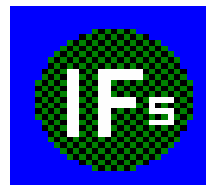


**Introduction to  
International Futures  
(IFs)**

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February, 2003



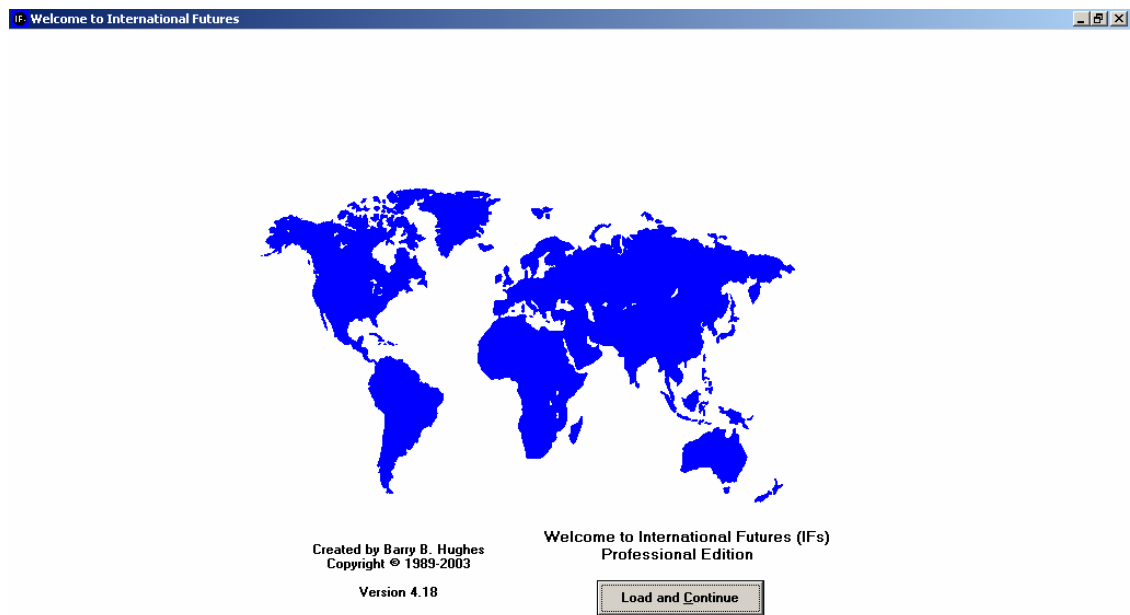
# Introduction to International Futures (IFs )

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## Abstract

This paper provides a basic introduction to the International Futures (IFs) modelling system. It touches briefly on purposes, model elements and structure, philosophy of the modelling approach, historic evolution, and the use of IFs.



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**Figure 1. Welcome to IFs.**

## 1. What is International Futures (IFs)?

International Futures (IFs) is a large-scale integrated global modelling system.<sup>1</sup> The broad purpose of the International Futures (IFs) modelling system is to serve as a thinking tool for the analysis of long-term country-specific, regional, and global futures across multiple, interacting issue areas.

IFs is heavily data-based and also deeply rooted in theory. It represents major agent-classes (households, governments, firms) interacting in a variety of global structures (demographic, economic, social, and environmental). The system draws upon standard approaches to modelling specific issue areas whenever possible, extending those as necessary and integrating them across issue areas.

The menu-drive interface of the International Futures software system allows display of results from the base case and from alternative scenarios over time horizons from 2000 up to 2100. It provides tables, standard graphical formats, and a basic Geographic Information System (GIS) or mapping capability. It also provides specialized display formats for age-cohort demographic structures and social accounting matrices.

The system facilitates scenario development via a scenario-tree that simplifies changes in framing assumptions and agent-class interventions. Scenarios can be saved for development and refinement over time. Standard framing scenarios, such as those from the third study of the Intergovernmental Panel on Climate Change (IPCC), are available.

The modelling system also provides access to an extensive database for longitudinal and cross-sectional analysis. Insofar as possible, data represent 164 countries since 1960. In addition to providing a basis for developing formulations within the model, the database facilitates comparison of data with “historic forecasts” over the 1960-2000 period.

The remainder of this document provides additional information on the modelling system. By far the most extensive documentation is, however, available in the Help system of IFs itself. That includes full documentation through causal diagrams, equations, and computer code. See <http://www.du.edu/~bhughes/ifs.html> for access to the model.

