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REPORT ON THE 1983 INTERNATIONAL SYSTEM DYNAMICS CONFERENCE
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By

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The 1983 International System Dynamics conference was held from Wednesday, July 27, to Saturday, July 30, at the beautiful and secluded campus of Pine Manor College in Chestnut Hill, Massachusetts, U.S.A. The conference attracted some two hundred participants, including all the leading practitioners from North America, Europe, and Scandinavia. The program included evening addresses by three distinguished speakers, plenary sessions focusing on key issues and developments in the field and parallel sessions reporting applications (private- and public-sector), modeling support methods, and new ideas in theory, philosophy and model analysis. The conference also marked the establishment of a system dynamics professional society and the first award of the Jay Wright Forrester Prize.

Evening Speakers. The evening addresses were given in the spacious Ellsworth Hall auditorium. Jay Forrester, Germeshausen Professor of Management and founder and director of the System Dynamics Group, M.I.T., delivered the opening address entitled "Future Development of the System

Dynamics Paradigm." He emphasized the need for consolidating and deepening the field rather than simply enlarging it. He called for continued efforts to develop exemplary teaching materials, to improve communication in the field, and to focus model development on the search for generic structure and theory. The second address, "Should One Believe System Dynamics Models?" was delivered on July 28 by John Kemeny, professor of mathematics at Dartmouth College and former president of Dartmouth College. Professor Kemeny advocated a more thorough analysis of model structure as a means of gaining insight into social system behavior. Using Forrester's Market Growth Model as an example, he outlined a fascinating blend of equilibrium analysis, simulation analysis, and eigenvalue analysis to synthesize understanding. Richard H. Day, professor of economics at the University of Southern California, delivered the final address, on July 29, entitled "System Dynamics and Behavioral Economics." He argued that system dynamics and behavioral economics share a common view that equilibrium does not satisfactorily describe the nature of economic activity and business enterprise. He emphasized the need to focus on concepts and methods that will allow system dynamicists to understand and model disequilibrium phenomena, particularly properties of human decisionmaking, planning, and action that generate and sustain disequilibrium. He also proposed that system dynamicists should widen their view of disequilibrium to encompass evolutionary entrepreneurial change--a concept quite new to traditional system dynamics, though related to European developments in self-organization from the so-called Brussels school.

Plenary Sessions. The four plenary sessions focused on the topics of "Enlarging the Paradigm" and "User Confidence and Model Validation." The format for these sessions was a brief presentation by the author of one or two key ideas in the paper (papers had been distributed in advance of the conference), then a structured discussion involving the audience, led by the session chairperson. This format worked well. Presentations were usually completed in thirty minutes, leaving about forty-five minutes for debate and discussion.

The plenary papers struck a healthy balance of the need to appreciate and refine the existing paradigm whilst recognizing and adopting new concepts. In the first session, chaired by Barry Richmond of Dartmouth College, papers were presented that explored the roots of system dynamics and its unique strengths. George Richardson of M.I.T. reviewed the evolution of the feedback concept in social science, arguing that the unique contribution of system dynamics is its heavy emphasis on closed-loop structure and internally generated behavior, a heritage we should stress as the field develops and matures. Eric Wolstenholme of Bradford University examined system dynamics in the context of other methods of system inquiry. He pointed to its unique power as a rigorous method for problem identification and system description. He suggested that the "front-end" qualitative aspects of system dynamics should be stressed more heavily, and proposed stepwise procedures for model conceptualization to enhance systemic understanding. John Morecroft of M.I.T. examined the "soft-rationality" that lies behind the formulation of decision functions

and the structure of system dynamics models. He argued that the field should strive for greater understanding of the organizational processes that create soft rationality, drawing on ideas from organization theory and the Carnegie school. He also proposed simulation testing methods designed to expose the intended rationality of policies in systems that exhibit dysfunctional behavior.

