INTERNATIONAL FUTURES: History and Status

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The *INTERNATIONAL FUTURES* (*IFS*) global model was developed for education and theory building. There are two versions: a smaller one developed specifically for microcomputers and a larger one initially developed for mainframes but now being revised for micros. The model represents global demographic, agricultural, energy, and economic systems. Incorporation of domestic governmental processes and interstate behavior is foreseen. *Keywords:* world modeling, global modeling, international futures, simulation, modeling.

This paper provides a brief historical review and status report on the *INTERNATIONAL FUTURES* (*IFS*) model and modeling project, the development of which began in 1978–79.[1] We look in turn at project purposes, the model structure, and probable future efforts.

Purposes

The project has two central purposes. The first is to make global models available for educational use. The experience of the 1970s, while often overselling the policy analysis potential of world models, did indicate that world models have a considerable capability to educate in at least three ways:

1. They communicate much substantive information, such as economic and demographic sizes and growth patterns of states and regions, the fossil resource base, or environmental loads.
2. They incorporate and therefore can communicate the theoretical structures which economists, demographers, and other scientists apply in trying to understand and forecast. In addition to representing theory, large-scale integrating models indicate the areas in which theory is especially weak or nonexistent.

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3. They provoke debates which illustrate the clash of major world views and help make them explicit. World views are large-scale integrating perspectives which selectively draw upon theory and data.

The third point leads to the second or scientific purpose of the *IFS* project, namely, to study the ties between world views and competing theoretical structures. *IFS* was intended to represent (via parameter and limited structural changes) competing world views in two dimensions, political economy and political ecology. In political economy, the views of the world represented by such liberal models as that of Leontief clash with the more radical or structuralist views of Bariloche. In political ecology, the Malthusian views of the Meadows project clash with the no-limits-to-growth orientations of both Leontief and Bariloche. Although considerably oversimplified here, these different world views have led the various modeling groups to quite different theoretical structures and even data selection (Hughes, 1985b).

One of the goals of the *IFS* project has been to sort out these world-view/theory linkages and then to take at least limited steps towards a more synthetic model. Students or other users of *IFS* are encouraged to approach use of the model in world-view terms. In fact, the acronym for the model itself was chosen to emphasize an if-then pattern of thought, with the *if* not restricted to simple changes in policy assumptions or parameters but open to significant differences in perceptions of how the world works.

It has been shown with *IFS* that parameter changes and embedded structural switches, which allow limited structural change by users, can be used to replicate the patterns of forecasts produced by such varied models as Leontief, Meadows, and Bariloche (ibid.).

Structure

There are actually two closely related but distinct *IFS* models: one initially developed for good-sized minicomputers or larger systems (Hughes, 1982) and a second, smaller version for microcomputers (Hughes, 1985a). Because the larger version has recently been adapted to a microcomputer with an 80286 processor, we will focus on it and comment only briefly on the smaller version.

The structure of *IFS* represents a conscious attempt to combine some of the stronger features of a number of global models of the 1970s. Particularly in demographic model structure it owes much to the first- and second-generation models of the Mesarovic-Pestel world-modeling project (Mesarovic & Pestel, 1974; Hughes, 1980). The *SARUM* modeling project (SARU, 1978) had considerable influence on the structure of the *IFS* economic model. Features of the Bariloche or Latin American model (Herrera et al., 1976), especially the importance they attach to basic human-needs indicators, also influenced *IFS*, as did the Leontief model (Leontief, Carter, & Petri, 1977).

IFS presents the world in 10 regions: the U.S., Western Europe, the rest of the Western developed world, Eastern Europe, the Soviet Union, non-

OPEC Latin America, Africa, OPEC, South and Southeast Asia, and China. *IFS* has five submodels: population, economy, energy, agriculture, and trade.

The population model is cohort-component in structure, with 17 age, mortality, and fertility cohorts. Fertility and mortality patterns change in response to income, income distribution, and government programs. The economic submodel divides the economy of each region into five sectors: agriculture, materials, energy, industry, and services. The basic design is that of a general equilibrium model (Scarf & Shoven, 1984), although it is a simple version of that model type without a full Leontief closure (i.e., without production-generated income being distributed to production factors and then to households and government).

The agricultural model represents production, consumption, and pricing of crops (grain and nongrain) and livestock (fish is included as a food type). Crop, grazing, forest, and urban-industrial land types are distinguished. Agricultural outputs respond to a mix of inputs. The energy model represents production, consumption, and pricing of oil, gas, coal, nuclear, and renewable energy. It takes into account known reserves and ultimate resources of fossil fuels. The trade model represents trade in each of the five economic sectors from a pooled, gross-trade approach. Cumulative trade deficits are computed and restricted. Some historical validity testing, focusing primarily on agriculture, has been done with the model (Liverman, 1983). Model behavior was generally reasonable.

The model is initiated in 1980 and runs indefinitely in 1-year cycles, or in bigger time steps at the user's option. Normal forecast horizons are 2000 or 2025. On an 8-MHz 80286-based microcomputer without coprocessor, the larger version requires about 30 seconds per cycle.

