It is appropriate that the Proceedings have been dedicated to the memory of Theos J. Thompson. Tommy was very much at the center of things in Tucson. We were all proud of him, proud that "one of us" would sit with the Commission and fight the good fight for superb science and technology. How much of a fight lay ahead came to me with a simple remark. After Thompson finished his address outlining in detail specific investigations needed in the dynamics and safety program, a young and talented colleague turned to me and said, "Those are precisely the lines of research I proposed to the DRD. They replied that they weren't interested."

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About the Reviewer: Noel Corngold has been professor of applied science at the California Institute of Technology since 1966, following 15 productive years at the Brookhaven National Laboratory. Dr. Corngold's graduate studies were at Harvard. His research interests have been in reactor and statistical physics, particularly in the theory of neutron scattering and transport.

Application of Invariant Imbedding to Reactor Physics. By Akinao Shimizu and Katsutada Aoki. Academic Press, Inc., New York (1972). 184 pp. $13.50.

Application of Invariant Imbedding to Reactor Physics consists of two parts. This little monograph treats the application of invariant imbedding theory to shielding calcu- two-dimensional systems (part B).

Part A begins with a brief recapitulation of photon cross sections and a quick review of the classical methods used for the solution of gamma-ray reflection and transmission problems. After a general discussion of the differences between the classical Boltzmann approach and the invariant imbedding approach to radiation transfer, the basic invariant imbedding equations are derived in Chap. 2 and then solved for some model problems in Chap. 3. The whole of Chap. 4 is devoted to the numerical method of solution which is then illustrated in Chap. 5 by numerous examples, including the reflection of gamma rays from various substances, dose transmissions, and buildup factors. The numerical material is here extensively confronted with Monte Carlo and moments calculations, as well as with experimental evidence.

Part A is an excellent introduction to the invariant imbedding theory for those who expect a clear physical motivation of the derived equations, not stuffed with proofs of existence and uniqueness, yet presenting a sharp distinction between the Boltzmann and invariant imbedding approaches. Simultaneously, the presented material is very convincing concerning the usefulness of the theory in shielding calculations, although the authors do not make a secret out of the fact that an extension of the theory to two-dimensional problems is an unsolved (or unsolvable?) problem today. The question is the reviewer's and is best illustrated by the fact that almost 15 years after the formulation of the theory by Bellman and Kalaba, invariant imbedding equations have only been generalized to spherical and infinite cylindrical geometries. But do we have to follow this way? The answer to that question is given by the authors in part B of their book.

Part B begins with a short review of the classical approach to reactor criticality problems which leads to multigroup diffusion equations that have to be solved in the reactor core (Chap. 6). Although the invariant imbedding equations for plane geometry can be supplemented with terms describing the fission process, they have not been further analyzed. Instead, the authors pass directly to the formulation of their own modification of invariant imbedding theory, the response matrix theory (Chap. 7). The latter uses the same concepts as invariant imbedding, such as partial currents and reflection and transmission matrices, but it does not use any functional relations between the response functions. Therefore, the response matrix theory can be extended to geometries where those relations do not hold any more or, even if they could be established, from which it would be too involved to construct invariant imbedding equations in a similar manner as Bellman did for plane geometry.

Application of the response matrix method to one-dimensional systems is given in Chap. 7. It is further developed for two-dimensional systems in Chap. 8 where the monograph culminates (and ends rather abruptly) in the description of the author's two-dimensional diffusion theory code, MERMAID. The numerical examples illustrate the potentialities of the response matrix method in comparison with the finite difference method. However, the material chosen does not go far beyond that published by the authors up to 1965, namely, a homogeneous bare reactor, a reactor with reflector, and the Toshiba Training Reactor. In the light of the present demands imposed on any numerical method which should compete with the finite difference technique, those examples are, however, not convincing. How would the method describe a large power reactor core, like that of a large BWR? Will the linear correction for the interface current distributions still be sufficient?

The monograph would be more up to date if examples of a typical PWR and a BWR were also included. Perhaps the method would then become a little less attractive, but the results would be more valuable. For instance, the first two examples refer to quadratic nodes in quadratic homogeneous cores. Experience shows that such systems are extremely favorable for nodal and macromesh methods. The problem starts with larger, rather loosely coupled BWR cores with large variation of the diffusion constant (due to void distribution) between neighboring nodes. The two other examples (pp. 8.5.3 and 8.6.1) do not resolve that problem, as they refer to relatively small, rather strongly coupled cores. Besides, in the last example no reference is made to other numerical methods, say a finite difference calculation with homogenized node data. Such a comparison would be very instructive and possibly throw additional glamor over the response matrix method. For completeness, the method should also be compared with other "fast" calculating models. In two-dimensions the nearest seems to be the finite element method with square nodes. In conclusion, the reviewer's intention would be, at this place, to warn the reader against a too optimistic generalization of the numerical examples of part B to problems encountered in power reactors today.

