

LOWELL DYNAMICS:
PRELIMINARY APPLICATIONS OF THE THEORY OF URBAN DYNAMICS

by

Walter Warren Schroeder III

S.B., Massachusetts Institute of Technology
(1970)

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF

SCIENCE

at the

MASSACHUSETTS INSTITUTE OF

TECHNOLOGY

February, 1972

Signature of Author
Alfred P. Sloan School of Management, January 6, 1972

Certified by..

.....
Thesis Supervisor

Accepted by.....
Chairman, Departmental Committee on Graduate Students



ABSTRACT

LOWELL DYNAMICS: PRELIMINARY APPLICATIONS OF THE THEORY OF URBAN DYNAMICS

by

Walter W. Schroeder III

Submitted to the Alfred P. Sloan School of Management

in Partial Fulfillment of the Requirements
for the Degree of Master of Science

While Jay W. Forrester's book Urban Dynamics has received considerable attention since its publication in mid-1969, very little has been done to apply the computer model which that book describes to an actual city. This thesis summarizes the beginnings of what may become the first large-scale effort to refine and apply the Urban Dynamics model to help meet the problems of a real urban setting. A three-month preliminary study in the city of Lowell, Massachusetts has developed strong official support for an expanded effort to develop an Urban Dynamics-type modeling process which can become an ongoing element of the city's long run policy and decision-making system.

The city of Lowell--its history and its current socio-economic structure--contains strong parallels to Forrester's general theory of urban behavior. Lowell has experienced a life-cycle which clearly reflects a period of exponential-type growth followed by a peak near 1920, and a subsequent decay to a less healthy condition. Many of the factors which have apparently influenced Lowell's current troubles are also suggested in Urban Dynamics.

Parameter modifications, made on the basis of current Census and other data, have generated model behavior which resembles the city in nearly all important general respects. Resulting in a good approximation of the city's past and, more important, a high degree of accuracy in describing the city's present employment, housing, and population characteristics, these modifications have increased our confidence in the model's potential utility.

The model's general framework provides an understanding of Lowell's urban system which points to some potential errors in present city policy, and some directions for change. To improve the quality of analysis, to allow precision in problem definition and resolution, will require substantially more work. This thesis is intended as a summary of the origins and a focus for the future of a promising new method of diagnosing and treating our most severe urban ills.

Thesis Supervisor: Jay W. Forrester
Title: Professor of Management

Table of Contents

| | |
|---|----|
| INTRODUCTION..... | 4 |
| CHAPTER I | |
| The Growth and Decline of Lowell..... | 7 |
| CHAPTER II | |
| The Dynamics of Lowell..... | 13 |
| CHAPTER III | |
| Modifying the Model to Describe Lowell..... | 34 |
| CHAPTER IV | |
| Some New Directions for an Old City..... | 53 |
| CHAPTER V | |
| Goals for Further Effort..... | 86 |
| FOOTNOTES..... | 95 |
| BIBLIOGRAPHY..... | 96 |

INTRODUCTION

This thesis is a summary of preliminary efforts to define, analyze, and propose solutions to the major problems facing Lowell, Massachusetts. Beginning in June of 1971, a research project* was begun to determine whether Professor Jay W. Forrester's Urban Dynamics, a computerized general theory of urban behavior, could in fact make a useful contribution in an actual urban setting. Since its publication in book form in May of 1969, this theory had been the subject of considerable interest and debate.

In order to bring the Urban Dynamics model into a specific city's decision-making structure, Professor John F. Collins, former Mayor of Boston and the other major force behind the development of Urban Dynamics, encouraged me to spend the summer working with James Sullivan, the City Manager of Lowell, to determine the feasibility of a successful application of the model. Specifically, we hoped to answer several questions:

1. Is there a need for a mathematical model of Lowell; are the problems ones which require additional analytical tools?
2. Can our own tool--Urban Dynamics--be modified and refined to fit Lowell's particular characteristics and needs?
3. What kind of policies and programs might the model suggest as appropriate for solving Lowell's problems?

* This summer project was funded by a grant from the Independence Foundation, Philadelphia, Pennsylvania.

All three questions are given preliminary answers in the following pages. Chapters 1 and 2 present Lowell's development from a town of 600 in 1820 to its role as the center of a large metropolitan region today. By first learning about Lowell's past, we will better understand its present problems. A look at present-day Lowell will help illustrate the problems inherent in the urban system. Despite a well-qualified professional administration, many of the city's problems remain acute. The city seems to defy even the best efforts designed to revive it.