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<sup>1</sup> Recent developments to International Futures have been funded in substantial part by the TERRA project of the European Commission and by the Strategic Assessments Group of the U.S. Central Intelligence Agency. In addition, the European Union Center at the University of Michigan has provided support for enhancing the user interface and ease of use of the IFs system. None of these institutions bears any responsibility for the analysis presented here, but their support has been greatly appreciated. Thanks also to the National Science Foundation, the Cleveland Foundation, the Exxon Education Foundation, the Kettering Family Foundation, the Pacific Cultural Foundation, the United States Institute of Peace, and General Motors for funding that contributed to earlier generations of IFs. Also of great importance, IFs owes much to the large number of students, instructors, and analysts who have used the system over many years and provided much appreciated advice for enhancement (some are identified in the Help system). The project also owes great appreciation to Anwar Hossain, Mohammad Irfan, and José Solórzano for data, modelling, and programming support within the most recent model generation, as well as to earlier student participants in the project (see again the Help system).

## 2. Purposes of International Futures (IFs)

International Futures (IFs) is a tool for thinking about long-term country-specific, regional and global futures. Although it is increasingly used in policy analysis, it began as an educational tool. Even in analysis applications the primary strengths of the system are in framing investigation and analysis. Users of computer simulations should always treat the forecasts as highly contingent scenarios, not as predictions.

IFs assists with:

- Understanding the state of the world
  - Exploring trends and considering where they might be taking us
  - Learning about the dynamics of global systems
- Thinking about the future we want to see
  - Clarifying goals/priorities
  - Developing alternative scenarios (if-then statements) about the future
  - Investigating the leverage various agent-classes may have in shaping the future

A number of assumptions underlie the development of IFs. First, issues touching human development systems are growing in scope and scale as human interaction and human impact on the broader environment grow. This does not mean the issues are necessarily becoming more threatening or fundamentally insurmountable than in past eras. But it does mean that attention to the issues must have a global perspective, as well as local and regional ones.

Second, goals and priorities for human systems are becoming clearer and are more frequently and consistently enunciated. For instance, the UN Millennium Summit and the 2002 conference in Johannesburg (UNDP 2001: 21-24; UNDP 2002: 13-33) set specific goals for 2015 that include many focusing on the human condition, including:

- Reducing by  $\frac{1}{2}$  the proportion of the world's population living on less than \$1 a day (at 1993 PPP); about 1.2 billion people live at this level, with about 2.8 billion on less than \$2 per day.
- Reducing by  $\frac{1}{2}$  the proportion of the world's people without access to safe drinking water and basic sanitation (about 1.1 and 2.4 billion, respectively, in 2000).
- Achieving universal completion of primary schooling (from 84% in 1998) and achieving gender equality in access to education
- Reducing maternal mortality ratios by three-quarters (about 500,000 die each year in pregnancy and childbirth)

- Reducing under-five mortality rates by two-thirds (about 11 million die of preventable causes each year).
- Halting and beginning to reverse the spread of HIV/AIDS, malaria and other major diseases (40 million carried HIV at the end of 2000).
- Developing a global partnership for development (perhaps doubling official development assistance of about \$56 billion annually).

Such goals are increasingly guiding a sense of collective human opportunity and responsibility. Also, our ability to measure the human condition relative to these and other goals has improved enormously in recent years with advances in data and measurement.

Third, understanding of the dynamics of human systems is growing rapidly. As discussed later, IFs development has roots that go back to the 1970s. Understandings of the systems included in the IFs model are remarkably more sophisticated now than they were then.

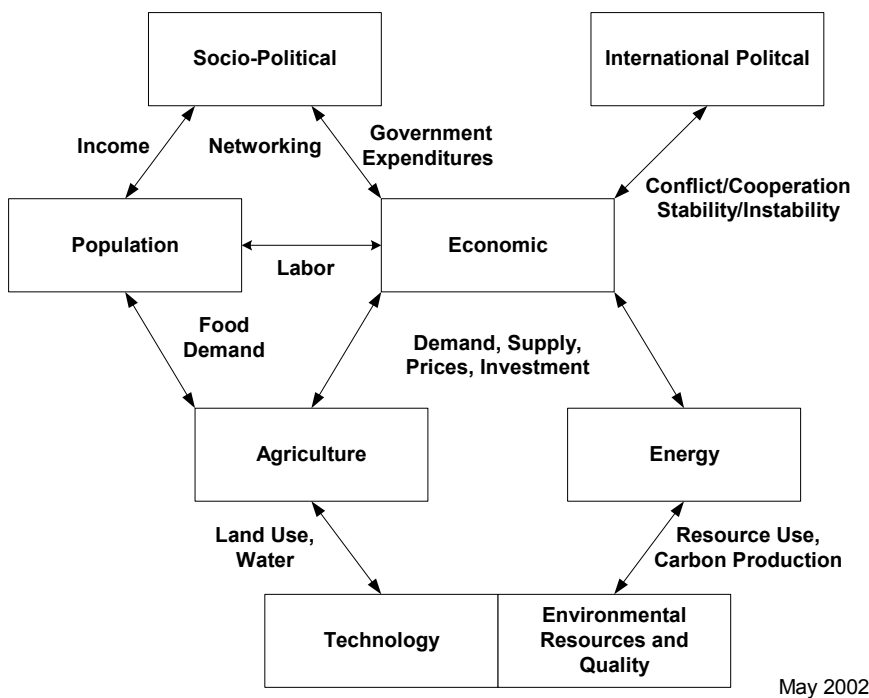
Fourth, and derivatively, the domain of human choice and action is broadening. As the scope and scale of interaction increase, goals become clearer, and understanding of underlying systems grows, the potential for useful human intervention increases. The law of unanticipated consequences has by no means been repealed, but the ability of human intervention to achieve human goals has increased. The reason for the creation of IFs is to help in thinking about such intervention and its consequences.

