Lage), and university educators (Dean Boelter, Dean Ernst, and Clifford Beck) attempted to clarify the problems of engineering education for reactor technologists or nuclear engineers. Educators as well as nuclear technologists seem to favor experimentation with various types of curricula: a special nuclear engineering program, a solid basic foundation in physics and chemistry, with appropriate courses giving the fundamentals of nuclear physics, tracer techniques, elementary reactor theory, nuclear instrumentation, and radiochemistry. And, as Weinberg emphasized regarding establishment of nuclear engineering courses in engineering curricula: "This can only be attained if each engineering school makes a temporary sacrifice by sending one or two faculty members to an atomic energy installation or industrial organization engaged in atomic energy development to get firsthand experience with the effort."

The engineer as well as the educator will certainly benefit by this summary of the engineering aspects of the atomic energy program. We hope new developments, as they become declassified, will be presented to keep the material up to date.

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The Planets: Their Origin and Development. Harold C. Urey. New Haven, Conn.: Yale Univ. Press, 1952. 245 pp. $5.00.

The Silliman Lectures at Yale University have in the past led to the publication of two outstanding volumes in the field of astronomy—W. W. Campbell's *Stellar Motions,* based on a 1910 series of lectures, and E. P. Hubble's *Realm of the Nebulae* (1935 lectures). The Urey book is a worthy addition to this distinguished pair. It is a volume written by a competent physical chemist, thoroughly conversant with the relevant areas of astronomy, geophysics, and geology and obviously a master in mathematical and practical physics. It is a book that deserves to be read and studied by everyone who is even remotely interested in the physics and chemistry of the moon and planets as they are today and as they may have been in the past.

Harold Urey has written a book that cannot be read and digested in one or two evenings, since much of the material in it is of a technical nature. In the introductory chapter the author reviews current theories on the origin and development of our solar system. Here he leans primarily on Kuiper's modification of von Weiszäcker's theory, according to which our system of planets came into existence as a result of the collapse of a turbulent solar nebula with a total mass of the order of one tenth that of our sun.

According to Urey's picture, our solar dust cloud was in the earliest stage a small, dark nebula, a globule, not unlike the globules one sees even now projected in abundance against the bright background supplied by diffuse gaseous nebulae—surprisingly most frequently against certain conspicuous, extended, and highly ionized diffuse nebulae. The globule is supposed to have collapsed gradually to become a proto-star, and as the sun was formed there would then remain behind sufficient matter for the formation of a cool disk of gas and dust, the solar nebula. Since the temperatures in the solar nebula are low at the start, most of it—with the exception of H, He, and Ne—would presumably be in a solid stage. The disk would rather promptly break up into large masses, the largest of them pretty far from the sun.

In a way, Urey's theory is a 1950 version of the planetesimal hypothesis proposed more than 50 years ago by Chamberlin and Moulton, also of the University of Chicago. Urey sees the lunar craters as of meteoric origin and—in agreement with most recent writers on the subject, notably Baldwin—he therefore rejects the volcanic theory for the origin of lunar craters. Accompanying the volume is an excellent composite map of the moon. With this map as a guide, the author analyzes many of the surface features of our moon in terms of planetesimal bombardment. Even the lava-flow features on the moon's surface are assumed to have arisen as a consequence of the melting of the planetesimals themselves.

Urey follows in detail the probable development of the terrestrial planets. After the formation of the sun, the first proto-planet stage is one of low temperature—close to freezing for the earth—with methane gaseous and not condensed in the disk to well beyond the range of Pluto, and with the terrestrial planetesimals largely composed of silicates, water, and ammonia. Ne, H, and He would not be bound and should already have largely escaped from the proto-planet at this early stage. The stage that comes next is one in which the interior temperature of the proto-planet is raised through adiabatic compression. Silicates will be reduced and volatilized, and a large fraction of the gases will escape from the proto-planet, thus increasing the proportion of iron phase in planets like our earth. With the departure of most gases from the proto-planet, the opacity should decrease, and the surface temperature will then begin to drop again. The temperature should then remain at a fairly low value, and this would hardly be changed by further gradual accumulation of mixtures of iron and silicate. The final stage is now approached with, for our earth, 45 per cent metallic iron and 55 per cent silicates, and with the iron gradually sinking to the core.

Urey considers it most likely that the moon was formed from a secondary nucleus within the earth's proto-planet, although he does not rule out entirely the possibility of wholly separate formation of earth and moon and subsequent capture. Under any circumstances, it does not seem likely that the moon has passed through a high-temperature stage. The more volatile solids, which escaped from the earth's proto-planet, have probably been retained by the moon. The moon has mostly silicates and some small admixture of metallic iron, and its composition still may be close to that of the original dust cloud.