In the second session, chaired by Jean Lebel of C.L.E.S., France, papers were presented that explored new analytical concepts and methods. Eric Mosekilde of the Technical University of Denmark talked about self-organization in social systems, a concept that has evolved in the European school of system dynamics but has not, until recently, received much attention in North America. He argued that system dynamicists have traditionally treated social systems as more stable than in reality they are. Random processes are important for the evolution of social systems, and greater emphasis should be placed on modeling structures whose dynamic behavior is unstable with respect to random disturbances. Richard Day of the University of Southern California talked about his work on chaotic behavior. He advocated that system dynamicists cautiously but deliberately adopt concepts from the mathematical analysis of chaos as a means of understanding structural stability in complex systems. He introduced and illustrated the strange attractor as a concept for explaining patterns in chaotic behavior. Nathan Forrester of the University of Nebraska talked about his work on eigenvalue analysis of dominant feedback loops. He pointed out the weaknesses of traditional loop isolation and parameter

variation methods of identifying feedback loops that dominate a system's behavior. He presented an alternative approach applicable to linear and nearly linear models that computes the sensitivity of eigenvalues to changes in the gain of each feedback loop. The technique provides a compact, automatic, and reproducible method of finding dominant loops.

In the third session, chaired by Dana Meadows of Dartmouth College, papers were presented that addressed the topic of model validation and user confidence. John Sterman of M.I.T. introduced the Theil inequality statistics for evaluating the historical fit of system dynamics models. He argued that the field should adopt such statistics to improve the professional appearance of its research. Moreover, the use of summary statistics should help overcome the rather sterile position adopted by traditionalists that historical fit is somehow an irrelevant and misleading test to apply to simulation models rich in feedback structure. Andrew Ford of Los Alamos National Laboratory and Jeffrey Amlin of Control Data Corporation presented a comprehensive approach to model-sensitivity testing based on the Latin hypercube sampling procedure. They argued that sensitivity testing is particularly important in system dynamics due to the subjective nature of a model's parameters. Sensitivity testing can also provide support for the often quoted assertion that a model's behavior is insensitive to wide variation in many of its parameters. They provided an illustration of their methods using an electric utility model subject to rate of return regulation. Henry Weil of Pugh-Roberts Associates made the final presentation in the validation session. He addressed the topic of

model adequacy, arguing that adequacy is situation dependent and cannot be meaningfully defined in absolute terms such as model fit or accuracy of model predictions. To illustrate his argument, he presented two very different models of the same life insurance division of a large diversified financial services company, showing that both were adequate in the sense of generating policy insight, being persuasive and credible and identifying implementable policy change.

The fourth and final plenary session was chaired by Edward Roberts of M.I.T. and returned to the issue of enlarging the paradigm. Barry Richmond of Dartmouth College made the first presentation, strongly advocating that the field devote its resources to developing substantive skill in solving organizational problems. Rather than reach out for more sophisticated concepts and tools of analysis, he argued that the field should evolve by absorbing concepts from organization theory and behavioral science. We should redirect our teaching, downplaying, at the graduate level, courses that emphasize transferability of structure across disciplines and developing courses that address enterprise engineering. Hermann Krallmann of the Technische Universität Berlin talked about the historical evolution of the field over the past decade. He argued that traditional system dynamics modeling should be complemented and enhanced by interfacing models with optimization algorithms based on the so-called razor search method. He presented an application of the approach to the optimal control of a chemical process plant. In a similar vein, he argued for interfacing system dynamics models with input/output models and with data-base systems.

The final presentation was made by Robert Appiah of the University of Zambia (based on a paper coauthored by Geoffrey Coyle of Bradford University). He suggested that system dynamicists should look to the field of optimal control theory for new methods such as linear model-following control to aid the policy design process. He illustrated his argument with a two-stage production model.

Parallel Sessions. The parallel sessions contained presentations of about eighty papers on applications, methodology, education, graphics, and software. Four sections were scheduled in parallel, with three or four papers in each section. This format required a focused and compact presentation that some authors found constraining. However, it was an effective way (possibly the only way) to provide brief exposure to the many ideas and projects going on in the field.