### 3. Elements of the Model

The IFs modelling system has evolved rapidly in the last three years and is now in its fourth generation. For introduction to the character and use of the third generation see Hughes (1999). Full documentation of the International Futures (IFs) modelling system, except for the most recent model developments, exists in the on-line help system of the system itself. The system is now in its fourth generation. The IFs system has evolved rapidly in the last three years. Only very basic summary information on the structure of the system and on its capabilities for support of analysis is provided here.

As stated previously, International Futures is a global modelling system. The extensive data base underlying it includes data for 164 countries over as much of the period since 1960 as possible. The model itself is a recursive system that can run without intervention from its initial year (currently 2000), while the model interface facilitates interventions flexibly across time, issue, and geography.

Figure 2 shows the major conceptual blocks of the International Futures system. The elements of the technology block are, in fact, scattered throughout the model. The named linkages between blocks and the linkages themselves are illustrative, not exhaustive.



**Figure 2 An Overview of International Futures (IFs)**

The population module:

- represents 22 age-sex cohorts to age 100+ in a standard cohort-component system structure
- calculates change in cohort-specific fertility of households in response to income, and income distribution
- calculates change in mortality rates in response to income, income distribution, and assumptions about technological change affecting mortality
- computes average life expectancy at birth, literacy rate, and overall measures of human development (HDI) and physical quality of life
- represents migration
- shows HIV/AIDS
- includes a newly developing submodel of formal education across primary, secondary, and tertiary levels

The economic module:

- represents the economy in six sectors: agriculture, materials, energy, industry, services, and ICT (other sectors could be configured, using raw data from the GTAP project)
- computes and uses input-output matrices that change dynamically with development level
- is a general equilibrium-seeking model that does not assume exact equilibrium will exist in any given year; rather it uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time
- contains a Cobb-Douglas production function that (following insights of Solow and Romer) endogenously represents contributions to growth in multifactor productivity from R&D, education, worker health, economic policies (“freedom”), and energy prices (the “quality” of capital)
- uses a Linear Expenditure System to represent changing consumption patterns
- utilizes a "pooled" rather than the bilateral trade approach for international trade
- has been imbedded in a social accounting matrix (SAM) envelope that ties economic production and consumption to intra-actor financial flows

The agricultural module:

- represents production, consumption and trade of crops and meat; it also carries ocean fish catch and aquaculture in less detail
- maintains land use in crop, grazing, forest, urban, and "other" categories
- represents demand for food, for livestock feed, and for industrial use of agricultural products
- is a partial equilibrium model in which food stocks buffer imbalances between production and consumption and determine price changes
- overrides the agricultural sector in the economic module unless the user chooses otherwise

The energy module:

- portrays production of six energy types: oil, gas, coal, nuclear, hydroelectric, and other renewable energy forms
- represents consumption and trade of energy in the aggregate
- represents known reserves and ultimate resources of the fossil fuels
- portrays changing capital costs of each energy type with technological change as well as with draw-downs of resources
- is a partial equilibrium model in which energy stocks buffer imbalances between production and consumption and determine price changes
- overrides the energy sector in the economic module unless the user chooses otherwise

The socio-political sub-module:

- represents fiscal policy through taxing and spending decisions
- shows six categories of government spending: military, health, education, R&D, foreign aid, and a residual category
- represents changes in social conditions of individuals (like fertility rates or literacy levels), attitudes of individuals (such as the level of materialism/postmaterialism of a society from the World Values Survey), and the social organization of people (such as the status of women)
- represents the evolution of democracy
- represents the prospects for state instability or failure

The international political sub-module:

- traces changes in power balances across states and regions
- allows exploration of changes in the level of interstate threat
- represents possible action-reaction processes and arms races with associated potential for conflict among countries

The environmental module:

- allows tracking of remaining resources of fossil fuels, of the area of forested land, of water usage, and of atmospheric carbon dioxide emissions
- provides a display interface for the user that builds upon the Advanced Sustainability Analysis system of the Finland Futures Research Centre (FFRC), Kaivo-oja, Luukkanen, and Malaska (2002)

The implicit technology module:

- is distributed throughout the overall model
- allows changes in assumptions about rates of technological advance in agriculture, energy, and the broader economy
- explicitly represents the extent of electronic networking of individuals in societies
- is tied to the governmental spending model with respect to R&D spending

There are large numbers of intervention points for the user across all of these modules. A later section outlines intervention and scenario development.

