the importance of variegation and shows how it assists adaptation and survival. Such distinctively biological knowledge will compel us eventually, I believe, to realize how essential is the quality of diversity in human affairs.

Yet (it may be asked) is diversity something that can be striven for, consciously and deliberately, or would that be self-defeating? Deliberate aim in this direction has in fact been proposed in an interesting essay by Maynard Shelly.[14] The possibility is suggested of developing methods which would maximise the preservation of individual differences. As an illustration he mentions what is already attained, in a rough and ready fashion, in any good research laboratory. Though the laboratory is necessarily highly organised, its goodness consists in being so organised that each scientist or engineer has the maximum freedom to develop those of his characteristics that *make him different* from his fellows—subject to the constraint that he does not interfere with *their* freedom.

What he suggests is needed is a better understanding of the constraints placed on an individual by the *diverse* needs of others. With this it might be possible to proceed to a kind of optimization concerned no longer with the mass, with people regarded as a smoothed-out aggregate, but which has the character rather of an n-person problem, where each individual is taken as having his own particular qualities and demands, and also as exerting his characteristic constraints on the $n - 1$ others.

Be this as it may, I would like to conclude by saying again

[14] *Human Judgments and Optimality* pg. 405 ff. Ed. Maynard W. Shelly and Glenn L. Bryan (Wiley, 1964).

what was said earlier; that we need to keep actively in mind that very few problems can be adequately solved by use of a single criterion. Almost all real-life issues involve a multiplicity of values. There is no contradiction in wanting greater social planning in certain directions, or in working (as every scientist does) towards greater intellectual orderliness, and yet criticising false simplification in instances where the optimizing approach, or similar mathematical idealization, is illusory.

For the same reason we must continue to hold our human decision-making abilities in respect. Certain researches might almost persuade us that our decisions can soon be left—like living to the servants—to our computers. Yet our talents in that direction are superior, as well as inferior, to those of the machine. Inferior in so far as we can take account, at any one time, of only a small part of the total logic of a situation (e.g. as in chess) and for such problems the computer is already doing much better than our heads. Superior however in that we do manage to deal, in however rough and ready a fashion, with logically unspecifiable situations and multiple criteria.

What mental struggles we often go through in making a choice! To buy an Austin and not a Morris, to holiday in Italy and not in Spain. Psychologists cannot say how this is done, but my own belief is that it is performed quite differently from optimization by computer. In reaching a decision the various possibilities are conjured up by the imagination and looked at, first from one aspect and them from another, like turning objects round in the hands. Decision in based on the finding, not of a mere optimum of a single variable, but rather of a best overall *shape*—that which fits the template of the personality like a key to a lock.

If this be so, personal decision making is like a process of recognition and is closer to aesthetic appreciation than it is to analytical reasoning. But that is perhaps only another way of saying that we cannot have a rich diversity and be completely systematic at the same time!