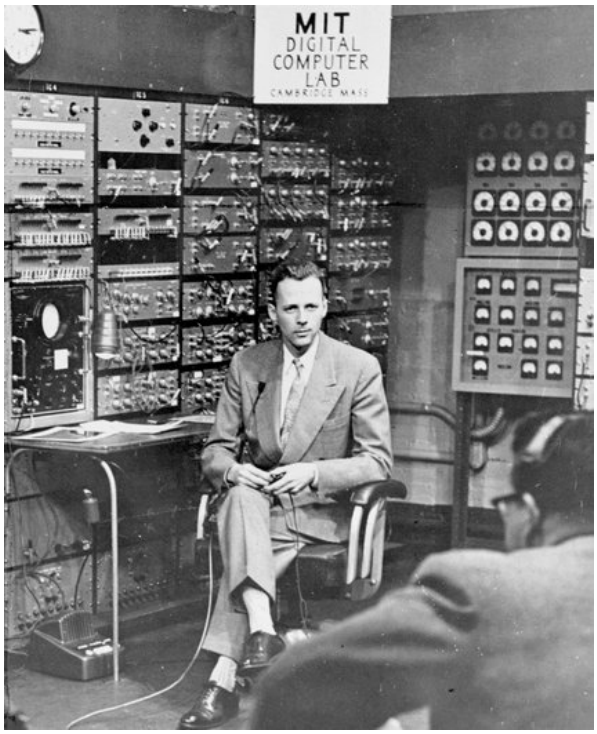
Meetup
Analytical Activists of Atlanta

The Master Speaks

The World Expert: Professor Jay Forrester of MIT



To my knowledge the world expert on solving difficult social problems was **Professor Jay Forrester** (1918 to 2016). Inventor of RAM memory and system dynamics, Forrester approached analysis this way: (From a chapter on *System Dynamics and the Lessons of 35 Years*, with italics added)

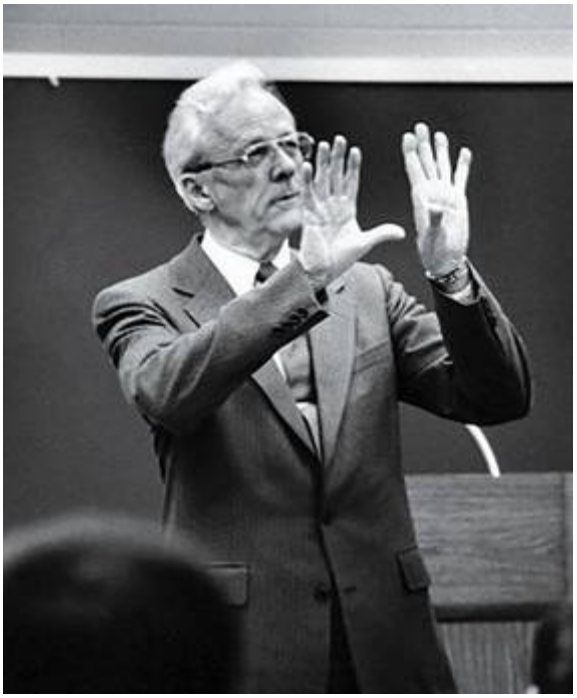
> Such an analysis draws on knowledge about how structure and policy relate to behavior. Information comes primarily from *interviewing people* in the company about *how they make decisions* at their individual operating points. Statements describing the basis for decisions are the rules or policies governing action. As I use the term 'policy,' it represents all the reasons for action, not just formal written policy. *These interviews are extensive and penetrating.* There might be several sessions with each of many individuals. The discussions range widely from normal operations, to what was done in various kinds of past crises, what is in the self-interest of the individual, where are the influential power centers in the organization, what would be done in various hypothetical situations that have never happened, and what is being done to help in solving the serious problem facing the company.
>
> Talking to a manager usually reveals *a clear and comprehensive picture of the rules and conditions driving decisions* at that position in the corporation. Then, when talking to another manager about the first manager, the same picture usually emerges. In other words, people see themselves very much as others see them. There is substantial consistency throughout the organization as to the actual operational policies that are guiding decisions. Furthermore, the policies are justified in terms of how those policies are expected to correct the great difficulty that the company is experiencing.