## 4. The Philosophic Approach to Modelling

Given the goals of understanding human development systems and investigating the potential for human choice within them, how do we represent such systems in a formal, computer-based model such as IFs? A general mental model helps frame the computer model. Specifically, global human systems consist of classes of agents and larger structures within which those agents interact. Over time agents and the larger structures evolve in processes of mutual influence and determination.

For instance, humans as individuals within households interact in larger demographic systems or structures. In the computer model we want to represent the behavior of households such as decisions to have children or to emigrate. And we want to represent the larger demographic structures that incorporate the decisions of millions of such households. A typical approach to representing such demographic structures is through age-sex cohort distributions, ideally with the addition of migration across countries. IFs adopts that approach.

Similarly, households, firms, and the government interact in larger economic and socio-economic systems or structures. The model can represent the behavior of households with respect to use of time for employment and leisure, the use of income for consumption and savings, and the specifics of consumption decisions across possible goods and services. It should represent the decisions of firms with respect to re-investment or distribution of earnings. Markets are key structures that integrate such activities, and IFs represents the equilibrating mechanisms of markets in goods and services.

In addition, however, there are many non-market socio-economic interactions. IFs should represent the behavior of governments with respect to search for income and targeting of transfers and expenditures, domestically and across country borders, in interaction with other agents including households, firms, and international financial institutions (IFIs). Social Accounting Matrices (SAMs) are structural forms that, in a sense, integrate representation of non-market based financial transfers among such agents with exchanges in a market system. IFs uses a SAM structure to account for inter-agent flows generally. Financial asset and debt stocks, and not just flows, are also important to maintain as part of this structural system, because they both make possible and motivate behaviour of agent-classes.

Further, governments interact with each other in larger inter-state systems that frame the pursuit of security and cooperative interaction. Potential behavioral elements include spending on the military, joining of alliances, or even the development of new institutions. One typical approach to representing such structures is via action-reaction dynamics that are sensitive to power relationships across the actors within them. IFs represents changing power structures and behavioural responses to those changes.

Still further, human actor classes interact with each other and the broader environment. In so doing, important behavior includes technological innovation and use, as well as resource extraction and emissions release. The structures of IFs within which all of these occur include a mixture of fixed constraints (for instance, non-renewable resources),

uncertain opportunities for technological change in economic processes, and systems of material flows.

In summary, International Futures (IFs) has foundations that rest in (1) classes of agents and their behavior and (2) the structures or systems through which those classes of agents interact. IFs is not agent-based in the sense of models that represent individual micro-agents following rules and generating structures through their behavior. Instead, as indicated, IFs instead represents both existing macro-agent classes and existing structures (with complex historic path dependencies), attempting to represent some elements of how behavior of those agents can change and how the structures can evolve. Philosophically, this approach rejects the premise that all model structures must be built up from micro-agent interaction. Although micro-agent modelling is laudable in more narrowly-focused models, global systems and structures are far too numerous and well-developed for such efforts to succeed across the breadth of concerns in IFs, at least given contemporary modelling capabilities.

In representing the behavior of agent classes and the structures of systems, IFs draws upon large bodies of insight in many theoretical and modelling literatures. Although IFs sometimes breaks new ground with respect to specific sub-systems, its strengths lie primarily in the integration and synthesis of bodies of earlier work.

## 5. History of the IFs Project

International Futures (IFs) has evolved since 1980 through three “generations,” with a fourth generation now well advanced.

**The first generation** had deep roots in the world models of the 1970s, including those of the Club of Rome. In particular, IFs drew on the Mesarovic-Pestel or World Integrated Model (Mesarovic and Pestel 1974). The author of IFs had contributed to that project, including the construction of the energy submodel. IFs consciously also drew on the Leontief World Model (Leontief et al. 1977), the Bariloche Foundation’s world model (Herrera et al. 1976), and Systems Analysis Research Unit Model (SARU 1977), following comparative analysis of those models by Hughes (1980). That generation was written in FORTRAN and available for use on main-frame computers through CONDUIT, an educational software distribution center at the University of Iowa. Although the primary use of that and subsequent generations was by students, IFs has always had some policy analysis capability that has appealed to specialists. For example, the U.S. Foreign Service Institute used the first generation of IFs in a mid-career training program.

