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THE DOCTRINE OF LEVELS APPLIED TO THE SCIENCES

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It is an obvious fact that the sciences tend to encroach upon each other. It is often conceded that if all the other sciences, and even the arts and religion, were made entirely explicit they would be expressed in a vast system of mathematical functions. The fact that much can be said for this contention only complicates the issue. Physics, in its turn, being the mother of most mathematical problems can with some justice regard mathematics as only a tool to solve physical problems. The same subject, reaching out through electronic theory in its application to the periodic system of the elements can hold with some plausibility that everything that is really respectable in chemistry is theoretical physics. And classical physics went even further in its claims. Chemistry on its part also reaches out beyond its borders. Through organic chemistry and bio-chemistry it crowds close on the domain of life. With refinement of technique it will penetrate even farther. There can be little doubt that the day will come when the songs of the angels will yield to chemical analysis. Nor are the biological sciences less pervasive. Not only can the physical environment be made to look like a mere incident of the life of the organism but the laws of the organism can seem to command all the intellectual and spiritual reaches of human experience. On the plane of the social sciences, a subject like human geography can cover the philosophy of India and the rubber industry of the Congo. Economics can rightly explain how the art of Leonardo was brought into existence and how the Mosaic laws were credited with having been announced on Sinai. Economic determinism can dwarf every other interest into insignificance. Going farther, there is a psychology explaining Hegel's dialectic and a dialectic explaining Fechner's psychology. Though music can be accounted for with ever greater adequacy as the *physics* of sound, and similar attacks can be made on the other arts, all the arts can retaliate by insisting that all the sciences are only means to realize their values. To go beyond Science and art, religion can claim to dominate the world or it can be assigned a place in anthropology or psychology. Such complete coverage by each field means that at the logical limit of extension no one field will take the others into account—each is monarch of all it surveys. Each science is a Leibnizian monad mirroring or including the whole universe.

The situation involves serious practical consequences. One of those consequences is that the exponents of certain sciences, having taken other sciences at those sciences' own valuation, become apologetic and beg for the right to exist. This is often true of workers in the less exact sciences. Having great respect for the experimental demonstrations and the quantitative results of the physical sciences they are afraid that they will be charged with being charlatans if they assert their own claims. They accordingly walk timidly and try to show that their methods are really those of the natural sciences and that their sciences are in very truth natural sciences. The current tendency to introduce "laboratory work" in the social sciences shows the extension of this influence. One may expect soon to see laboratories in philosophy, religion, and poetry. If this were a mere fad or craze it would not be so unfortunate, but in fact, it represents a neglect of the distinctive material of the more complex and there-

fore less exact sciences. Some of the richer and finer aspects of experience are in this way deliberately abandoned.

A worse consequence of the overlapping of fields is the arrogance of the representatives of certain sciences. Strange as it may seem, the workers in the exact sciences are not the only offenders in this regard. Often the exponents of the social sciences look upon the simpler and consequently more exact disciplines as not only subsidiary and possibly unnecessary but as actually dangerous. There are political thinkers who will pass knowing glances if one speaks of the mathematics of the social process. The implication is that all that is worth knowing they know—everything else is fantasy or insanity. There are biological thinkers who, rightly liberated by the doctrine of emergence from the tyranny of the exact sciences, attempt to extend their own domination over all the social sciences. And it need not be said that physical scientists often feel that if they could take a few weeks off they could read up on the social sciences and know more than the social scientists themselves. In evaluating such a conviction it must be remembered that such mastery would include all that Justice Cardozo knew about the law, all that Bryce knew about the American Commonwealths, all that Harnack knew about the history of Christian dogma, and all that Charles Beard knows about American civilization. And the artist with equal arrogance often insists that all scientists are bores.

A consequence of this attitude is an unwillingness to master the distinctive methods of adjacent fields, though attempting to employ them. Frequently a social scientist will resort to statistics without taking pains to learn the subject technically. A physical scientist will dabble in the social sciences without taking the trouble to examine their methods or to cultivate his judgment in their fields. A biologist will adopt methods from both the social sciences and the exact sciences without paying either field the respect either to invite their experts in for consultation or to study their mehods adequately himself. The result is a little academic feudalism with each feudal lord claiming sovereignty over the whole domain.