To make use of this model reasonably straightforward for those not associated with its development, Thomas Shook developed an interactive front end which processes user commands to run the model (RUN), change parameters or initial conditions (PAR, SERIES), display results (PRINT,PLOT), and so on. Use requires knowledge of variable names and some understanding of reasonable values in the case of parameter changes, but the user's manual is helpful. This full version of the model and its interactive shell were programmed in FORTRAN.

The micro version of *IFS* is considerably scaled-down and is suitable for an IBM PC or a compatible. The two versions provide comparable behavior but not identical results. The micro version is in BASIC and will soon be available for Apples as well. It represents only eight world regions, two energy types (fossil and eternal), a single food category, and a single population (no cohorts). Further, it cycles only in 5-year time steps. One significant advantage of this version is that it is entirely menu-driven and incorporates dictionaries of variable names, essentially eliminating the need to learn command structures and greatly simplifying both input and output. A manual exists for this version but is not necessary for many users.

The parameters and initial conditions for *IFS* have default values based on 1980 data. Users need change only those in which they have

interest and are encouraged to change them one at a time in order to see the impact on model behavior. Output is either tabular or graphical, with line graphs and pie-chart options. Users can select from the total output file for display or can request a full "dump" of it.

Given the larger memories and higher speeds of the newer microcomputers, many of the constraints on model development with micros have vanished. The larger version of *IFS* has recently been translated into BASIC (MICROSOFT QUICKBASIC) and embedded in a menu-driven structure like that of the simpler version. Not yet ready for distribution, this version should give IBM XT, IBM AT, or compatible users the power of the larger model and the simplicity of the smaller.

Future Efforts

Technically, the project has now switched completely to microcomputers. It is not expected to return to larger computer systems not under the direct control of individual users. This should greatly simplify its distribution and use.

Substantively, there are several directions of development. Perhaps the major weakness of *IFS* has been its grossly inadequate representation of government and politics, which resulted in part from the generation of models on which it was based. The progress made in the last few years in modeling government and global politics, especially in the *GLOBUS* project (Bremer, 1984, 1987; Cusack & Hughes, 1986), opens new avenues for the extension of *IFS*. For instance, the representation of government budgeting in categories like health, education, and defense has been considerably extended in *GLOBUS* by Cusack (1987) beyond the extremely simple representation in *IFS*. Similarly, Smith (1987) has made considerable progress in representing interstate conflict and cooperation. In another modeling project, Caporaso and Hughes (1987) have sought a synthesis of some aspects of liberal and dependency theory with respect to political-economic development. They are trying to develop a coherent, integrated view of the state as an internal and external political-economic actor.

It is now anticipated that a second-generation *IFS* will be released near the end of the decade. It will be a microcomputer model embedded within a menu-driven structure, with roughly the following characteristics:

1. It will carry over, with some refinements, many of the demographics, agricultural, and energy submodels of the first-generation (larger) *IFS*.
2. It will replace the current economic model with a more comprehensive general equilibrium model (GEM) embedded in a dynamic social-accounting matrix (SAM) which will close the economic model more tightly and tie it to government budgeting. But GEMs normally represent only firms and households as major economic actors (government budgeting, for instance, is exogenous). The *IFS* approach will

also portray the state as an actor with important domestic, economic, and political involvement. The grafting of a role of the state (for each geographic unit) on to a more complete model of the economy should result in a domestic political economy for each of the geographic units, which again will reflect competing thought and theoretical approaches through alternative world views, namely, those of liberals/pluralists versus those of radicals/dependency theorists.

3. It will add an international political model representing interstate conflict and cooperation. As always, competing approaches will be considered and incorporated as far as possible. For instance, the model will most likely contrast two general approaches: the action-reaction, or billiard-ball, state model, which owes so much to realist thought, and the idealist, or communitarian, world view, which posits a dense and growing set of political-economic ties among states which increasingly constrain their behavior.

Conclusion

World models are now well into their second decade of development. Although a great deal has been accomplished, the horizon of potential seems as far away as it did 10 years ago. Though we are progressing, *IFS* will probably never be presented as a policy-analysis or predictive tool. Instead, the emphasis on educational use will remain, even as the emphasis on theoretical definition and synthesis is extended.

Models are described as "thinking tools" so often that the term has become a cliché. Nevertheless, *IFS* has developed one and will continue to be a thinking tool for educational use and for theory formalization.

Notes

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1. Comments and suggestions are always welcome. Those interested in using the model should contact the author or CONDUIT, University of Iowa, Oakdale Campus, Iowa City, IA 52244. CONDUIT, a nonprofit organization, is the official distributor of *IFS*. The CONDUIT price for model and manual (the smaller version) is $95 and the program is copy-protected. The development of *IFS* was begun with the financial support of the Cleveland Foundation and the National Science Foundation. Subsequent financial assistance was provided by the Exxon Education Foundation and the Kettering Family Foundation.

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