

WORLD3 AND STRATEGEM: HISTORY, GOALS, ASSUMPTIONS, IMPLICATIONS

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Summary

In 1972 a team at MIT developed a global model, World3, which shows the long-term causes and consequences of growth in material aspects of human society. The model suggested that the limits to global growth would soon be reached and that collapse would be the result unless there were rapid efforts to stabilize population and material consumption. These results were reflected in three books and one computer-assisted game, STRATEGEM, created by members of an MIT team. The widespread attention accorded these controversial results stimulated more than a dozen other global modeling efforts.

A revision of the 1972 results twenty years later and reflections on thousands of sessions with the game now lead the author to conclude that sustainable development is no longer possible; it is a myth. The global society inevitably faces a period of decline in the mid decades of the twenty-first century. It is time now to face this fact

realistically and begin addressing a series of questions associated with survivable development.

1. Introduction

World3 is a computer simulation model that portrays the long-term causes and consequences of global growth in the material aspects of global society. The model has five main sectors, representing the interrelation of changes in the level of: population, nonrenewable natural resources, agricultural production, production of goods and services, and the generation of persistent pollutants. The time horizon of the model is 200 years—typically World3 is run with data and relationships representing the period 1900—2100.

The model was created at MIT during the period 1970–72 using the modeling method system dynamics that had been developed by Jay Forrester and his colleagues at MIT. Originally the model was coded in the computer language DYNAMO. The World3 project lasted two years and involved a team of 17 technical and administrative staff members from six countries. Dennis Meadows directed the work; it was financed by the Volkswagen Foundation in Germany at the instigation of an international group of statesmen, The Club of Rome.

The first report, *The Limits to Growth (LTG)*, unexpectedly became a worldwide phenomenon, quickly selling more than three million copies in at least 23 languages. The storm of debate about the findings reported in the book stimulated political and scientific interest in global modeling and quickly led to creation of more than a dozen groups around the world all developing their own global models for use in confirming, criticizing, or extending the results reported in *LTG*.

In 1992, on the twentieth anniversary of the original publication, three of the original co-authors examined data on the main global trends for the period 1972–1992. They compared those numbers with projections that been produced by World3 in 1972. There were very minor differences. Eight relatively small changes were made in all the hundreds of equations and coefficients of the original 1972 model—too insignificant a difference to justify changing the name of the model.

This updated version of World3 was used to carry out analyses and produce scenarios for a new text, *Beyond the Limits*, which reaffirmed the original *LTG* conclusions from the perspectives of the early 1990s. This book had much more limited impact—an indication of how common had become by then the perception of global problems. But it was translated into nearly 15 languages and still attained best-seller status in countries as diverse as Austria and Japan.

Many people were fascinated by the 1972 book, but they had neither the technical expertise nor the computer equipment required to analyze the model for themselves. In casting about for a medium that would give a wide spectrum of the public a hands-on relation with the model, Dennis Meadows developed a new model. Similar to World3 in its goals and philosophy, though drastically different in mechanics, STRATEGEM is an educational game that involves a board, physical pieces, and role descriptions for the

players. It is based on a model that incorporates assumptions about the factors and relationships that influence demographic and economic growth in a region or country over 50 years—just long enough to encompass a rapid demographic transition.

The STRATEGEM model is much simpler than World3, but it is derived in many important ways from that predecessor. It also has five sectors, representing interconnections among: population, energy production and use, agricultural production and environmental protection, production of goods and services, and international trade and foreign debt. Players interact with the model through ten cycles of decisionmaking; each cycle represents five years in the development of the region in their game.

STRATEGEM was created at the International Institute for Applied Systems Analysis during the period 1983–1984. It was originally coded in a simple version of the computer language BASIC. Dennis Meadows directed the effort, developing the game for use by the United States Agency for International Development. A four-person team carried out the work in collaboration with a steering committee comprised of senior personnel from the United Nations Industrial Development Organization, which is based in Vienna.

The game requires about four hours to play. It was originally intended for use by US government officials, but it has come to enjoy a wide and diverse audience.