The remedy for the situation is an application of the doctrine of levels to the sciences themselves. At this point it is of prime importance to determine what the doctrine is. It is often identified with the principle that the whole is more than or different from the sum of its parts. This principle means that five is more than or different from two plus three, that nine is not identical with three plus six, that each, whatever it is made up of, has its distinctive character as five or nine. And the same is true of any other number. The principle means, likewise, that any composite thing, whether it be a mechanical mixture like a salad or a new substance like the result of chemical action, has its own qualities, *as such*, additional to the qualities of its several ingredients taken separately. A modification of the relation of whole and part is that of formal principle and content. Each element in this opposition also has its irreducible status. And so the general idea can be applied throughout the universe. So far as coexisting relations are dominant, whole and part with their implications express a significant aspect of the doctrine of levels.

The doctrine under consideration demands, however, a consideration of dynamic relations. Not only does it guarantee the character of the whole against the tyranny of the parts, and vice versa, but also the effect against theoretical absorption by the cause. When an effect is traced to a cause or set of causes the tendency is to regard the cause as dominant and the ef-

fect as only an appearance. When a disease is referred back to a certain germ the latter is likely to receive the whole emphasis. When thinking or some neurological situation is correlated with some electrical condition the logically unwary begin to assert that thinking and nervous states are "nothing but" that physical condition. When it was discovered that man was descended from some simian form of life the conclusion of the unsophisticated was that man is a monkey. Similarly all the effects in the universe tend to collapse into a dead level of causes. The doctrine of levels has been employed to assure the reality of effects more than it has to establish the whole-part relation.

An illustration of the use of the doctrine in this sense is the theory of emergent evolution. The evolutionary theory of the nineteenth century, whether its proponents intended so or not, had the effect, as a result of its necessarily non-teleological methodology, of emphasizing naturalistic causes at the expense of the biological, social, and ethical stages in the process. The reductive tendency involved was at war with the immediate facts of the organism, society, art, and religion. The first one to take issue with this naturalistic fallacy in a significant way was Bergson. His Creative Evolution revolved around the reality of time. If time is real each moment must, according to him, possess an element of novelty to distinguish it from the past moments. If this is true then everyhing in the world, be it a moment of time or a new individual or species, has its own irreducible novelty. On this assumption, effects cannot be reduced to their causes. This is beyond question a doctrine of levels. But a much more satisfactory statement came from Lloyd Morgan in 1922 and 1923. In essence the position is that there are certain irreducible stages in the evolutionary process, that there are differences in kind, that arranged in some way between them are "resultants" that do not usher in new qualities. It will be seen that emergent evolution in providing certain ratchets to keep organic and social effects from slipping backward toward their naturalistic causes illustrates the principle here under discussion.

In the definition of the doctrine of levels a further character must be added. It is usual to think of the different levels as parallel terraces, one above the other. Such terraces would have their extensions in the same directions so could not be differences in kind. For levels to be different in qualitative character they would need to be right-angular to each other. It would accordingly be impossible to represent a set of levels by a simple, ladder-like model and would be necessary to conceive it as an infinite set of orthogonal dimensions.

The separateness of levels or emergents often makes them seem to be unrelated. That is an error which must be guarded against. A chemical compound has its own unique qualities but that fact does not prevent its being composed of atoms which are in turn made up of electrons and protons which, again, are susceptible of further analysis. Likewise the fact that a particular substance acts in a certain way does not prevent its entering into larger combinations such as a shop, a factory, and a system of distribution. A mammal has its own distinctive character but that fact does not keep it from being substantially related to birds, reptiles, amphibians, fishes and so on down the line. Similarly the individual human being is not less real because he is a part of the society around him and ultimately a part of the development of the race.

Applying the principle in question to the sciences, we find that each is a basic kind or level or dimension. In definition mathematics is formal and hypothetical: it will apply to one thing as well as to another. It is a colorless scheme of terms and relations. Taken as such it is not a mere