Up to this point, the study of such a company follows the case-study approach to management education. That is, a comprehensive examination of all related parts of the company is made in the context of the problem that is to be solved. *But, if left at this point, the weakness of the case-study method would dominate the outcome.* A descriptive model of the company would have been assembled, but the human mind is not able to deal with the inherent dynamic complexity of such a situation.

For those who have studied mathematics through differential equations, such a descriptive model is equivalent to a high-order nonlinear differential equation. No scientist or mathematician can solve such a system mentally. Just as with the operation of a chemical plant, only computer simulation methods are capable of revealing the behavior implicit in the structure that can be built from knowledge about the many local decision-making individuals and how they are connected. After obtaining a description of the important policies, information flows, and interconnections in a company, *the next step is to translate that description into a computer simulation model.*

The Prophet

Here's another extract, from *The Prophet of Unintended Consequences*, 2005, by Lawrence Fisher for Strategy-Business.com.



Thus one of the most controversial aspects of Professor Forrester's work is also his core premise. He argues that most social organizations, from corporations to cities, represent a far higher level of complexity and abstraction than most people can grasp on their own. And yet corporate and government leaders of all sorts persist in making decisions based on their own "mental models" — Professor Forrester's term for the instinctive theories that most people have about the way the world works. These decisions, no matter how well intentioned or intuitively comforting, are decidedly inferior, he says, to policies and strategies based on computer models of "system dynamics" — the interplay of complex, interrelated forces over time. As a result, Professor Forrester argues, most of the pressing problems facing humanity today will elude solution until a new generation, familiar with computer models, enters leadership roles.

The Most Obvious Solutions

And here's part of an article on *What Companies Can Learn from Urban Dynamics*, September 1993, *The Systems Thinker*, Vol 4 No 7. (Italics are in the original.)

According to Forrester, the counterintuitive discoveries in *Urban Dynamics* are indicative of the nature of all complex systems. Pushing on one facet of a system will eventually create repercussions in other, seemingly unrelated areas. Any city improvement program will change the balance of the system as a whole, regardless of the individual program's potential.

For example, every city has a natural rate of upward mobility through which the unemployed move into the labor pool. If a city becomes dependent on job training programs to spur growth, other job creating initiatives will be de-emphasized. Because of this shift, you can never experience a positive program's full benefits.

Therefore, in any complex system, *the most obvious solutions are those most likely to fail*. Forrester wrote in *Urban Dynamics*, "With a high degree of confidence we can say that the intuitive solutions to the problems of complex social systems will be wrong most of the time. Here lies much of the explanation for the problems of faltering companies, disappointments in developing nations, foreign-exchange crises, and troubles in urban areas."

In addition, any kind of complex system is almost always accompanied by a conflict between short and long-term thinking. Such dynamics play out frequently in business situations, where short-term thinking and quick results are often rewarded. In many companies, annual and sometimes quarterly reports are considered to give accurate indication of the organization's health, when in reality they provide only a narrow view of the company's position. Budgetary and political pressures often result in decisions that will have positive results in the short-term, but negative consequences over the long-term.

The Attractiveness Principle

From analyzing different scenarios in Urban Dynamics, Forrester concluded that attempting to improve all aspects of a city will result in the inevitable problem of attracting more people than the city can accommodate. **An urban area tends toward an attractiveness equilibrium with its surroundings;** thus, if any region is more attractive than its neighbors (due to employment and housing opportunities), new residents will flock to that city.

The same can be said about companies who try to be the most attractive in every dimension. A single company cannot maintain a superior position in every attribute because smaller niche players will always be able to focus on specific elements (e.g., cost, features, responsiveness) and do as well or better. Even if a company were able to start out of the top in ...