**The second generation** of International Futures moved to early microcomputers in 1985, using the DOS platform. It was a very simplified version of the original IFs without regional or country differentiation.

**The third generation**, first available in 1993, became a full-scale microcomputer model. The third generation improved earlier representations of demographic, energy, and food systems, and added new environmental and socio-political content. It built upon the collaboration of the author with the GLOBUS project and adopted the economic submodel of GLOBUS (developed by the author). GLOBUS had been created with the inspiration of Karl Deutsch and the leadership of Stuart Bremer (1987) at the Wissenschaftszentrum in Berlin.

The third generation has produced three editions or major releases of IFs, each accompanied by a book also called *International Futures* (Hughes 1993, 1996, 1999). The second edition moved to a Visual Basic platform that allowed a much improved menu-driven interface, running under Windows. The third edition incorporated an early global mapping capability and an initial ability to do cross-sectional and longitudinal data analysis.

**The fourth generation** has been taking shape since early 2000. It has been heavily influenced by increasing interest in the model as a policy analysis tool by several important organizations. First, General Motors commissioned a specialized version of IFs named CoVaTrA (Consumer Values Trends Analysis) with updated and extended demographic modelling and representation of value change. An alliance was established with the World Values Survey, directed by Ronald Inglehart (1997), to create that version. Second, the Strategic Assessments Group (SAG) of the Central Intelligence Agency has supported a specialized version named IFs for SAG. The work involved in preparing IFs for SAG greatly extended and enhanced the socio-political representations

of the model, both domestic and international. Third, the European Commission sponsored a project named TERRA which has led to a specialized version named IFs for TERRA. Work on IFs for TERRA led to enhancements across the model, including improved representation of economic sectors, updated IO matrices and a Social Accounting Matrix (Duchin 1998), GINI and Lorenz curves, and formulations for extended environmental impact representation that draw upon the Advanced Sustainability Analysis framework of the Finland Futures Research Center (Kaivo-oja, Luukkanen, and Malaska 2002).

Throughout this emergence of a fourth generation IFs (incorporating all of the above elements) there has been also a heavy emphasis on enhanced usability. Ideas from Robert Pestel in the TERRA project led to the creation of a new tree-structure for scenario creation and management. Ideas from Ronald Inglehart, as well as his assistance in arranging funding from the European Union Center of the University of Michigan, led to the development of the Guided Use structure and the programming of a more game-like character within that structure.

## **6. The Use of IFs**

One important goal of the IFs project is that the model be easy to use. The size and scope of the model complicate accomplishing this goal. Nonetheless, basic use of the model has three simple components. The first is display of results, because most users begin with considerable exploration of the model's base case before turning to scenarios. The second is scenario analysis, normally involving simple interventions at first, and then more extensive ones. The third step is more detailed investigation of the model itself, with an eye perhaps to changes or extensions. Such investigation often builds on data analysis. This section comments in turn on display, scenario analysis, and data analysis.

