is no unique theory that describes a given phenomenon, as is easily proved by making a trivial modification of any given theory which does not change its description of the set of phenomena that are on hand. The theory that endures is the one that describes a large set of phenomena compactly. This involves the minimization of a subjective quantity, human effort, which, like many quantities in engineering, is not capable of exact measurement. A theory is modified or abandoned when it fails to describe a phenomenon that it should describe. A theory does not necessarily have predictive power, and it may not necessarily be capable of predicting numerical values in a useful way. For example, consider the problem of designing a pulse circuit using diodes and transistors. Many have felt the desirability of applying digital computers to this task, but only a few have achieved any significant degree of success. Fundamental philosophic difficulties have impeded progress. To see this, first note that if the transient performance (response to arbitrary time-varying waveforms) of the circuit can be computed, then by known procedures a circuit can be designed (component parameter values obtained) given a circuit configuration. The determination of a circuit configuration is a creative act. To compute the transient response to a given waveform by known methods requires that differential, integral, and other equations be available for each component. A semiconductor diode is a physical device whose operation is described by solid-state theory. However, the equations describing the response of a real, physical diode to arbitrary stimuli have not been obtained. In principle, quantum mechanics applied to the physical structure of the diode could give quantitative answers, but no computer smaller than the universe could solve the problem in a reasonable time. The band approximation and the diffusion theory serve only to describe but do not give quantitative, useful results except for nearly ideal cases. The circuit designer has to design his circuit to use real devices obtainable from a manufacturer. He is limited to only those tests that can be made at the diode terminals. For linear black boxes, systematic procedures exist for obtaining accurate describing equations, but none exist for nonlinear systems. This problem is very similar to that faced by the physical scientist in constructing a mathematical theory on the basis of experiment or experience. That is, if a general synthesis procedure for nonlinear systems based on terminal properties could be found, the pulse-circuit-by-computer-design-problem could be done mechanically, and the procedure would be of inestimable value to the physical scientist.

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## For Complexity

Szent-Györgyi's suggested resolution of the problems of teaching associated with expanding scientific knowledge (4 Dec., p. 1278) would have the undesirable effect of perpetuating an underlying assumption of simplicity or parsimony in the "laws of nature" that is directly contradicted by the increasing complexity evident in the very "explosion" of scientific knowledge to which Szent-Györgyi addresses himself.

As I have attempted to document in detail elsewhere ["Parsimony in psychology," *Psychol. Rept.* **11**, 555 (1962)], an inappropriate adherence to simplicity of scientific investigation and explanation has been a major deterrent to progress in experimental psychology, and probably in other fields of science as well. It is most unfortunate that current scientific methodology offers no satisfactory guarantee that an excessively simple principle or technique will be rejected merely because it is too simple to cope with the empirical facts. Consequently, it becomes exceedingly difficult in practice to rid science of oversimplified formulations, especially when so many scientists, like Szent-Györgyi, appear dedicated to the proposition that the many presently unresolved "riddles of nature" will ultimately yield to a single simple and general explanation. . . .

Our teaching will be far more helpful and effective if we attempt to convey the great importance and excitement attached to the complexities of science and the investigation thereof, rather than misleading the student by emphasizing an underlying simplicity which he probably will never experience.

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