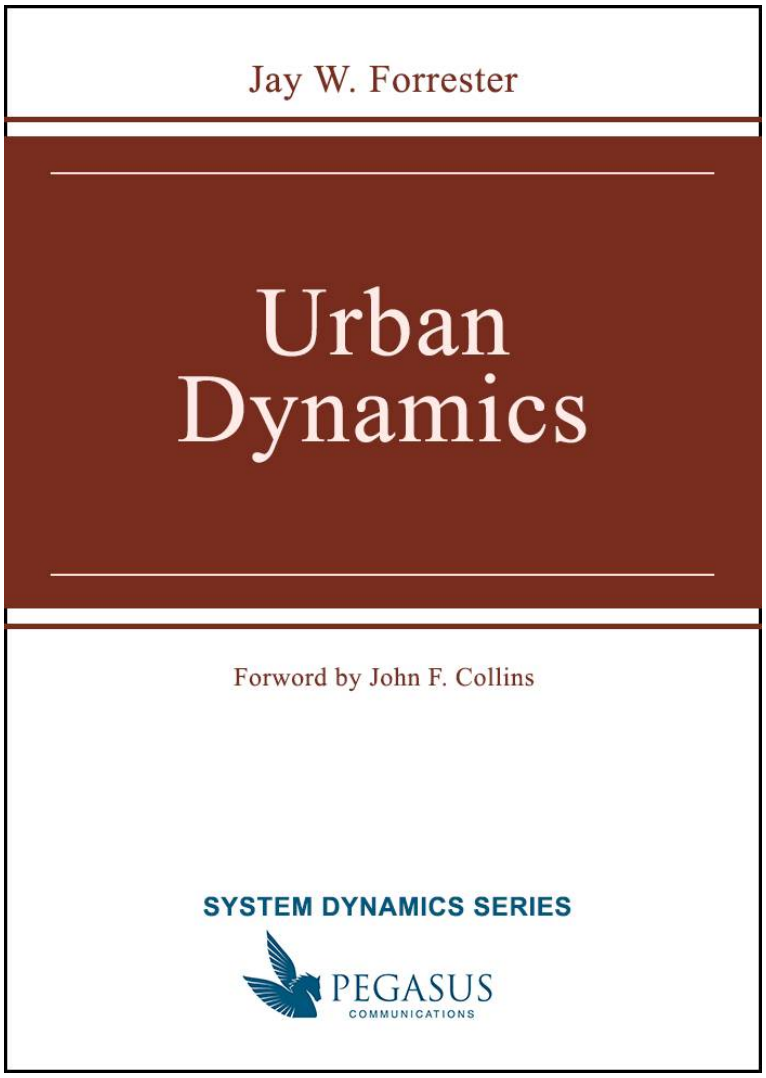
The Tale of the Urban Decay Problem

Finally, here's the exciting story of the urban decay problem, from Forrester's banquet talk in 1989 on *The Beginning of System Dynamics*, with italics added. This contains some profound insights.

> Another series of incidents in 1968 moved system dynamics from corporate modeling to broader social systems. John F. Collins, who had been mayor of Boston for eight years, decided not to run for re-election. MIT gave him a one year appointment as a Visiting Professor of Urban Affairs bringing him into the academic orbit to meet students, interact with faculty, and advise the administration on political issues.
>
> In discussions with Collins about his eight years coping with Boston urban problems *developed the same feeling that I had come to recognize* in talking to corporate executives. *The story sounded persuasive but it left an uneasy sense that something was wrong or incomplete.* So, I suggested to Collins that we might combine our efforts, taking his experience in cities and my background in modeling, and look for interesting insights about cities. He immediately asked how to go about it. I told him we would need *advisers who knew a great deal about cities from personal experience,* not those whose knowledge came only from study and reading. We needed people who had struggled with cities, worked in them, and knew what really happens. And furthermore, *we would not know what would come of the effort, or how long it might take.*
>
> *The process would be to gather a group that would meet half a day a week, probably for months, to seek insights into the structure and processes of cities that could explain stagnation and unemployment.* Collins listened and said, "They'll be here on Wednesday afternoon." Collins' position in Boston at that time was such that he could call up almost anybody in politics or business, ask for their Wednesday afternoons for a year, and get them. He delivered the people and it was out of the following discussions that Urban Dynamics developed.
>
> Urban Dynamics was the first of my modeling work that produced strong, emotional reactions. As you know, *it suggested that all of the major urban policies that the United States was following lay somewhere between neutral and highly detrimental*, from the viewpoint either of the city as an institution, or from the viewpoint of the low-income, unemployed residents. And that *the most damaging policy was to build low-cost housing.* At that time, building low-cost housing was believed to be essential to reviving the inner cities.
>
> *The conclusions of our work were not easily accepted.* I recall one full professor of social science in our fine institution at MIT coming to me and saying, "I don't care whether you're right or wrong, the results are unacceptable." So much for academic objectivity! Others, probably believing the same thing, put it more cautiously as, "It doesn't make any difference whether you're right or wrong, urban officials and the residents of the inner city will never accept those ideas."