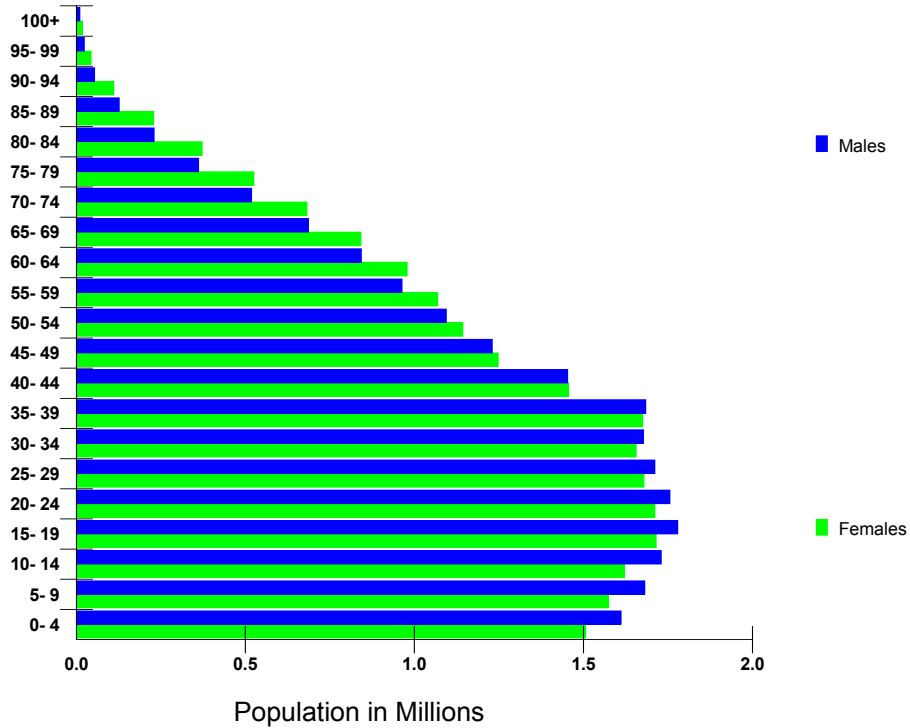
### **6.1 Display**

The display capabilities of the IFs platform contain most standard formats such as tables, line graphs, bar charts, and pie diagrams. IFs also contains a Geographic Information System (GIS) capability that allows mapping of all variables from the base case or other scenarios. The third generation of the IFs system offered the user the ability to choose any variables or parameters in the model and to display those over time in any combination and with any output format. In addition, computational capabilities exist to combine and/or transform existing variables into ones newly defined by the user.

The wealth of variables and parameters in the model make it difficult, however, for beginning users to identify important focal points. Therefore the fourth generation has added two additional display capabilities. The first is a Report capability. The Report feature shows the user a basic sub-set of variables for any country or region in the model (or grouping of countries/regions) in any forecast year. A simple double-click on a cell brings up a table of the selected variable over time and across scenarios. The user can customize the sub-set of variables displayed in the Report.

Second, the fourth generation has added specialized display capabilities. One specialized display shows population variables using the typical age-sex format (see Figure 3). Another shows cohort-based variables from the World Values Survey. Still another shows a social accounting matrix (see Figure 4) with collapsed categories that can be expanded across sub-categories or over time by double-clicking on cells. And another shows indicators from the environmental sustainability system of the Finland Futures Research Centre. In essence, such specialized displays help organize images of and learning about the structural systems discussed earlier.

**Population Distribution for Argentina in Year 2015  
[Base Case]**



**Figure 3. Age-Sex Cohort Distribution for Argentina in 2015 (Base Case)**

**IF Social Accounting Matrix**

Exit Use Country/Regions Percent Change From Base Case Show Stocks About SAM

Groups: European Union Select Year: 2015

Select File: 0 - Working File, based on IFSBASE.RUN

Categories	Sectors	Household	Firms	Capital	Government	ROW	Total	Environment
Sectors	11176.08	7120.788	0	3067.932	2620.635	4760.229	28745.66	0
Household	7800.275	0	3785.048	0	2589.432	0	14174.76	0
Firms	5520.24	0	0	0	0	0	5520.24	0
Capital	0	4942.873	-1668.404	0	-194.9336	-23.6511	3055.884	0
Government	0	2111.096	2942.085	0	0	0	5053.181	0
ROW	4710.579	0	0	0	38.0472	0	4748.626	0
Total	29207.17	14174.76	5058.729	3067.932	5053.181	4736.578	61298.35	0
Environment	0	0	0	0	0	0	0	0

Currency Units in the SAM are Billion \$ except Environmental cells.  
Double click on any numerical value for options.

**Figure 4. Collapsed Social Accounting Matrix (SAM) from IFs**

Another useful feature in the display sub-system of IFs is the ability to click on names of variables selected for display and to call up diagrams of causal linkages, the equations around the variables, and even the computer code of the program for the selected variable. These features add to the transparency of the model.

## 6.2 Scenario Analysis

International Futures (IFs) has been evolving in support of investigation into integrated global demographic, economic, social, and environmental transitions. Integrated modelling offers a number of advantages that supplement individual issue analyses:

