The nuclear energy program initiated in the 1950's gave rise to the launching of an entirely indigenous effort in the development of reactor control electronics, an effort which also had beneficial fallout results for the other application fields of electronics. The transfer of know-how to a commercial production agency developed in this manner, set up specially to give a productive outlet to the results of such development, was carried out and useful lessons, which relate to the most favorable conditions required for such transfer on both sides, have been learned from this process. One of the conclusions is that knowledge transferred from one developing country to another is more effective in terms of applicability and results than that from a developed country to one that is developing

5. The Implantation of Reactor Physics Codes: A Case of Technology Transfer, *Roberto Y. Hukai, Willem J. Oosterkamp, Marcos A. V. Peluso (IEA/Brazil)*

A successful example of technology transfer is the reactor physics calculational capability acquired by the Instituto de Energia Atômica (IEA) in Brazil during the last four years. The Institute has an IBM 370/155 with 2 Mbytes memory and a large number of codes have been made operational. An effective transfer of calculational capability requires that the physical and numerical approximations used in the codes are understood by the national scientists and engineers operating the codes; this will only be achieved by utilizing the codes in applications to the receiving country's relevant applications. The effectiveness of foreign specialists who are generally contracted for approximately one-month periods has been greatly enhanced by the few specialists who stayed for several years.

Effective technology transfer to the IEA is demonstrated by the successful implantation of an integrated system of reactor physics codes named ANDREA (ANalise De REAtores) (see Fig. 1.) Most of the codes were obtained from the Argonne Code Center, some from Germany, and some were developed within the IEA; e.g., HAMMER was developed into a burnup code and linked to CITATION. HOTDOG is a program written by D. Ting in the IEA for heat transfer in pebble bed reactors. Program control is by means of the IBM job control language and the data transfer between links is by means of IBM data sets.

One of the principal objectives of code implantation and development has been verification of calculational methods. Because Brazil is to construct three pressurized-water reactors (PWRs), calculations of these reactors are considered to be of the greatest importance; the German Obrigheim 300-MW(e) PWR was taken as a representative example. Calculations (made with the CITHAM chain) of critical boron concentrations as a function of burnup, power distributions, and control-rod worth agree well with experimental results.

The XSDRN-ANISN chain is very flexible and has been used for a number of special problems. Its input preparation is elaborate, however, and a source of many errors. The calculation of some experiments (thermal flux distributions around neutron sources) showed discrepancies that have not yet been clarified.

The CITHAM chain is now available at all Brazilian research centers and the National Nuclear Energy Commission (CNEN). Fuel alternatives in PWRs and HTGRs, power distributions and control-rod worths for the licensing process, a number of possible arrangements in our critical facility, and several subcritical arrangements haye been studied using the ANDREA System.

6. Transfer of Radioisotope Production Technology from the Developed to the Developing Countries, *Md. Matiur Rahman (AEOI/Iran)*

Next to power production, the applications of radioisotopes occupy the second position in the utilization of nuclear energy. The major fields in which radioisotopes are being increasingly used are medicine, agriculture, industry, and scientific research. Both research reactors and various types of particle accelerators are presently used for the production of radioisotopes. Whatever may be the source of activation, the technology of irradiation, post-irradiation handling of the samples, their chemical processing, dispensing, quality control, and packaging and dispatch procedures are almost the same.

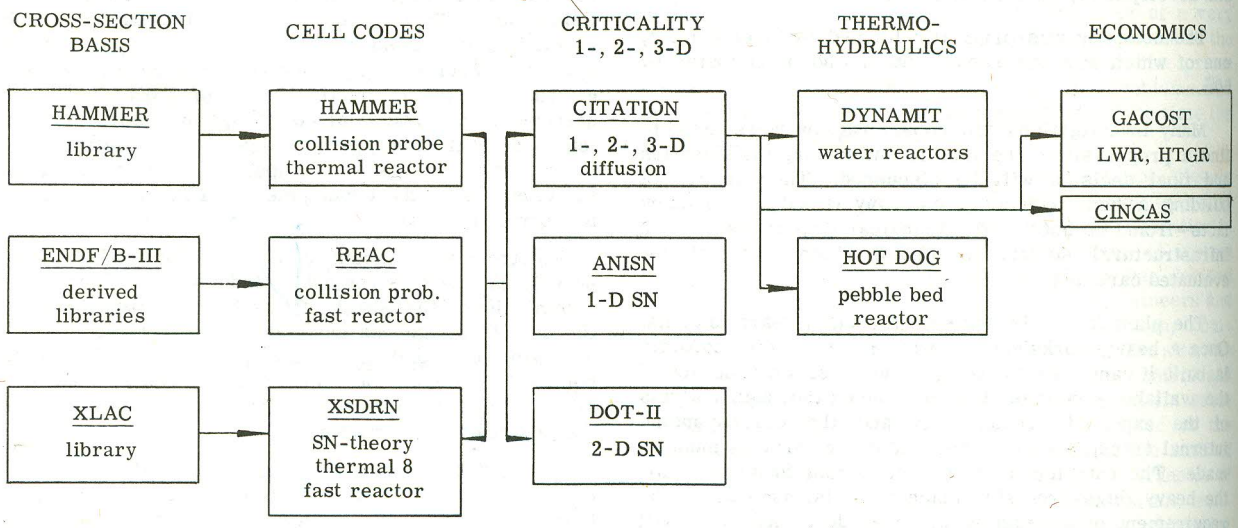

Fig. 1. The structure of ANDREA.