Both World3 and STRATEGEM deal in a unique way with issues that are of even more concern today than they were in 1972. The technical results of the two models are reported in great detail in publications that are widely available. So the technical results will not be the focus of this text. Instead it is important for the reader to understand the cultural context out of which the models emerged and to appreciate the empirical content that went into them. After a brief discussion of alternative possible model functions, this text will describe the history, goals, and assumptions of the two models. The last section will build on 25 years experience with the two models to speculate about future trends. The information has present relevance, since both models are still being used widely for teaching and research.

Both have been kept up to date through reprogramming, so that they can be executed on present-day PC operating systems. They are easily and inexpensively available for purchase <<http://www.unh.edu/ipssr/index.html>>. They are used today in many nations, especially for university teaching and research. The insights they convey remain of crucial relevance to efforts everywhere on behalf of sustainable, equitable improvements in the quality of life.

2. Possible Functions of Global Models

A model is a tool. One does not ask whether a tool is true; our concern is whether or not it is useful for a specific purpose. Consequently, it is important to begin any discussion of a specific model with an explicit description of the purposes for which it was intended. Generally there is at least a pretense that any global modeling effort is undertaken out of an objective, scientific concern for important problems.

However, many unscientific motivations have also led to modeling efforts. For example, global models have been created to justify a preexisting point of view, decision, or policy recommendation. Some have been undertaken merely as a public relations strategy to enhance the reputation or credibility of their authors or sponsors.

Even where the model is created through objective, scientific efforts, many goals are possible. A dynamic model may be developed to provide at least five different types of information.

1. Absolute, precise predictions. (On which date and at what time will the next 100 percent eclipse of the sun be visible from New York City?)
2. Conditional, precise predictions. (If the reactor's emergency core cooling system fails, what will be the precise maximum pressure that must be accommodated within the containment vessel?)
3. Conditional, imprecise projections of dynamic behavior modes. (If corn prices were fully stabilized, would the fluctuations in pork prices become larger or smaller?)
4. A conceptual framework useful for summarizing and communicating a set of important interrelationships. (What terms and relationships should be used to anticipate the impact on employment in the town that might be observed from a reduction in property tax rates?)
5. A purely philosophical exploration of the logical consequences of a set of assumptions without any necessary regard for the real-world accuracy or usefulness of the assumptions. (If the force of gravity were reduced by half on the earth's surface, what would be the influence on car fuel efficiency?)

World3 and the other serious global models developed in the period 1970–1980 were designed to provide information of the third sort.

The goal of providing conditional and imprecise projections, rather than precise predictions, was mandated for three reasons. First, social systems are, by their nature, unpredictable in the absolute sense. Since any prediction made about the future of a social system becomes an influence on social policy, the prediction itself may change the system's behavior.

This phenomenon is known as self-fulfilling or self-defeating prophecy. Second, the incomplete understanding of cause and effect relationships in social, political, and other systems combined with incomplete and inaccurate data make accurate models impossible.

Third, models are only useful if they are simplifications of reality. (For example, a full-sized map of the journey from New York to Los Angeles would obviously be of little use to a driver planning the trip.) But as soon as the model omits details of the real system, it can give only incomplete portraits of behavior.

However, conditional, imprecise projections of dynamic behavior modes can be helpful to policymakers, for those who are genuinely concerned about important, long-term problems and eager to find ways their effects can be ameliorated.

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Biographical Sketch

Dennis Meadows is a systems analyst, trainer, consultant, and author. Since 1970 he has directed research and teaching centers within American universities: MIT (1970–1972), Dartmouth College (1972–1988), and the University of New Hampshire (1988–present). He has been a lecturer and consultant in more than 40 countries. He has authored or co-authored eight books, which have been translated into more than 35 languages. One was awarded the German Peace Prize. His educational games are used in schools and corporate training programs around the world; they have earned him three honorary doctorates from European universities for his contributions to education.

For many years he was US Director of the US-USSR Environmental Education Exchange Program. He was a Fulbright Fellow in the USSR in 1989.

His present focus is on the development of ostensibly simple games that convey profound insights about team work, systems behavior, and sustainable development. He is Senior Academic Advisor to LEAD/International, a Rockefeller Foundation program to create a new generation of leaders for sustainable development policy in 12 of the world's great nations.