Chapter 3 summarizes work done to date on adapting the Urban Dynamics model to Lowell. Rather than an attempt to refine the model to fully reflect the city's spectrum of problems, modeling efforts thus far have only provided general tests of the model. Work has focused first on determining whether the Urban Dynamics model's general framework is appropriate for development into a rigorous tool for urban policy design. Expansion and refinement of the original model will be easier and more fruitful once greater confidence has been developed in its general structure.

In Chapter 4, a number of present and proposed city policies are examined. With the help of the Urban Dynamics framework, possible inconsistencies in present doctrines are brought to light. Policies which at first seem expedient may be having unexpected secondary effects which counteract the policy's desired effects, and may even worsen the city in the long run. With a better understanding of the complex workings of the urban system as a whole, new directions for policy change are proposed. The policy changes are presented not as final recommendations, but as the starting point for efforts which may ultimately produce a clear definition of Lowell's problems

and a strategy for attacking the causes of those problems.

Finally, Chapter 5 raises questions and issues to which future efforts both in Lowell and within the present Urban Dynamics Group might usefully be addressed. Several subsectors of the general model deserve refinement if they are to become more reflective of Lowell. If both Lowell and national urban officials can be brought into the refinement process, a more articulate model will result. Since Lowell's problems appear characteristic of many medium and large cities, there is likely to be a high degree of transferability of these efforts to other cities as well.

CHAPTER I

THE GROWTH AND DECLINE OF LOWELL

Lowell, Massachusetts, incorporated in 1824, was once the center of textile production in the United States. Today, economic growth and vitality have been replaced by stagnation and decay. Population has fallen from a high of 113,000 in 1920 to 93,000 in 1970. The origins of the city's problems lie deep within its history. To better understand these problems let us look first to the city as it once was.

Situated at the junction of the rapids of the Merrimack and Concord Rivers, Lowell was a typically lazy farm town with a population of 600 in 1820. These rapids, because of their tremendous reserves of water power, attracted the attention of Frances Cabot Lowell, who was looking to develop the first large textile mill in the United States.

In 1822, a site for the new mill was selected in East Chelmsford [Lowell] and the Merrimack Manufacturing Company was incorporated on the sixth of February in that year, with a capital of \$600,000....The Hamilton Manufacturing Company was incorporated in 1825. (1)

The growth of the area's economy was truly impressive. Census data shows that from 1830 to 1840 the population of the city more than tripled from 6,500 to over 20,000. The prime force behind this growth can be found in Figure 1, which details the more than 8,000 new jobs created from 1822-36. (2) So rapid was the industrial development that

[By] 1839, the land and water-power which the original company had for sale was wholly taken up by the ninth factory to be established. (3)

Boarding houses were quickly erected by the mill owners to accomodate and "induce the American girls from the farms and country villiages to

LOWELL MANUFACTORIES.

FIGURE 1
STATISTICS OF LOWELL MANUFACTURES, JANUARY 1. 1837.
COMPILED FROM AUTHENTIC SOURCES.