And furthermore, we would not know what would come of the effort, or how long it might take.

It turned out that those were the two groups we could count on for support if they became sufficiently involved to understand. That is a very big "if"—if they came close enough to understand.



Three to five hours were required to come to an understanding of what urban dynamics was about. Urban officials and members of the black community in the inner city would become more and more negative and more and more emotional during those three to five hours. *If they were not a captive audience, they would walk out before* they understood and accepted the way in which low-cost housing was a double-edged sword for making urban conditions worse. Such housing used up space where jobs could be created, while drawing in people who needed jobs. Constructing low-cost housing was a powerful process for creating poverty, not alleviating it.

My first experience with reactions to Urban Dynamics came soon after the book was published. We had been running a four-week urban executive's program twice a year for department-head level people from larger cities to teach various aspects of management. A group was convening shortly after Urban Dynamics came out. I was asked to take a Monday afternoon and a Wednesday morning to present the Urban Dynamics story.

I have never had a lecture on any subject, any place, any time *go as badly as* that Monday afternoon. In the group was a man from the black community in New York who was a member of the city government. *He was from Harlem, intelligent, articulate, not buying a thing I was saying, and carrying the group with him.* At one point he said, “This is just another way to trample on the rights of the poor people and it's immoral.” At another point he said, “You're not dealing with the black versus white problem, and if you're not dealing with the black versus white problem, you're not dealing with the urban problem.” And when I said decay and poverty in Harlem in New York or Roxbury in Boston was made worse by too much low-cost housing, not too little, he looked at me and said, "I

come from Harlem and there's certainly not too much housing in Harlem." That is a sample of the afternoon.

On Tuesday evening, a dinner was held for the group. Neither Collins nor I could go; but several of our students attended. One student called me at home in the evening to report what was fairly obvious anyway—that the group was very hostile. On that bit of encouragement, I started Wednesday morning.

An hour into Wednesday morning, *the New Yorker's comments began to change character*. He was no longer tearing down what was being said. *His questions began to elicit information.* Two hours into the morning, he said, "We can't leave the subject here at the end of this morning. We must have another session." I ignored the request to see what would happen next. In about twenty minutes, he repeated it. I agreed to meet them again if he could find a time and place in the program. I was not trying to put him off, however, that usually ends such an exchange. But he went to the administration and scheduled another session.

