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Forrester Book

The first full-scale exposition of a new philosophy and method of business analysis is presented by Dr. Jay W. Forrester, professor of industrial management at the Massachusetts Institute of Technology, in a new book, "Industrial Dynamics," ($18) published by the M.I.T. Press and John Wiley & Sons.

Drawing upon his experience in such diverse fields as cattle ranching, gunfire control, computer design and continental air defense, Dr. Forrester now sums up the conclusions of five years of research in industrial management and discloses ways in which he believes industry can plan more efficiently, create greater employment stability, increase productivity and grow more successfully.

Dr. Forrester grew up on the Nebraska cattle ranch of his father, M.M. Forrester, who is a Nebraska state senator. He studied electrical engineering at the University of Nebraska and M.I.T. During World War II he designed servomechanisms for Army guns and Navy radar. In 1946 he took charge of the construction of Whirlwind I, one of the first high-speed electronic computers. He was then head of the digital computer division of the Lincoln Laboratory, using Whirlwind as an experimental model in the design of the vast and complex SAGE system for continental air defense.

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In 1956 Dr. Forrester decided that engineering principles and computer techniques could be applied to business problems and he became a professor in the M.I.T. School for Industrial Management. The new book reports on his research since then.

Recognizing that one of the major problems of industry is that of fluctuations in such factors as costs, wages, sales and employment, Dr. Forrester sought to find a new method of rapidly analyzing their relationships. A clear understanding of how such factors affect each other might lead to wiser decisions in management strategy. He has found that in using a high-speed digital computer as a tool, as many as 2,000 variables can be studied. This is far more than a manager can properly interrelate mentally and intuitively.

The relationships of that many variables are extremely complex, but digital-computer models of such systems provide a management laboratory and a means of pretesting proposed changes in policies. Rather than waiting for months or years to see how policies will work out, an industrialist can simulate operations on a computer and determine which will be the most successful.

What Dr. Forrester proposes is to view management as an information-feedback control system, as engineers call a self-monitoring system. The most familiar such system is that of the modern residential heating plant. When the temperature drops in your house, the thermostat signals the furnace, which produces enough heat to bring the temperature up to the desired level, which causes the thermostat to shut off the furnace. The situation leads to a decision that creates action to correct the situation.

In the same way, the flow of money, orders, materials, personnel and capital equipment in an industry can be better regulated, Dr. Forrester says, by a more adequate understanding of the feedback network that couples information to decisions to the

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actions that generate new information. The separate functions of management -- marketing, investment, research, personnel, production and accounting -- can be integrated. In fact, Dr. Forrester says, the method can be applied not only to single companies but to whole industries and to national and international economic systems.

The book is devoted chiefly to an explanation of industrial dynamics as a method of analyzing and evaluating the information concerning industrial operations and has dozens of graphic charts in which the roller coaster effect in the relationships of production, inventory, sales and cash flow curves is apparent. Information on actual industrial operations was used to provide a realistic basis for the studies.

Two chapters in the book are devoted to a description of the application of principles of the new system in dealing with the employment stability problems of an actual company. In spite of a fairly steady demand for the products of the company, extreme fluctuations were occurring in its employment, inventory and factory backlog. Study of such factors on a computer showed that the fluctuations were caused chiefly by interactions within the policies of the company itself. Application of industrial dynamics resulted in the design of policies to reduce fluctuations in employment and production to about a third. Many industries experience similar instability which Dr. Forrester feels can be reduced by recognition of the enterprise as a complete system and the design of internally compatible policies.

Also explained is a system, known as DYNAMO, which was developed for translating industrial data into instructions and numbers that could be understood by a computer. The IBM 709 computer in the M.I.T. Computation Center, which was used for much of the work, can handle 1, 500 variables and respond to any of 10, 000 instructions in the DYNAMO program.

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"Management now stands at a frontier leading to a new understanding of industrial growth and stability," Dr. Forrester writes. "This new insight into industrial and economic behavior will come from a better grasp of the time-varying interactions between the major facets of our social system.

"Management education and practice are, I believe, on the verge of a major breakthrough in understanding how industrial company success depends on the interactions between the flows of information, orders, materials, money, personnel and capital equipment. The way these six flow systems interlock to amplify one another and to cause change and fluctuation will form a basis for anticipating the effects of decisions, policies, organizational forms and investment choices...

"Management science does not mean automatic management. It means a platform from which to reach further by the exercise of managerial intelligence and judgment."

Long-range planning is one area in which the methods of industrial dynamics are indispensable, according to Dr. Forrester. "Here we see much lip service but little real action," he writes. "Plans, where they exist, are apt to be but wishes -- goals of greater sales or higher profit without a plausible sequence of steps for achieving those goals.

"Where long-range plans do exist, they seldom have substantial content beyond a five-year span; yet the momentum of our corporations and our economy is such that five years is practically the minimum time in which it is possible to create any real changes...

"In a simple agrarian economy, a decision to plant and till affected production and the ability to consume six months or a year later. In early industrial economies, the essential decision to construct simple factories affected production and

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consumption two or three years later...

"Now we find that key decisions relate to research in frontier products that will require the development of materials and tools, then of production facilities, then of markets -- the span from primary research decision to the full consequences has risen to twenty years or more."

In the preface to the book, Dr. Forrester says, "The cattle ranch operated by my parents, M. M. and Ethel W. Forrester, at Anselmo, Nebraska, provided my first exposure to business and to the nature of commodity markets. The study of electrical engineering at the University of Nebraska laid the foundation for graduate research. My graduate study at M.I.T. was under Professor Gordon S. Brown (now Dean of the School of Engineering), who was then starting the Servomechanisms Laboratory and developing the concepts of information-feedback systems in a research project atmosphere that gave leadership experience to graduate students and junior staff.

"In the late 1940's the challenging environment of the M.I.T. Division of Industrial Cooperation under Mr. Nathaniel McL. Sage, Sr., gave me an opportunity to plan, and to direct with broad managerial responsibility, the construction of Whirlwind I, which was one of the first high-speed electronic digital computers.

"As head of the Digital Computer Division of Lincoln Laboratory, I had the opportunity to manage a growing technical organization, to coordinate the early planning of the Air Force's Semi-Automatic Ground Environment (SAGE) system for air defense, and to guide the early stages of industrial company manufacturing to build the needed equipment. Together, these experiences provided a view of management problems at all levels as well as a foundation for the methodology on which the book is based."

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While head of the Digital Computer Laboratory, Dr. Forrester invented "random access magnetic storage," on which he holds a patent. This is a method by which magnetic beads, strung on fine wire in a kind of honeycomb, constitute a memory device for computers. It is widely used in commercial digital computers.

Dr. Forrester, who was born in 1918 at Anselmo, Nebraska, was awarded an honorary degree of doctor of engineering by the University of Nebraska in 1954. In 1955 he received the Institute of Radio Engineers Fellowship Award "for his contributions to the development and engineering design of high-speed computers." He lives at 11 Holden Wood Road, Concord, Mass.

The first phase of Dr. Forrester's research, he says in his preface, has "dealt primarily with philosophy and methodology and with the 'steady-state' dynamics of mature industries." He is now embarking on research on transient situations and their relation to the design of policies controlling company and economic growth.

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