| CORPORATIONS. | Locks and Canals. | Merrimack. | Hamilton. | Appleton. | Lowell. | Suffolk. | Tremont. | Lawrence. | Middlesex. | Boott Cotton Mills. | Total. |
|---|--|--------------------------------------|-------------------------------------|-------------------------------|-----------------------------------|-----------------------|----------------------------------|---|---|--|-----------------------------|
| Capital Stock, | 600,000 | 1,500,000 | 1,000,000 | 500,000 | 500,000 | 450,000 | 500,000 | 1,500,000 | 500,000 | 1,000,000 | 8,050,000. |
| Number of Mills, | 3 shops and a mill by. | 5 and Print Works. | 3 and Print Works. | 2 | Cotton & Carpet Mill, 1 building. | 2 | 2 | 5, another or bleaching preparing. | 2 and Dye-House. | 4, two in operation, and 2 going into operation next season. | 27, exclusive of Works, &c. |
| Spindles, | . | 35,704 | 21,258 | 11,776 | 5072 cotton beside, woolen. | 11,264 | 11,520 | 31,000 | 4620 | 14,016 | 146,128 |
| Looms, | . | 1253 | 620 | 380 | 14 cotton 70 carpet. | 352 | 404 | 910 | 38 broadcloth, 32 cassimere. | 404 | 4667 |
| Females employed, | . | 1400 | 860 | 470 | 375 | 470 | 460 | 1250 | 350 | 450 | 6085 |
| Males, | 500 | 437 | 230 | 65 | 200 | 70 | 70 | 200 | 185 | 70 | 1827 |
| Yards made per week, | . | 186,000 | 110,000 | 100,000 | 200 carpet, 15,000, 80,000. | 90,000 | 125,800 | 200,000 | 6300 cassimere, 1500 broad-cloth. | 73,000 | 950,250 |
| Bales Cotton used in do. | 1250 tons wrought and cast iron yearly | 120 | 100 | 95 | 76 | 86 | 90 | 180 | None. | 60 | 807 |
| Pounds Cotton wrought in do. | . | 44,000 | 39,000 | 33,000 | 30,000 | 32,000 | 34,000 | 64,000 | 600,000 lb. wool per ann. and 3,000,000 trachs. | 21,000 | 237,400 |
| Yards dyed and printed do. | . | 165,000 | 70,000 | None. | None. | None. | None. | None. | Broaddoth and Cassimere. | None. | 235,000 |
| Kinds of Goods made, | Maciney, Cars and Engines for Rail-roads. | Prints and Structures, No. 32 to 40. | Prints and Drillings, No. 14 to 30. | Sheetings and Springs, No. 1. | Carpet, Rugs, and N. gto Cloth. | Drillings, No. 7, 14. | Sheetings and Drillings, No. 14. | Printing Cloths, Shirtings, No. 14 to 30. | Broaddoth and Cassimere. | Drillings, No. 14; Shirtings, No. 40 | |
| Tons Anthracite Coal per annum, | 207 chaldrons Smith's coal; 200 for hard coal. | 5200' | 2800 | 300 | 350 | 330 | 329 | 650 | 500 | 300 | 10,759 |
| Cords of Wood per annum, | 300 | 1500 | 1250 | 3375 | 500 | 70 | 60 | 60 | 1000 | 70 | 4510 |
| Gallons of Oil, | 2300 | 3700 | 6500 | 13 | Olive, 1000. Sperm, 4000. | 3840 | 3692 | 8217 | Olive, 11,000 per m. 1500 | 3500 | 59,324 |
| Diameter of Water Wheels, | 13 | 30 | 13 | 13 | 13 | 13 | 13 | 17 | 17 and 12 | 17 | |
| Length of do. for each mill, | 14 | 24 | 42 | 42 | 60 | 42 | 42 | 60 | 46 and 21 | 60 | |
| Incorporated, | 1792 | 1822 | 1825 | 1828 | 1828 | 1830 | 1830 | 1830 | 1830 | 1835 | |
| Commenced operations, | 1822 | 1823 | 1825 | 1828 | 1828 | 1832 | 1832 | 1833-4 | Waketield Furnace and Steam. | 1836 | |
| How warmed, | Hot Air. | Hot Air Furnace. | Hot Air Furnace. | Hot Air Furnace. | Hot Air Furnace. | Hot Air Furnace. | Hot Air Furnace. | Steam. | | Hot Air. | |

work in the mills" (4).

In the History of Lowell by Frederic Coburn, the city's early growth is summarized as follows:

An industry...[fixed] upon a locality as suitable for exploitation of resources and employment of the local labor.

Capital, in other words, has seen an opportunity for favorable investment. New machinery is set up in factories or workshops, and work that pays better, at least in point of cash disbursements, than that previously available begins to tempt people from the adjacent farms. (5)

Soon after Lowell was founded, and throughout the remainder of the nineteenth century, the mills had to rely on inducing workers from further and further away.

Presently, however, as it becomes increasingly difficult to induce the sons and daughters of the farm to work at the wages paid under competitive conditions in the urban workshops, and as at the same time the growing demand for the city's products tends to exhaust the local supply of labor, employers, thus situated, reach out for the help of immigrants. (6)