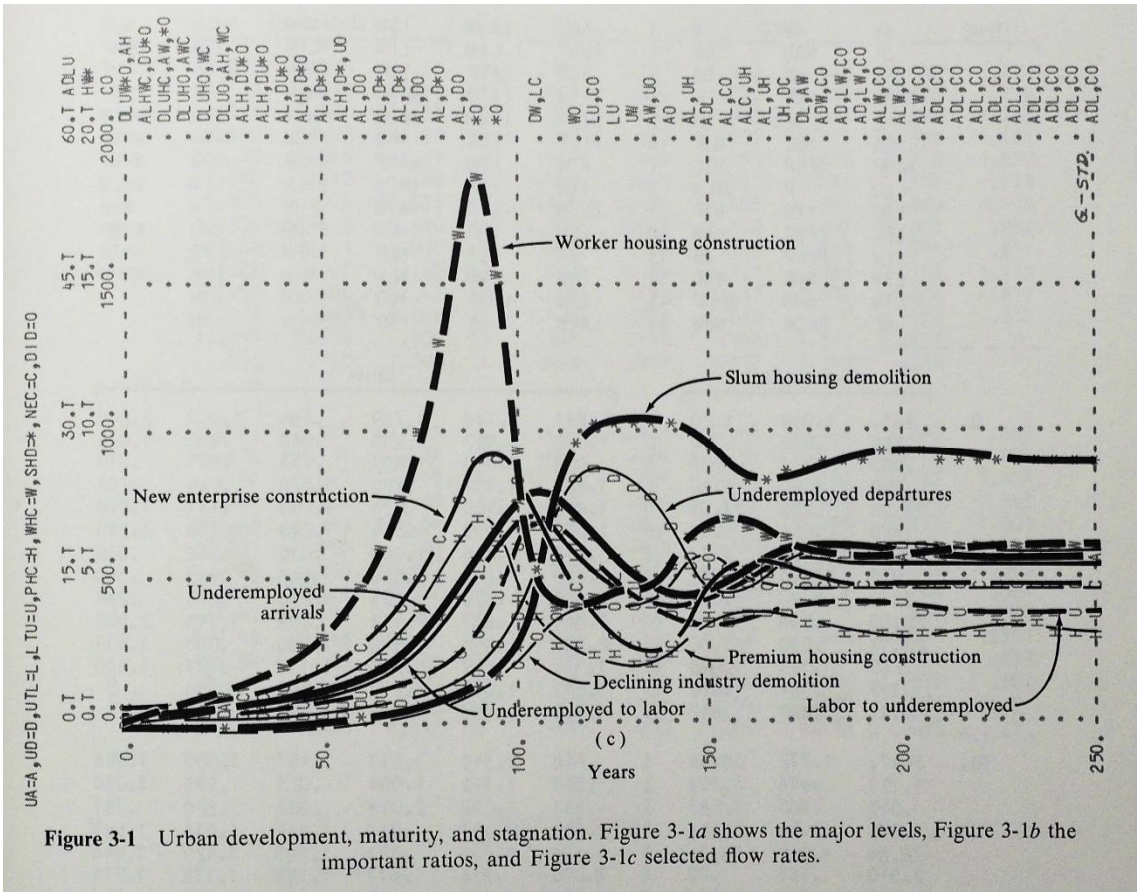


Figure 3-1 Urban development, maturity, and stagnation. Figure 3-1*a* shows the major levels, Figure 3-1*b* the important ratios, and Figure 3-1*c* selected flow rates.

The reference scenario from the *Urban Dynamics* simulation model. This is the typical boom and bust cycle that was occurring in US cities. The final equilibrium was high unemployment for low income workers and their concentration in slums, which contributed to the eruption of slum riots in the 1960s in the US.