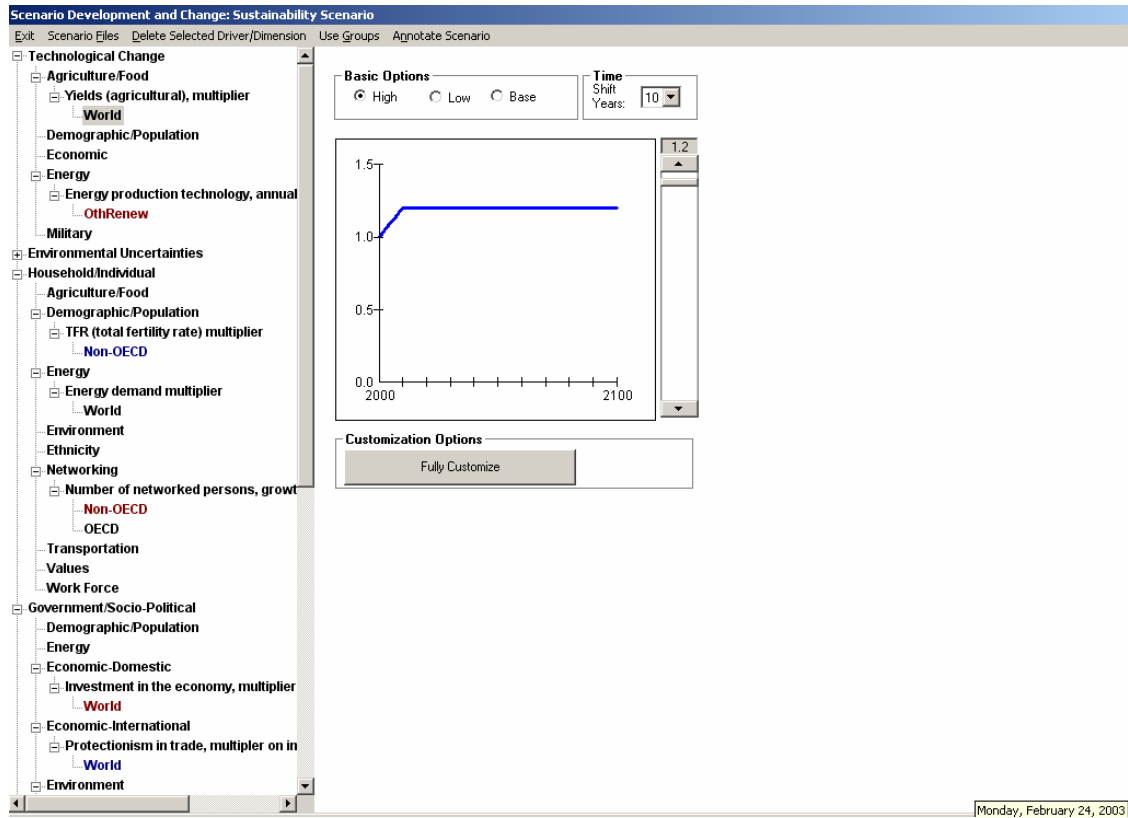
1. The ability to compare the impact that alternative policy levers produce relative to a range of goals within a consistent framework. No modelling system will ever provide a comprehensive representation of all complex underlying systems, but over time such an integrated system can evolve to capture what analysts identify as the dominant relationships and the dominant dynamics within them. Both relationships and dynamics are essential.
2. The potential to explore secondary and tertiary impacts of policy interventions or of attaining policy targets. For instance, we know that rebound effects are persistent in many systems that have a general equilibrating character; without the representation of such equilibration, such rebound effects are difficult, if not impossible, to analyze.
3. The option of exploring interaction effects among the policy interventions themselves. While we want to consider interventions individually, in order to isolate the leverage they provide us, we also need to investigate them in combinations that might, on one hand, represent politically feasible policy packages or, on the other hand, maximize our ability to reach goals.

To take advantage of this analysis potential, it must be relatively easy to build and refine a scenario. Tied closely to the model structure, the IFs interface facilitates the iterative development of scenarios through use of a scenario tree structure as shown in Figure 5.<sup>2</sup> That tree structure distinguishes among key framing assumptions, policy interventions, and relationship parameters. The modelling system carries standard framing scenarios such as the four major scenario families of the Intergovernmental Panel on Climate

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<sup>2</sup> Robert Pestel identified the need for a “policy cockpit” to facilitate interaction with IFs. The scenario-tree interface is a significant step towards creating such a cockpit. Ronald Inglehart also urged the development of a more game-like interface for the IFs system; moreover, he facilitated support for graduate assistance in development of such a system from the European Union Center at the University of Michigan (appreciation to the Associate Director, Daniela Gobetti, and to graduate student Ramandeep Arora). For many years, one of the most active users of IFs in the classroom has been Richard Chadwick at the University of Hawaii; he is now developing a version of IFs in which Hawaii is broken out from the rest of the United States. He also imbedded use of the model in Thomas Saaty’s (1996) framework of hierarchical decision-making, and he advocated the more conscious inclusion of such an approach in the model’s interface. The Guided Use scenario interface is a step in that direction.

Change (IPCC).<sup>3</sup> This system is being used, for example, in development of a global sustainability scenario (see the next section of the paper). The three component parts of the total sustainability scenario (policy levers around human capital, growth/equity and environmental quality, respectively) are saved in scenario input files that can be retrieved into the tree structure of Figure 5 for examination and alteration.



**Figure 5 Policy Cockpit/Scenario Management System**

<sup>3</sup> The IFs project will ultimately set up scenario input files corresponding generally to the scenarios of the Global Scenario Group (Kemp-Benedict, Heaps, and Raskin: 2002; see also Hammond 1998): Market Forces, Policy Reform, Fortress World, and the Great Transition Scenario. In addition, the IFs project will develop other scenario input files for scenarios such as those of the Hart-Rudman Commission (Rudman and Hart 1999): Democratic Peace; Protectionism and Nationalism; Globalization Triumphant; and Division and Mayhem. IFs already has first-cut input scenario files for four scenarios of the DI's Strategic Assessment Group (2001).