There is no way in this review to do full justice to the content of the parallel sessions, so I will point to some highlights, allowing the proceedings to speak for themselves. There were four sections on private-sector applications, covering topics from coal mining to software project management. Several papers were presented by participants from business organizations--a trend that should be encouraged in the future. There was an interesting section on modeling support methods. Ian McIvor of British Telecom explained the influential role that sophisticated color graphics have had in increasing executive acceptance of model-based strategic planning at British Telecom. David Kreutzer and Janet Gould of

M.I.T. talked about computer graphics for aiding the diagramming of complex models. There was also discussion and demonstration of new software for modeling on microcomputers--a potentially exciting and important area for the future of the field, which could revolutionize system dynamics teaching and usher in the age of model-assisted policy and strategy design.

There were six sections on public-sector applications covering topics in economic modeling, resource and energy policy, and developing economies. There were four sections on philosophy and paradigm, including a presentation by Roger Hall of the University of Manitoba on the logic of management policymaking. This work establishes strong links to organization theory and has drawn favorable attention to system dynamics from behavioral scientists and organization theorists. Geoffrey Coyle of Bradford University and the S.H.A.P.E. Technical Center put together an interesting session on defense and military modeling, a new and growing area of application. Overall, the quality of papers in the parallel sessions was very high, setting a standard that the field should strive for in the future.

The conference marked several important steps in the professionalization of the field. The first award of the newly established Jay Wright Forrester Prize in System Dynamics was given to Nancy Roberts, David F. Andersen, Ralph M. Deal, Michael S. Garet, and William A. Shaffer for their jointly authored text Introduction to Computer Simulation: A System Dynamics Modeling Approach. The book, published by Addison-Wesley, makes

system dynamics accessible to a broad high school and undergraduate audience and sets an important new educational direction by designing curriculum materials around the use of microcomputers.

A system dynamics society was established with a constitution and slate of officers approved by the conference participants. Professor Jay Forrester of M.I.T. (U.S.A.) was nominated president of the society for its first year of operation. David F. Andersen of SUNY Albany (U.S.A.), Jørgen Randers of the Norwegian School of Management (Norway), Jean Lebel of C.L.E.S. (France), Alexander Pugh of Pugh-Roberts (U.S.A.), and John Morecroft of M.I.T. (U.S.A.) were nominated as officers.

Two special events were planned. On the opening afternoon, July 27, there was a presentation of the ongoing work on the National Economic Modeling Project by members of the M.I.T. System Dynamics Group. The session outlined the history of the project and described research on the economic long wave and inflation. On the evening of July 29 there was a cocktail party in the magnificent Founders Hall of Pine Manor College, sponsored by Pugh-Roberts Associates of Cambridge, Massachusetts in celebration of their twentieth year in business as a system dynamics consulting firm.

During the conference, special interest groups met to discuss publications, future conferences, and private-sector modeling efforts. Michael Karsky of Elf-Aquitaine, France gathered a group of participants

from private business organizations with the intention of coordinating their efforts and increasing the visibility of their work in the private sector. Eric Wolstenholme of Bradford University convened a meeting of the DYNAMICA editorial board to review progress and plans. It was agreed that during the year there should be discussions between the newly formed society and the editorial board to explore the establishment of an official journal of the society. Finally, plans were solidified for the 1984 International System Dynamics Conference, to be held August 1-5 near Oslo, Norway under the chairmanship of Jørgen Randers. Tentative plans were laid for the 1985 International System Dynamics Conference to be held in the western U.S.A., possibly Denver, in the summer of 1985, under the chairmanship of Nathan Forrester of the University of Nebraska, Lincoln.

The conference was an intense, enjoyable and rewarding experience. Great strides were made in the development of the field that should be reflected in coming years in improved communication, emerging professional identity, and a shared sense of purpose and direction.