The virtues of Dr. Urey's book are many. It represents the result of a clear and open-minded thinking through of a difficult problem. It is a far cry from the theories involving hot filaments between colliding stars, which held sway not very long ago, to Urey's dust-cloud hypothesis! The principal value of the book probably lies not so much in the fact that it deals with an "up-to-date" theory of the origin of the solar system, as in the approach of a careful following through of the detailed physical-chemical processes that must have taken place as a consequence. One gets the distinct feeling that proponents of future theories on the origin and development of the solar system, who wish to be taken seriously, will of necessity have to examine with care the detailed physicochemical processes that follow from their hypotheses. One only hopes that there may always be enough Ureys in the world with ability, vision, and training equal to these tasks!

The book is well printed and is not tiring to read. As far as this reviewer has been able to judge, it is remarkably free from printing errors and errors in figures, although one cannot help but be amused by the editorial slip on page 123, where the word "retention" is in one prominent place spelled correctly, to be misspelled with equal prominence on the same page and on nine pages after that!

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Statistical Design and Analysis of Experiments for Development Research. Donald Statler Villars. Dubuque, Iowa: Brown, 1951. 455 pp. $6.50.

The appearance of another book on statistical methods in these days when statistics seems to be the vogue is noted with interest and hopefulness. This text is an attempt to acquaint research personnel (often lacking in formal statistical training) with the more frequently used techniques of statistical analysis. A wide variety of topics is included: (1) The use of calculating machines; (2) "Student's" t test and required size of sample for the detection of real differences; (3) a discussion of the binomial, Poisson, normal, chi-square, t, F, and other theoretical distributions of use in statistical methods; (4) analysis of variance and the design of efficient experiments; (5) the use of regression (linear and nonlinear) and an introduction to the principles of covariance; (6) quality control charts and the elements of sequential analysis; (7) miscellaneous topics including efficiency studies, components of variance, Sheppard's corrections, and a short note on the Behrens-Fisher test.

In the preface, the author indicates that this book is intended to aid the research worker in properly planning his experimental projects so that statistical methods may justifiably be used in the interpretation stage. A minimum of mathematics is to be used. In general, he does an excellent job of emphasizing the need for good planning. For example, on pages 84–5:

> It is desired especially to emphasize that the way the variability should be analyzed is entirely dependent upon the way the experiment was set up. There is only one correct way to analyze a particular experiment. It is predetermined the moment the runs are made. The manner of replication of the different possible effects is the determining factor. Obviously, use of an incorrect scheme of analysis can lead to erroneous conclusions. Incidentally, as has already been mentioned, if the results of the statistical analysis seem to violate common sense, the chances are great that common sense is right and that an error has been made because of an incorrect subdivision of the error degrees of freedom—one did not have as much replication in the places that the incorrect method of variance analysis implies.

On the other hand, however, the presentation of the techniques, especially analysis of variance, shows a certain lack of sophistication, with the result that incorrect test procedures are sometimes suggested or may be inferred. For example, the second paragraph on page 7 and the second paragraph on page 75 lead one to believe that an interaction mean square is the correct "error" against which main effects should be tested. Such is seldom the case! This matter is better explained later in the text, but it is feared that the damage has already been done. Then, too, at the top of page 69, the impression is given that, if F is significant (in an analysis of variance), one has the right to make t tests for comparing all possible pairs of treatment means. This is generally considered to be poor procedure.

It is unfortunate that Villars has not seen fit to adhere closely to the accepted terminology of statistics, poor though it may be in some instances. The addition of new terms, when no need appears to exist, only adds to the large list of terms and symbols that already awaits the statistical novice. His introduction of "replication degeneracy" seems a misguided effort, indeed. Also, the classification of designs given in Chapter 7 is peculiar. The setting up of two classifications—*simple* ("between and within") and *factorial*—is misleading, since factorials are not designs as the statistician interprets the word. What the author is attempting to do is to classify treatments according to their composition, simple or factorial; and designs as completely randomized ("between and within"), randomized complete block, Latin square, and so on. He adds further to the confusion by referring to a "between and within" design as a "uniform medium" design—another new term to be learned. Other items such as these could be mentioned if time and space permitted.

The reviewer is flattered to be included (a presumption on his part) in the ". . . small nucleus of agricultural statisticians in Iowa . . ." (p. vi) who have paid some attention in the past to small sample (*exact*) statistics. However, he feels that the implication that all other statisticians in America have only recently deviated from consideration of purely large sample (*asymptotic* or approximate) statistics and awakened to exact statistics is unjustified. It is realized, of course, that much depends on the interpretation given to the word "recently." In view of this wide latitude of meaning, let us be charitable and assume that people outside Iowa have heard of, and believe in, small sample statistics.

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