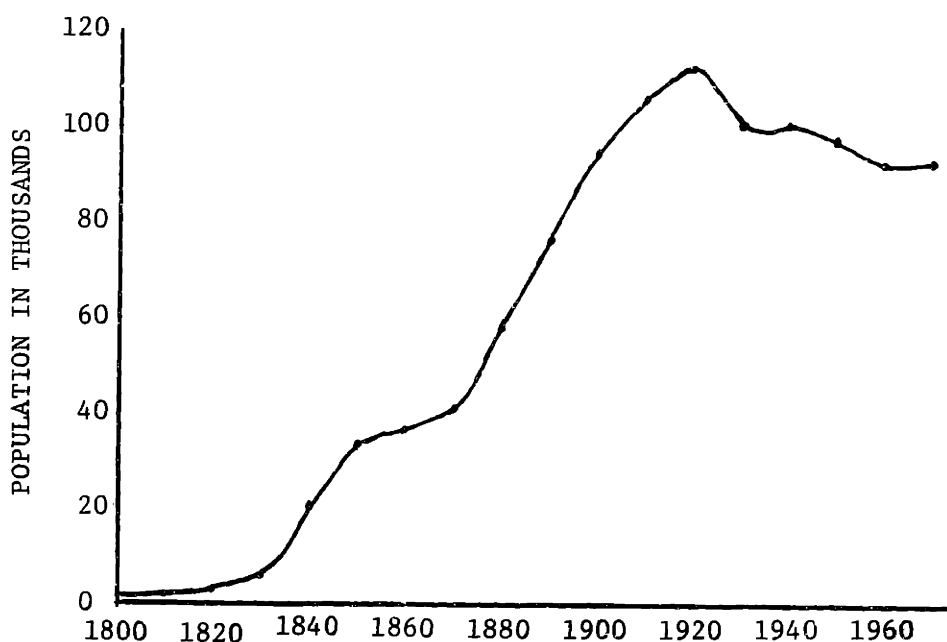


FIGURE 2

LOWELL'S POPULATION SINCE 1800

Growing at an exponential rate, Lowell drew workers from an ever increasing distance

From every part of New England, and presently from the British Isles and Canada, they began to arrive...Lowell [was] practically the only town of its kind in North America, [and] it naturally secured the very pick of aspiring young manhood. (7)

Toward the end of the nineteenth century, however, the city's vitality, as measured by the growth in population (Figure 2) began to falter. Even before growth actually stopped, people in the city were aware that their city was changing.

Today [1890], youths of similar ability often turn to one of the newer and presumably more progressive industrial centres of the West of South. An opinion is sometimes expressed to the effect that Lowell in its first years was a more stimulating place to live than today. (8)

What happened to the early prosperity to yield a more recent sluggishness of Lowell and its economy? One factor was the decreasing strength of the city's economic base. During the last half of the nineteenth century Lowell entered a "bitter struggle for existence against Southern competition" (9) in the cotton industry. The more efficient, newer mills in the South were winning, economically, against the more labor-intensive mills of Lowell (10). As a result, most firms began cutting back on employees and production. Others wisely diversified when possible (11).

The '49 Gold Rush also had an impact on Lowell. Approximately 1,500 young men (well over 5% of the labor force) left Lowell for the West in 1849 (12) An equally large number of young men were affected by the Civil War, for

Amidst the extensive enlistment and the departure of individuals and families (to the West), the population fell from 36,827 in 1860 to 31,000 in 1865 according to the state census. (13)

When the Civil War ended, Lowell gradually regained some of its earlier livelihood, yet

While progress was steady and continual in many directions, this (1870-90) was not a time of sensational developments or so much display of enterprise and initiative as had characterized the first years of the community. (14)

Many of the gravest problems of the twentieth century city first became acute in the last decades of the nineteenth century; deterioration of originally inadequate housing facilities for the working class; indifference to city planning for the future; neglect of the welfare of newly arrived immigrants.... (15)

By 1920 the problems of Lowell had become still more evident. The population reached 113,000 yet many of these people came to Lowell seeking opportunities which no longer existed. Evidence for this is the fact that from 1920 to 1930 (a period of great national prosperity) the population of Lowell dropped by 10% to 100,000. Lowell was no longer a unique city. Other newer cities had gained the upper hand.

The depression of the 1930's inhibited many from leaving Lowell because there was neither the money nor the incentive to move elsewhere. It is doubtful, for the same reasons, that many moved to Lowell during this same period. Census data provides the only support for this notion, since the decline in population of modern Lowell appears to have been interrupted by the depression and World War II--both of which served to keep people where they were during the 30's and early 40's. Since World War II, Lowell has gradually settled to a population which seems fairly steady near 94,000.

During recent years Lowell has been the unfortunate victim of a severely stricken economy. Foreign competition all but wiped out the last of the mills in the late 40's, and unemployment has remained well above the 6% level for the past 30 years. Lowell's unemployment rate in August of 1971 was 14%. Once a thriving city, Lowell now consists primarily of half-empty factories. The erosion of the city's industry and commerce has resulted in a rising tax rate (Figure 3) (16) and an inadequate, overpriced housing supply. The present unemployment rate is now blamed for a rapidly rising crime rate. With too few wage earners in the city, retail trade has also suffered.

