Meetings

Computing Methods Applied to Reactor Problems

The use of computers in solving reactor problems had been planned as the major topic of an international conference at Argonne National Laboratory, Argonne, Illinois, 17–19 May 1965. However, the main concern and primary discussions returned repeatedly to the question of the proper role of computers and man in technical computations. From the first paper by W. J. Worlton (Los Alamos) on recent developments in computer technology and their implications for reactor calculations to the summary panel, there was little that did not reveal an attitude toward the proper use of computers. There was a dichotomy of views among the speakers. One group assumed that the great increase, of the order of 20 or more, in computer speed and memory anticipated during the next year or two will allow reactor problems to be handled in a straightforward, unsubtle manner. The view further states that a computer should be used in any way to save people from thinking. A computer does not eliminate thinking, but if a problem has been carefully considered and satisfactorily programmed, there is no necessity for good minds to repeat the same thinking process. The counter-view is that the straightforward, brute-force use of a computer can lead to a failure in understanding the physical problem or the resulting answer. In this view the "black box" role for a computer can lead not only to obvious errors for reactor problems, but also to more subtle errors because of the character of computers. A few examples were presented by this side to show that simpler models could give as good results as the more direct models that involved more computations.

L. Kowarski (European Nuclear Energy Agency) presented the consensus of the panel when he said ". . . there should be a combination of sufficient and competent computations and some amount of good common sense to see whether your black box hasn't lead you astray. . . . Computers should not be used too blindly in that there should still remain a role for the human intervention to check them by their common sense. . . ." It is apparent that this statement, which was made in connection with reactor calculations, is equally valid for all technical calculations.

The only similar international meeting on reactors and computers was held in Vienna, Austria, in April 1960 by the International Atomic Energy Agency (IAEA). Although most of the techniques of reactor computations were known and used in 1960, there is little doubt of the increased elegance and sophistication of present reactor calculations. The main advances in this 5-year period have been brought about primarily because of the increase in computer speeds and memory and not through new theoretical techniques.

The most interesting feature mathematically during the meeting was the major use made of the variational principle in the derivation of many of the difference equations used in reactor calculations. The variational principle was used for both time independent and time dependent problems. In all cases, derivations depended on developing an appropriate functional and then deriving the useful equations or properties from the stationary property of the functional.

A continued interest exists in improving the iterative techniques for multidimensional diffusion problems. Although new iterative techniques and new difference equations were derived, the advances do not appear to be major. Work has also continued in the synthesis method, particularly for three-dimensional problems. There still appears to be a need for establishing good mathematical and experimental justification for these synthesis methods. In spite of the rather substantial amount of mathematical work in the field of reactor numerical analysis, the major effect on reactor calculations during the last 5 years has occurred because of the increased speed of computers. The computer field is advancing so rapidly that mathematical advances play a less significant role than mathematicians would desire.

There was an important trend for computing and reactor calculations in a number of the papers, especially during the session dealing with linked calculations. This trend is to join together a number of codes, here reactor codes, and run them together in one large system rather than individually. One object of such linked calculations or systems is to eliminate the need for human intervention between each individual code. The future availability of larger and faster memories will further increase this trend to systems. The NOVA system, proposed by Knolls Atomic Power Laboratory, is the most elegant of the systems discussed. It consists of a collection of Fortran programs which have access to a common set of mass storage devices called the DATAPOOL.

The existence of three information centers containing libraries of nuclear codes is evidence of the maturity of the use of computers for reactor calculations. These three centers were discussed and their present and proposed activities noted. The first center, the Argonne Code Center, was established in 1961 at the suggestion of the Mathematics and Computations Division of the American Nuclear Society. Within the United States, this center is the agency for collecting, maintaining, and distributing available reactor code information. In 1964 in Ispra, Italy, a similar center, the European Nuclear Energy Agency Computer Programme Library, was established. At this library an attempt is also being made to test, evaluate, and formulate common standards for the reactor codes. In 1962, a Reactor Shielding Information Center was established at Oak Ridge National Laboratory (ORNL). One of the activities of this center is to collect, evaluate, and disseminate information on computer codes dealing with radiation shielding. These three centers have proven to be of great value in eliminating duplicate work and assisting in the interchange of information.

