No Mean City

Jay W. Forrester, *Urban Dynamics.* MIT Press, Cambridge, Mass., 1969, 285 pp., $12.50.

by Gordon D. Shellard

This book presents a mathematical model of a city and uses it to study the effects of various urban improvement programs. A mathematical model would normally appeal to only few readers, but the city and its intractable problems are the objects of such concern that the book should interest many, particularly actuaries who may reasonably form some judgments on the validity of the model and on some of the conclusions drawn.

The model primarily concerns three components of a city: its business, people, and housing. Each component is divided into three classes. Business is classified as new, mature, or declining. Families are classified, by employment status of the family head, as full time employed professional-managerial, other full time employed, and under-employed. Housing is classified according to that normally occupied by each class of family listed above. The number of units in each class of each component is represented by a variable. There are thus nine class-component variables which are related in various ways.

Typical of the ways in which the class-component variables are related are those arising from the facts that business enterprises require workers, and that families require housing. These relations can be made more specific, such as, a unit of new enterprise requires x professional-managerial type employees and y other workers. Each of these requires housing of a certain type, and so on. Each such relation is written in the form of an equation. Variables other than the basic class-component variables enter into some of these equations.

Units of one class of a component may pass into another class—e.g., new enterprises may become mature, and mature enterprises may become declining. Similarly, workers may pass from one employment class to another, back and forth, and units of housing may similarly change class. Rates of change of units from one class to another may be thought of as rates of flow, and are expressed mathematically as first derivatives of the appropriate variables. These rates of flow are considered dependent functions of the various variables themselves. The relations give rise to further equations, so

that the complete set is quite complex and extensive.

A final concept entering the model is that of a limitless environment surrounding the city but not a part of it. Units can freely migrate between the two according to the relative desirability of conditions within and without the city. Thus, if conditions seem relatively favorable within the city, enterprises or people will migrate into the city. On the other hand, enterprises or people will move out if conditions within the city are relatively unfavorable. Throughout this book the outer environment surrounding a city is assumed constant as conditions within the city are varied. Resulting changes within the city would necessarily be different if conditions also changed in its outer environment—e.g., in rural areas and other cities.

Once all the relations are specified and initial values entered, the model can be run, or runs itself, from the end of one time period to the next, indefinitely. The process generates not only values of the class-component variables, but also ratios such as those of the number under-employed to the number of available jobs, of persons to housing and to the fraction of land occupied, and tax ratios.

Perhaps the most troublesome part of constructing this model lies in properly specifying in detailed numerical form the many functional relationships involved. It appears to the reviewer that, because detailed data are lacking, judgment, impression, and general observation have had to be substituted. The model has then been run, and the functional relationships adjusted, until the values assumed by the variables over a period of time appear reasonably like those that have been observed in the development of real cities. This means that the variables assume values indicative first of growth, then of maturity, and finally of decay. This is the primary validation of the model: that it appears to develop as actual cities have.

At this point various changes are introduced to learn their effect upon the model. For example, a low-rent housing construction program is introduced, financed by some outside source, so that construction costs are not borne by the city. The model indicates that the increased low-rent housing will draw additional under-employed to the city, will dampen other building activity in both business and housing, and will end by

increasing the ratio of under-employed to available jobs, decreasing the amount of business in the city, and increasing the tax rate.

Other urban improvement programs actually tried or suggested for cities were tested on the model with little favorable and generally somewhat unfavorable results. Among these were the external creation of additional jobs, inauguration of a job training program, and a direct external subsidy. The favorable results of such programs were largely offset by an influx of under-employed drawn by the programs themselves.

Other programs were tried, to test their effect. Construction of any type of housing had generally unfavorable effects. Neither a forced increase in new enterprises nor the forced retirement of declining business had much net effect.

Somewhat surprisingly, the demolition of slum housing led to generally favorable results: an increase in the number of new and mature business enterprises, an increase in housing for all fully employed workers, a decrease in the ratio of under-employed to available jobs, and a decrease in the tax ratio. These results were enhanced when further accompanied by a policy encouraging the introduction of new business enterprises.

What value can be placed on inferences drawn from tests on the model? Because of the large element of judgment necessary in setting the individual functional relationships, certainly results obtained from the model must be accepted only with considerable caution. No one should be surprised if in a live test results should differ from those obtained with the model. Some idea of the extent and likelihood of such a discrepancy might be obtained if tests were run on the model with various combinations of different possible functional relationships.

But uncertainty of the model's results must be viewed against the certainty or uncertainty with which results of urban improvement programs can be predicted without a model. Results from programs that have been put into effect have not been too successful thus far. Indeed, for these programs, results have been closer to those suggested by the model than to those hoped for when the programs were initiated. The model can be refined an altered as more data become available. Analysis of what goes on within the model to cause some of the results may offer insights of value.   □