| Fiscal Yr. | Gross Charges | Credits | Net Amount Raised by Taxation | Valuation | Tax Rates |
|------------|---------------|---------------|-------------------------------|----------------|-----------|
| 1970 | 32,528,687.66 | 9,413,755.16 | 23,114,932.50 | 154,099,550.00 | 150.00 |
| 1969 | 29,399,294.28 | 9,550,639.08 | 19,848,655.20 | 150,268,600.00 | 132.00 |
| 1968 | 28,080,102.13 | 10,143,832.93 | 17,936,269.20 | 147,018,900.00 | 122.00 |
| 1967 | 26,638,236.01 | 10,517,035.59 | 16,121,200.42 | 143,427,050.00 | 112.40 |
| 1966 | 25,609,207.92 | 10,094,812.80 | 15,514,395.12 | 141,554,700.00 | 109.60 |
| 1965 | 22,988,288.43 | 7,607,717.65 | 15,380,570.78 | 140,333,675.00 | 109.60 |
| 1964 | 21,050,820.83 | 7,703,993.27 | 13,346,827.56 | 137,880,450.00 | 96.80 |
| 1963 | 19,614,202.11 | 7,140,460.91 | 12,473,741.20 | 132,163,800.00 | 94.00 |
| 1962 | 18,244,296.31 | 7,143,557.35 | 11,100,738.96 | 130,311,450.00 | 84.80 |
| 1961 | 16,905,027.38 | 6,705,951.63 | 10,199,075.75 | 127,161,250.00 | 79.80 |

FIGURE 3
CITY OF LOWELL TAX RATE AND TAX LEVIES

It is a simple matter to conclude that Lowell's severe problems are strongly intertwined. To begin working to untie and resolve some of these problems, it seemed important to learn first-hand from city officials their own perceptions of the city. "What are the biggest problems facing Lowell? What would you do to solve these problems?" These questions were intended to help me (first) define and (second) find feasible solutions for the city's most imposing problems. Chapter 2 summarizes the city's response to these questions.

CHAPTER II
THE DYNAMICS OF LOWELL

Why was Lowell chosen as the site to begin an application of Urban Dynamics? Several factors contributed to its choice. The size and location of Lowell make the city ideal for implementation. It is small enough to have definable decision points, but large enough to have those mechanisms fairly well structured. Similarly, because of the lack of extensive bureaucratic filters (which would be found in larger cities), one could expect a more rapid response from the city. The location of Lowell provided hope that the suburb issue, which has confused many urban experts, would not become the stumbling block to our efforts. Little commuting to or from Lowell takes place. From a procedural perspective, Lowell was close enough to Cambridge to allow close contact between the M.I.T. group and the decision makers in the city. Because the city exhibits the characteristics of many other larger cities, it appeared that the results from the Lowell effort might be transferable to other cities as well. A most important factor, however, was a mutual respect between Professor Collins and Lowell City Manager James Sullivan.

Formerly the City Manager of Cambridge, Sullivan is a powerful Manager who makes clear his views on most important issues. He came into disfavor (much to his credit) with the City Council in Cambridge because of his uncompromising stance on major city questions. Recruited by Lowell which, like Cambridge, has a strong City Manager (versus a strong Mayor) form of government, Sullivan has restored respect and city-wide confidence

to a governmental structure in Lowell which had recently come under considerable local criticism. Only weeks before Sullivan moved to Lowell in October of 1970, a Charter Commission had, with strong public support, made the recommendation to do away with what appeared to be an inappropriate strong City Manager structure of city government, and to return to a strong Mayor. Evidence of Sullivan's overwhelming success in Lowell is the 2 1/2 to 1 margin of vote in the November, 1971 elections, to overturn the recommendation of the Charter Commission and retain Sullivan as a strong City Manager.

Jim Sullivan has taught periodically at the Urban Systems Laboratory at M.I.T. and has long been a believer in the merits of applying technology to urban problems. Even before the project described in this thesis was begun, Sullivan had read and agreed strongly with the theory of Urban Dynamics. He was as interested as the Urban Dynamics Group to see this theory applied to a real city, and was happy to offer Lowell as the "proving grounds." When Professor Collins called Sullivan to inquire about such a possibility, Sullivan enthusiastically invited me to spend the summer teaching him and his city about Urban Dynamics while simultaneously learning about Lowell.

During the next three months there was, in fact, an important exchange of ideas and information. As I became more familiar with the city, my confidence in the value of an Urban Dynamics application in Lowell grew steadily. Even in its presently generalized form, the model gives the perceptive observer a number of insights into potential sources of urban trouble. Many of these sources are clearly evident in Lowell. They are described

in the following pages.