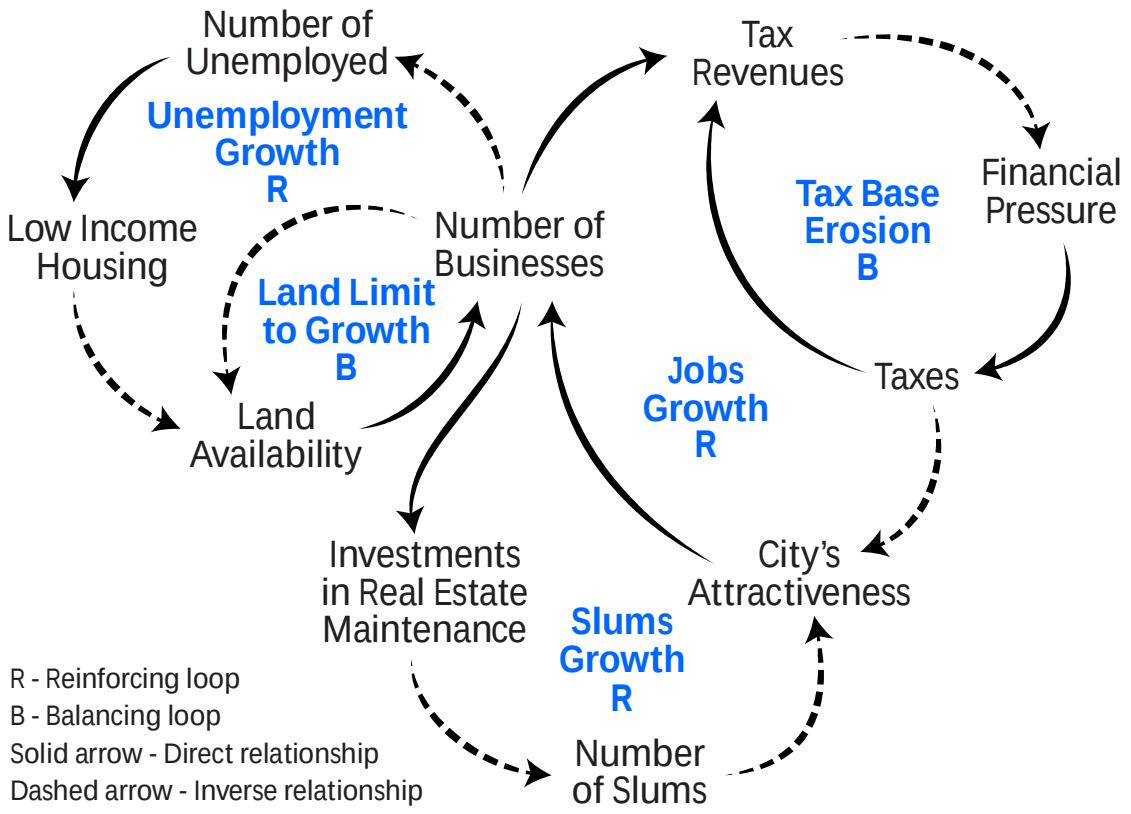
Later he made an appointment to come to my office to ask that I talk to a group he would invite in New York—his colleagues on his home turf. He sat in my office as relaxed as could be and said, "You know, it's not a race problem in New York at all, it's an economic problem," after telling me four days earlier that I was not even addressing the urban problem if I was not dealing with the black versus white issue. He gave me a report out of his brief case documenting the amount of empty housing in every borough of New York and the rate at which it was being abandoned. My point had been that too much housing meant that there was too much for the economy of the area to support. *He had all the proof right in his brief case. He simply had not realized what his knowledge meant until it was all put together in a new way.*

But we have not solved the challenge of how to bring enough people across the barrier separating their usual, simple, static viewpoint from a more comprehensive understanding of *dynamic* complexity.

Two years later a journalist asked me what people thought in the aftermath of Urban Dynamics. I suggested that he talk to others, and especially with the man in New York whom I had not contacted in the intervening two years. After the interview, the journalist called me to report that he had been told that *"They don't just have a solution to the urban problem up there at MIT, they have the only solution."* The lesson about urban behavior had stayed clear and alive for two years even back home in his native environment. The five hours of exposure to Urban Dynamics had made a lasting impression. But we have not solved the challenge of *how to bring enough people across the barrier* separating their usual, simple, static viewpoint from a more comprehensive understanding of *dynamic* complexity.

That last sentence describes our top analytical barrier. If we can't correctly understand *dynamic* complexity we will fail to find the *true* root causes of the problems we analyze. We will instead find *pseudo* root causes, intermediate causes posing as root causes, and our solutions will mysteriously fail. To avoid the **Pseudo Root Cause Trap**, we will be using a set of powerful tools designed to help us crack through the barrier of *dynamic* complexity. The tools are the mode change of social force diagrams, exploratory causal loop diagrams, and most important of all, thoughtful feedback loop simulation models.

Boom and Bust of Urban Dynamics



The classic cycle of boom and bust works like this: New businesses provide employment opportunities in a developing city, attracting many new people (**Jobs Growth**). Construction booms until land availability begins to decrease (**Land Limit to Growth**), slowing the growth of industry and jobs (**Unemployment Growth**). As the city and its buildings age, investments in real estate maintenance drop, creating urban slums and decreasing the attractiveness of the city (**Slums Growth**). The resulting erosion in the city's tax base causes further financial pressure on the city (**Tax Base Erosion**). Unless policies are changed, based on understanding how the feedback loop structure works, the cycle is inevitable.

This diagram and caption originally appeared in The Systems Thinker, Vol 4, No 7, 1993, by Pegasus Communication. It has been redrawn, loop names added, and the caption improved by Thwink.org. Solid and dashed arrows instead of S's and O's have been used to indicate relationship polarity. The causal loop diagram summarizes the structure of Jay Forrester's system dynamics simulation model in Urban Dynamics, 1969.