PREFACE (to Structuring Complex Systems – John Warfield – 1974)

This monograph presents an approach to organizing thoughts about systems with assistance from a computer. This approach can help people who conscientiously seek to

. apply logical reasoning to complex issues

. communicate their reasoning fully to others.

It is proposed as a logistical apparatus to enable them to do so more efficiently and effectively. This is the third Battelle monograph that treats complex systems. The first, “A Unified Systems engineering Concept’, sought to appraise the strengths and deficiencies of methodology applicable to the planning phases of systems engineering. The second, “An Assault on Complexity", explored various philosophical and methodology-cal approaches for organizing complex issues, presented short case studies, and delved into structural aspects of policy analysis and synthesis. The experience gained in developing these monographs led to the conviction that it is necessary to find ways of improving human capacity to develop structures germane to complex systems and issues. In pursuing this idea, the name "structural modeling" developed as an appropriate title for the knowledge and methodology that seemed to he needed.

Four excellent books (1-4) contain important contributions or background relevant to structural modeling. Each of them has strongly influenced the work leading to this monograph. While (1) concentrates on directed graphs ("digraph"), (2) uses non-directed graphs as a basis for system organization. Both types have appeared in the two prior Battelle monographs mentioned.

(1) Harary, Frank, Norman, Robert Z., and Cartwright, Dorwin, Structural Models: An introduction to the Theory of Directed Graphs, John Wiley & Sons, Inc., New York, 1965.

(2) Alexander, C., Notes on the Synthesis of Form, Harvard University Press, Cambridge, 1964.

(3) Hartmanis, J., and Stearns, R. E., Algebraic Structure Theory of sequential Machines, Prentice-Hall, Englewood Cliffs, 1966.

(4) Klir, (G., An Approach to General Systems Theory, Van Nostrand Reinhold Co.,New York, 1969.

In developing this monograph, it was useful to think of structural models of two generic types. The first type, the basic structural models, are those whose theory has evolved out of mathematics. They are the graphs and digraphs which carry no empirical or substantive information. Much is known about their properties. Methods exist for performing operations upon them that permit extensive manipulation and structural insight. The second type, the interpretive structural models, are those delve-oped to help organize and understand empirical, substantive knowledge about complex systems or issues. Intent structures, DELTA charts, and decision trees, illustrated in the earlier monographs, are examples of interpretive structural models, other examples include interaction graphs, PERT diagrams, signal flow graphs, organization charts, relevance trees, state diagrams, and preference charts.

If the full knowledge of basic structural models could he brought to bear upon the development of interpretive structural models, a significant advance could be made in the rational analysis and synthesis of complex systems. Yet, it seems impractical to expect that those who are engaged in day-to-day interaction with complexity in human affairs would take the time to learn to apply such abstract concepts as mathematical logic, matrix theory, and the theory of graphs in their work, it also seems unlikely that mathematicians would take the time to become highly knowledgeable of complex real-world systems and issues. The dilemma of how to wed substantive issues and knowledge of complex systems to the mathematics seems significant. But, even if people had all the mathematics and understood the complex system or issue, still another problem would be present. That is the extreme tyranny of working systematically to establish relations among many elements in the form of an interpretive structural model, and the long time period required to do this by manual methods.

One approach shows promise of a way out or the mentioned difficulties. This approach is to introduce the digital computer to aid in problem definition. If the necessary mathematical knowledge as well as the logistical tyranny can he transferred to the computer, leaving to the developer of the interpretive structural model only the minimum, but critical, core of effort - providing the substantive knowledge of the system or issue — then the developer would not need to learn the associated mathematics, nor would he have to absorb the tyranny associated

with the extensive manipulation of ideas on paper
that would otherwise he required. The computer
could he a major factor in compressing the time

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