throw-off from other fields, it has its own status as a separate type or activity. Yet it has its essential relations with the material of the other subjects to which it applies. Physics, on its part, though making wide use of mathematics, is not a mere aspect of that subject. It has its own distinctive phenomena in mechanics, heat, light, electricity, and the like. Around these spheres of activity center its peculiar experimental technique and its adaptation of mathematical procedures. On the side of the more qualitative sciences it is fenced off from chemistry by the fact it does not in the main deal with change of substance. With this definition it is a level or, looked at as appearing in the process of experience, it was at one time an emergent, something new under the sun. With sure footing in this unique character it can reach out and help determine the structure of the earth and even the structure and function of the organism. Chemistry, in its turn, is not a thinly disguised physics. It takes its stand in those phenomena that involve change of substance. However far electronic theory may go in explaining that change of substance, and admittedly it may go far, it does not wipe out the fact of change of substance as observed and as explained by acknowledged chemical principles. From that definition as a sure center chemistry can invade physics and biology with impunity and be invaded by them without loss. Geology, a more concrete study, has to do with the history of the earth. Admittedly it is a composite subject but its preoccupation with a definite type of phenomena gives it a point of reference. From that center, it can reach out and appropriate from physics the principles of erosion, sedimentation, pressure, upheaval, and the means of determining geological time by using the rate of transmutation of certain elements. It can reach into biology to check its conclusions by reference to fossil forms. It can also contribute to other fields as high as that of religion. Yet it does not lose itself in these outlying subjects. About the beginning of the nineteenth century geology was an emergent in the process of scientific thinking. Leaving out the time factor one may call it a level.

When the transition is made to the life sciences new distinguishing marks are found. The unique material is the organism. The organism increases by intussusception, it reproduces itself, its parts are reciprocally determining in a high degree, it possesses irritability in various measures. However far analysis by natural science methods may go, the organism as such, as the point from which the analysis starts, persists. However far the organism extends its own domain it does not completely fade out into extension nor does it succeed in assimilating the other domains.

The social sciences taken as a whole have likewise their own dominating concept. It is that of society as such. Much harm has been done by likening society to an organism with the stress on the central unity rather than on the various local autonomies and coordinations within the organism. The concept of society is one of a looser level of organization than that of the organism. Society is made up of organisms at the highest level of mentality. They are themselves ends instead of being mere means. The interests of these individuals as such have to be protected within the whole of society. Hence we have within society the problem of civil liberties. It may be that the static notion of natural rights which prevailed in the eighteenth century is inadequate but a functional notion of the necessary vitality of the individual in the group must be retained if society is not to degenerate into some kind of vast primordial reptile. Society must accordingly embrace all of the instrumentalities, like courts, investigating commissions and committees, as well as private agencies, to insure that the distinctively social conditions shall prevail. Grounded in this characteristic social concept the social sciences can accept the contributions of

the biological sciences and the more exact sciences and in turn contribute to those fields of investigation. However far society is explained in terms of other fields it cannot be explained away.

With each science allowed its own dominating concept as a level, its own material and its unique method, and yet permitted to reach beyond its boundaries to explain and to be explained, what are the practical consequences? Predominately it means a fine comradeship among scientists. No group of sciences will constitute a limited scientific hierarchy; all the sciences will belong to the hierarchy. This condition will bring a greater degree of objectivity among the researchers in the different fields. As every science is acknowledged in its own precinct there will be less suspicion of motives and a greater openness to suggestion. Out of objectivity will grow cooperation. When one scientist finds himself near the borderline of another field, instead of carrying on his investigations furtively for fear he will be charged with encroachment, he will generously call specialists in the adjacent field in for consultation. They will then be studying the same material from different angles and with different methods. The result will be greater illumination and understanding as well as more cordiality.

But probably the best result of the application of the doctrine of levels to the sciences will be the mutual recognition of the complexity of the several fields and the talent and training required to operate in them. The social scientist will not feel that relativity and quantum theory can be mastered in three weeks with the acquisition of a few general principles. He will recognize that they require long years of acquisition in at least adjacent fields. They may not demand the brain of an Einstein or a Bohr but they will need deep and protracted thinking. The exact scientist will not look with contempt upon the biologist because of the inexactness of the sciences of life. He will rather honor the long researches of a Darwin, the logical subtleties of a T. H. Morgan, the speculative range of a Jennings or a Wheeler. And the exponents of the natural sciences will hesitate to ignore the amazing detail of human society on the ground that it is inexact and to assume on that account a bourbon attitude toward social change. They will realize that human association requires the greatest logical subtlety and imaginative insight for its analysis and the precision of an accomplished stylist for its expression. They will understand that at its greatest height social science approaches the art of a Dostoyewski, a Galsworthy, or a Thomas Mann. With this understanding the natural scientists will bring all the wonders of their achievement to promote the social program.

In the clear sunlight of just appraisement and mutual respect insured by the application of the doctrine of levels to the sciences research workers will be more cooperative, more effective, and in the end happier in their undertakings.