Thus we come to the main weakness of the monograph. Although it was edited in 1972, the most recent publications quoted by the authors date from 1968 in part A and from 1966 in part B. This rather large time gap does not qualify the book as a review of the state of the art, which, judging from the editing date, one would expect to have been updated to at least 1970. On p. 102, when referring to flux synthesis methods, the authors quote publications from 1962 and 1964, in spite of the long list of publications which have appeared since and still appear today. Therefore, the reviewer is inclined to believe that the book was actually written around 1966-1967. Did editing the book require five to six years or did the authors find no interest in supplying it with more recent information on the subject? For example, point 7.1 (pp. 107-109) could have been illustrated with calculations done by Mingle (1967), while the time-dependent response functions calculations (only a short appendix in the book!) could have been supplemented with the publications of Mockel (1967). In the preface, the authors clearly point out that . . . "the present monograph describes the application of the method of invariant imbedding to radiation shielding and to criticality calculations of atomic reactors." However, the title of the book suggests applications of invariant imbedding theory to reactor physics in general. In fact, the book would be more complete, and its title would have been fully justified, if the very interesting thesis of W. Pfeiffer (1969) or at least the article in *Nuclear Science and Engineering* by Pfeiffer and Shapiro (1969) had been included and discussed. The reader would then be better informed about the usefulness of the theory in other branches of reactor physics, for instance, the possibilities of using response functions for the evaluation of cross-section measurements.

I would not like to seem too critical. As a matter of fact, I have merely pointed out what the book should contain in order not to mislead the reader with its title and monographic character, which according to the definition of the word should contain a rather "exhaustive presentation of the chosen subject." Thus, although the book is rather old in material, it is nevertheless, to the reviewer's knowledge, the first book on invariant imbedding applications to reactor physics; therefore, it will serve the purpose of spreading this interesting method beyond the narrow group of specialists in this field. Furthermore, it can be considered a source book on response matrix theory, written by the commonly recognized inventors of the method. In the near future the reviewer expects a strong development in this area and an avalanche of publications devoted to response function calculations of various compound subassemblies used in large power reactors, analogous to the days when thermal neutron cross sections were evaluated for compound molecules and crystals. The book is definitely the valuable first step towards this development and it can be used as an introductory course since it contains the numerous publications of the authors collected in one volume.

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About the Reviewer: Zbigniew Weiss has been reactor physicist at ASEA-ATOM, Sweden, since 1966 and as visiting professor, taught reactor physics at Kansas State University in the academic year 1968-69. His current research interests are power reactor physics, nuclear safety, transport theory, and, in particular, reactor computational methods as response matrix theory, nodal models, and finite element methods. He received his PhD in theoretical physics from the Polish Academy of Science in 1963. Prior to 1966 he was reactor physicist at the Institute of Nuclear Research, Warsaw, Poland, for seven years and at the Institutt for Atomenergi, Kjeller, Norway, for two years. His earlier graduate training was at the Polytechnic of Wrocław, Poland (1950-1955), and at the University of Wrocław, Poland, in mathematics and theoretical physics (1955-1959).

Radioisotope Engineering. By G. G. Eichholz (Ed.). Marcel Dekker, Inc. (1972). 418 pp. $26.50.

"It is the purpose of this book to discuss many of the engineering aspects of the use of high-level radioisotope sources in medicine and industry and to present in convenient form much information and data material that until now were accessible only through the report literature." The objective stated by the editor in his preface is fulfilled. He and his colleagues have produced a useful book. However, I wish *Radioisotope Engineering* were a different kind of book.

First I will describe the kind of book it is. Following a 40-page introduction, there are 130 pages devoted to radioisotope source production and encapsulation, 45 to teletherapy units, 135 to high level gamma source irradiators for industrial processes, and a concluding chapter of 20 pages, comparing the relative merits of accelerators and radioactive sources. The general level is elementary so that the book may serve as an "introduction to the field for radiologists, health physicists, and food technologists." Only three pages contain mathematical material that would tax the abilities of a high school senior. There is an appendix which defines such elementary terms as "accelerator," "radioactivity," and "Z."

But don't let this apparent simplicity fool you. Despite the minimal use of mathematics, much of the descriptive material is highly concentrated, and it can be tough going for an engineer, much less a novice. In addition, for the reader interested in a detailed quantitative approach, there are many useful references which direct him to computer programs and other information at the forefront of the field.

The reader should also know what the book is not. It is not a textbook. While the chapters on "Gamma Irradiation Systems" (Bradburne) and "Design of Teletherapy Units" (Shewchenko) contain several illustrative examples and sample calculations, the others do not meet this educational requirement. There are no student exercises. Despite the attempt to cover a wide range of topics, too much is missing. There is some discussion of the absorption of gammas but it is inadequate. The absorption of alphas, betas, and electron beams is almost ignored. So is the whole of radiation chemistry. The applications of high level radiation to industrial processes are listed, but not one is discussed in sufficient detail. There are only a few simple formulas and rules-of-thumb for back-of-the envelope calculations.

To understand the reviewer's point of view, the reader should know that I have been teaching a two-semester graduate course in radiation engineering for twelve years. The course covers the transport of ionizing radiation, radiation source technology, radiation chemistry, and radiation processing. Other topics (such as gauging, activation analysis, and radiotracer applications) are covered but the principal emphasis is in the areas cited. I have no textbook and am constantly searching for educational materials which will serve my interests and make my job easier. While this book "is valuable as a complement to theoretical texts used in courses in radioisotope training and mechanical design of radiation systems," it does not have the coverage or the style that would make it the primary text