### **6.3 Data Analysis**

In addition to display and scenario capabilities, the graphical user interface or GUI of IFs is the port of entry into data analysis capabilities. The database of IFs draws widely from standard sources, including the United Nations (basic population data, as well as data on migration and HIV/AIDS), the World Bank (considerable economic and social data), the IMF (international financial data), the Organization for Economic Cooperation and Development (social expenditures), the Global Trade and Analysis Project (input-output matrices and income returns to skilled and unskilled households). In addition, a large number of specialized sources were used in preparation of the database and are credited in the data dictionary.

IFs includes a variety of tools for analyzing these extensive data, all of which share a constant format within IFs. These include again a GIS mapping capability for simple univariate display. The tools include cross-sectional (bi-variate and multi-variate) and longitudinal statistical analysis, with graphical display as well as statistics computation. The tool kit also includes the ability to produce historic validation runs of the model over the 1960-2000 period with the capability of comparing model results with empirical series from the data base.

A key problem in all large-scale global modelling is initialization of variables and parameters. Updating the base year of large-scale models often involves several person-years of effort. Basic problems include missing data, incompatible data from different data sources, and simple unit conversion. To simplify initialization and to allow flexible re-regionalization of the model, IFs has relied for some time on a pre-processor that uses a staged sequence of data processing steps to create a new initialization through data consistency checking and hole filling. The pre-processor, in turn, draws upon the modelling platform's statistical analysis capability for estimating missing values.

### **6.4 Extended Capabilities**

A number of other capabilities exist via the graphical user interface (GUI). These include the ability to change the regionalization of IFs. Most users do not want more than 60-70 countries and/or aggregated regions in their display of the world. Capabilities exist for users to individualize selected sets. Similarly, extended capabilities allow the addition of new countries to the database (most recently Eritrea and Palestine).

## 7. Analysis With IFs

Earlier analyses, using the third generation of the modelling system, can be found in Hughes (1997 and 2001). As the fourth generation of IFs takes form and moves towards packaging for wider distribution (near the end of 2003), analyses with the model in its current state are beginning to emerge. These analyses are currently working documents that will evolve considerably as they move towards publication and distribution.

For instance, within the TERRA project, there is a working document called “Integrated Sustainability Analysis: Using the International Futures (IFs) Modelling System.” This paper describes work done within the TERRA project with integrated modelling towards better understanding the potential for a global transition to sustainability in the 21<sup>st</sup> century. It first reviews human progress in defining goals for such a transition and in measuring conditions relative to those goals. It then summarizes the growing understanding of global dynamics that makes it possible to understand the trajectory of human development relative to the goals and to investigate the potential for human leverage in reaching them. The paper moves next to a brief discussion of the tools that the research initiative uses for analysis of those dynamics and human leverage. A series of chapters follow that investigate trajectories and leverage in three areas of great importance for the sustainability transition: human capital, equity and growth (with broader social impact), and environmental sustainability. Finally, the paper reassembles the discussion of leverage into an integrated investigation of global sustainability scenarios.

A second working document is “Threats and Opportunities: International Futures for the Strategic Assessments Group.” This living document explores threats and opportunities facing the United States and the broader world over the next two decades, focusing on domestic instability (state failure) and interstate conflict. The paper also gives considerable attention to underlying change in global and regional power balances and to the prospects for democratization around the world.

A third working document is “Analysis of Long-Term Global Social Change: Using Universal Social Accounting Matrices (SAMs) in the International Futures (IFs) Modelling System” (co-authored with Anwar Hossain). This paper is in early draft. The intention of it is to examine issues such as the “pension crisis” in more economically-developed countries and the potential for emergence of social safety nets or social protection systems in less economically-developed countries. As the title suggests, it will use the emerging SAM structures of IFs, representing the dynamic interaction of classes of social agents, to investigate these issues. For the broader study surrounding this paper, the IFs project is forming an alliance with analysts at the RAND Frederick S. Pardee Center for Longer Range Global Policy and the Future Human Condition. The intention is to link IFs with the Computer-Assisted Reasoning System (CARS) of the Pardee Center so as to explore the effects of a wide range of social options over a selection of global scenarios.

No one is more familiar with the weaknesses of any model than its developer. IFs has many remaining weaknesses. It is important to return in conclusion to the statement of purpose for the project. International Futures (IFs) is a tool for thinking about long-term global futures. The results of models should never be considered “predictions” and accepted uncritically. A model can, however, be a wonderful instrument for exploration of possible futures and for organizing thoughtful investigation of human leverage with respect to them. This is what IFs seeks to be.

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