After spending two days in City Hall reading about Lowell, talking to Sullivan, and setting objectives for the next three months, I began a series of interviews with various people throughout the city. These people included:

- One of the city's three Tax Assessors
- Several City Planners
- The Assistant to the President of the Chamber of Commerce
- Nearly all of the City Councilors
- The Editor of the Lowell Sun (the city's newspaper)
- The City Solicitor
- The president of one of the local banks
- A past City Manager of the city
- The President of the Lowell Housing Authority
- The owner of one of the city's mills
- The Housing Inspector.

The City Development Authority--Planning Arm of the City

Because Urban Dynamics is first and foremost a tool for policy planning, the first interviews were held with the three directors of the Lowell City Development Authority (CDA), the city's internal planning agency, to determine their own views concerning planning for Lowell. What are the city's major problems? Where is the city headed in the foreseeable future? Planning for a city requires that one continually ask these questions, yet Lowell's planners seem to be so burdened with present problems that little if any time is left to do long range planning. When asked "How large a population should the city contain?" there was a surprising set of responses. One director answered: "Two hundred thousand"; the second answered: "One hundred thousand"; and the third stated simply: "I don't know--I've never really thought about it." A one hundred per-cent

deviation of opinion of this--what would seem a major question constantly facing the city planner. Should not city planners be planning for people?

It is clear that planners, at least in Lowell, do not recognize their potential for influencing the future size or shape of the city. Instead, they focus upon responding to existing pressures within the city. They fail to see that their own efforts, over time, can and do influence the character of the city, and have as a result been partly responsible for the pressures that exist today, and the population which determines these pressures.

This misconception appears to be common among planners--common because of the nature of complex urban systems--not just in Lowell, but in most cities. Forrester pinpoints the common denominators of the reactionary (rather than anticipatory) nature of traditional city planning when he states:

In a very real way, our cities are being designed [not by city planners, but] by the dynamics of the urban structure itself. We have set in motion a self-directing system that is leading us into our "urban crisis." The present procedure for designing an urban system is to respond sequentially to the social pressures that develop. As each pressure arises, we attempt a direct assault on either the symptoms of difficulty or on what appears to be the immediate cause.

In searching for causes, we look close in time and location to the symptoms of difficulty. The nature of complex systems produces an apparent cause near to the symptoms. But this apparent cause is usually a coincident symptom and is not a lever through which the fundamental difficulty can be corrected. By accepting the apparent cause that the system presents, we are misled into action that merely shifts the symptoms of trouble to another point. We fail to reach the true causes that lie deeper and more remote within the system.

As we act to relieve one set of symptoms, we cause another set of symptoms to arise. The system itself determines a sequence of pressures which lead people from one action to the next, each action creating the next trouble point.

Unless the characteristics of complex systems become understood and recognized in city planning and in our national attitude toward the urban situation, those plans will fail. Most city development plans and national actions violate one or more of the requirements imposed by the fundamental dynamic nature of an urban system. (17)

This helps explain why the CDA appears to avoid taking action of any major impact. They have been treating symptoms (which is superficially easier but mechanically less effective) rather than finding the causes of problems and dealing with those causes. They do not want to be held responsible for "rocking the boat," nor do they have criteria for measuring alternative plans for rocking. Yet the city desperately needs to be rocked --and hard. No longer in need of land inventories and traffic analyses, (current CDA activities) the city instead needs a good measure of effort to stimulate industrial development. The CDA could, better than anyone else, help provide that measure. Unfortunately, they are still treating the symptoms of the city's decay. When I asked the directors what problem appears most crucial, they responded: "Parking." Inadequate parking facilities in the downtown area, they said, was inhibiting the city's economic redevelopment. I suspect that while this may in fact be true, there are other problems far more important which are being overlooked. Retail trade is suffering--but the cause of that suffering goes far deeper than a lack of parking facilities.

If the interview with its directors can be taken as evidence of the type of goals and objectives set by the City Development Authority, then the agency is not apt to succeed in getting to the source of the city's economic drought. Planners should anticipate and help adapt a city for the future.

Lowell's link with the future, however, seems weak indeed.

No achievable goals are guiding our urban planning. Without clear goals of what a city is to be thirty to fifty years hence, there is no basis for choosing between present alternatives. We must think that far ahead because the institutions, buildings, services, facilities and populations now being established will last that long. (18)

These statements are by no means intended to call to question the capabilities, credentials, or motivations of the CDA and its directors. In fact, I found these men to be extremely knowledgeable and genuinely devoted to making Lowell a better city. But good intentions and traditional planning tools are no longer sufficient to solve the city's complex problems.