The nuclear data which are used as input for the codes contain most of the physics of a reactor problem and

are therefore vital to obtaining significant calculations. It was evident at the meeting that a considerable amount of effort has gone into the collection and organization of good nuclear data. More than a dozen systems have been developed to process evaluated nuclear data. Perhaps the most advanced nuclear data system, the Evaluated Nuclear Data File, is being worked on at the Sigma Center at Brookhaven National Laboratory. Most nuclear data will be primarily available through inquiry to some computer system.

The time behavior of reactors is receiving increased emphasis. W. K. Ergen (ORNL) pointed out a number of mathematical problems in nuclear safety analysis which would require additional computations. However, because large reactors can lead to spatial instability in the flux, it is becoming necessary to consider spatial kinetics problems. Judging by papers presented from the United Kingdom and France it appears that this is an area of reactor computation in which the United States does not lead.

Depletion codes continue to be based on a series of steady-state diffusion codes. The new interest appears to be centered about allowing the user to specify the depletion chains of interest to him. Depletion or burn-up codes are tending to become systems or linked calculations and, for example, the KARE and NOVA systems, allow depletion calculations to be selected.

The usual competition was present between advocates of probabilistic methods (Monte Carlo) and deterministic methods. On the deterministic side, some results were shown for supposedly complex problems for the transport equation which gave good comparative results with Monte Carlo codes. The deterministic methods used only a fraction of the machine time required by the Monte Carlo codes. Two papers dealing with Monte Carlo codes, however, indicated that, by astute techniques, it was possible to reduce the computer time and still get satisfactory results. L. H. Underhill (United Kingdom) commented that a Monte Carlo program had the advantage of eliminating unnecessary human thinking and allowed the computer to do the real brute-force work. After comparing some deterministic and probabilistic results, the comment was attributed to Bengt Carlson that his faith was restored in the Monte Carlo method because it agreed so well with the deterministic methods.

This conference was very valuable to those present and will also be valuable to those who will receive the conference proceedings. Two of the "facetious" remarks made by J. J. Syrett (United Kingdom) point out the concern of man and computers. He commented, in reference to the new faster and bigger computers that are appearing, that "a sort of Parkinson's Law applies to computing in that the computing requirements always expand to fill the machine available." His second comment was that "the really important question was not the cost per operation on the computer but the cost per useful piece of output that one gets off the computer."

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Forthcoming Events

September

19–22. **Power**, natl. conf., Albany, N.Y. (Inst. of Electrical and Electronics Engineers, Box A, Lenox Hill Station, New York 10021)

19–25. World **Medical** Assoc., 19th general assembly, London, England. (H. S. Gear, 10 Columbus Circle, New York 10019)

20. **Organic Solid State**, 3rd annual symp., Franklin Inst., Philadelphia, Pa. (M. M. Labes, Franklin Inst. Research Laboratories, Philadelphia 19103)

20. **Photo-Electronic Image Devices** as Aids to Scientific Observation, symp., London, England. (G. V. McGee, Dept. of Physics, Imperial College of Science and Technology, South Kensington, London S.W.7)

20–22. **Glacier Mapping**, symp., Ottawa, Ont., Canada. (Intern. Assoc. of Scientific Hydrology, 61 rue des Ronces, Gentbrugge, Belgium)

20–24. **Biochemistry**, 8th Latin meeting, Lisbon, Portugal. (S. F. Gomes da Costa, Laboratorio de Quimica Fisiologica, Faculdade de Medicina, Hospital de Santa Maria, Lisbon)

20–24. **Burn Research**, intern. congr., Edinburgh, Scotland. (A. Sutherland, Royal Hospital for Sick Children, Sciennes Rd., Edinburgh 9)

20–24. **Fundamental Research**, 3rd intern. symp., Cambridge, England. (H. W. Emerton, Reed Paper Group Ltd., Research and Development Centre, Aylesford, Maidstone, Kent, England)

20–24. International Council of Societies of **Industrial Design**, 4th general assembly and congr., Vienna, Austria. (Mrs. D. des