Having spent some time thinking about the interview with the CDA, I approached Sullivan to discuss what I felt was a strong need to supplant present planning tools with a more comprehensive mechanism for projecting (and directing) the course of the city's future. I could not believe that a city as large as Lowell could have so large a void in the area of large-scale policy planning. Who decides upon questions of major impact? It would seem that the CDA, with its 20-man staff and several hundred thousand dollar-per-year operating budget would be best suited for integrating contemporary issues with plans for restoring the city's health.

Sullivan agreed that this is the way things should be. The City Development Authority was set up in order to bring formalized urban planning activities into the city. But the CDA was never given an opportunity to express itself and take part in major city-wide debates and the scope of its activities have fallen to a point where the agency makes planning-type motions, but almost nobody watches. The potential role of the CDA in

establishing major city policy is great, but to realize that potential will take some time and re-thinking of responsibilities.

That an Urban Dynamics model could ultimately provide a useful focus for attention by city planners is certain. Yet Sullivan revealed his control over the city's long-term decision making structure by stating that an Urban Dynamics model would be even more useful to a City Manager (directly) than through his planning staff. As he put it, the City Manager, more than any other individual or agency, is faced with the complex task of trying to solve the city's ills. Sullivan makes most of the important decisions. His enthusiasm for Urban Dynamics leaves open the possibility that our own efforts may, in time, form the basis for a more comprehensive policy making mechanism than currently exists. Sullivan frequently makes the point that there are only three viable decision-making tools. The first is a best guess. The second, which is better, is a best guess based on experience. The third, best by far, is a systematic approach to problem solving which may help eliminate the need to guess at all. Cities seldom have anything better than the first tool. Some have the benefit of experience. Sullivan wants Lowell to achieve the near-unique capability of utilizing the third tool.

The City Manager--The Primary Decision Point in the City

An example of Mr. Sullivan's extraordinary strength in Lowell was provided during the first City Council meeting I attended. The question before the Council was whether Chapter 842 of the Massachusetts Statutes--Localized Rent Control--should be adopted in Lowell.

Six months earlier Sullivan had appointed a committee to study the rent control bill in order to make a policy recommendation to the City Council. This committee, by a 6 to 3 vote, opposed the adoption of 842. The council would most likely have been happy to kill the issue and defeat 842, except that over 100 citizens (a near record at a City Council meeting), armed with minority reports and grievances against "slumlords" were on hand to get rent control passed in Lowell. Suddenly the Council members were torn between the constituency and the committee report. They responded as would any normal political body--they put forth the recommendation to the City Manager to convene a second committee to study the issue further.

At this point Sullivan asserted himself. He stated flatly: "My position on rent control is already well-understood. Rent control is like using an atom bomb when you only need a flyswatter. It's ruining Cambridge, it will ruin Lowell. I see no need to study the issue any further." With no further debate, 842 was defeated by the Council.

Sullivan uses his influence well. He takes great pride in his achievements in Lowell--as well he should. Fortunately, Sullivan's uncompromising beliefs have thus far been backed up by sound logic and experience. Sullivan aims to turn the city around. He will need new ideas and better planning tools as his city readies itself for the future. He does not need to be convinced, but only given the tools which can help devise a strategy for Lowell's revival.

It was decided that the best way to display the scope of applicability of the Urban Dynamics modeling process to Sullivan was to define a major

problem, analyze the forces which produce the problem, and submit a set of recommendations which show evidence of being effective for controlling and abating the causes of the problem. This, then, became the fundamental objective of the effort: first, to define the city's problems by talking with city officials; second, to refine a means for attacking those problems (the Urban Dynamics model); and third, to begin work to bring the expertise of the Urban Dynamics Group at M.I.T. to bear upon these problems.

Problems with Problem Definition--A Lack of Consensus

Defining Lowell's problems turned out to be less simple than it first seemed. The city needs new industrial development, but is this the problem? How can the lack of a potential solution explain the causes of a present problem? Clearly, it cannot. Instead, we must ask: Why is there little new development taking place? Why does the city have a 12-14% unemployment rate? What are the forces behind Lowell's dwindling tax base? Contributing to my own confusion in defining the city's problems was the fact that there was little consensus among important officials as to Lowell's most pressing problem. In fact, out of 15 interviews, at least 10 different major problems were cited, including:

- | | |
|-----------------------------|----------------------------------|
| 1. Housing | 6. Transportation |
| 2. Parking | 7. Federal and State controls |
| 3. Unemployment | 8. Poor housing code enforcement |
| 4. Taxes | 9. Education |
| 5. Inadequate City Revenues | 10. Crime |

One can't help but wonder whether Lowell's major problem is the fact that the city can't seem to agree on a major problem. Different people in cities perceive and are affected by problems differently. Each person wants

to see his most pressing problem solved, and complains loudly when solutions do not appear. Traditionally, City Hall has tried to allocate its limited financial and personnel resources in order to keep all problems under control. As a result, each problem gets some attention, but none are ever fully solved.

In reality, city problems are normally linked strongly with one another. The ten problems cited above, when considered from the perspective of say, the City Manager, have identifiable ties which are diagrammed in Figure 4. This figure is far more simple than would be required to fully encompass all of a city's problems, but even this simple representation underscores the nearly impossible task of problem-solving in systems in which everything affects everything else.

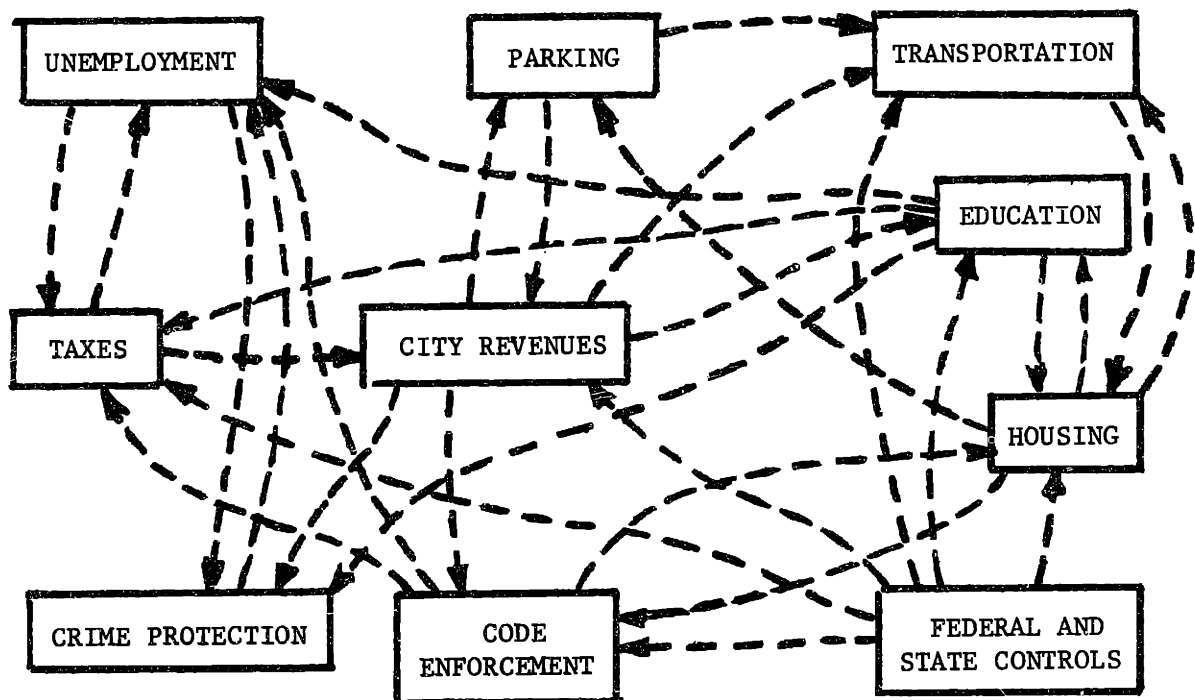


FIGURE 4

LOWELL'S INTER-RELATED PROBLEMS (SIMPLIFIED)

Consider the City Manager's constant pressure from the School Committee for a larger share of the city's revenues. Making this increased allocation will have both good and bad results. First the good results: the quality of education may rise; ultimately a better skilled and more knowledgeable generation may help reduce the city's high unemployment; a better educational system may also help lower the city's crime rate. But second, a number of painful side effects are also generated. Because fewer revenues are now available for maintaining and improving transportation and parking facilities, code enforcement capabilities, programs aimed at directly reducing unemployment (job training, etc.) and other supporting urban services (crime protection, health care, and public works), the adequacy of each of these other city components will diminish.

Less obvious is the fact that this extra allocation, even if it successfully raises the city's quality of education, may stimulate new pressures in the city which directly worsen other problems. For example, people may move to the city in order to take advantage of better educational opportunities for their children. These new families will require sewerage and solid waste facilities, will most likely contribute to traffic jams, will take up parking spaces, and will require additional police security. These extra demands upon the city may wind up worsening the city's imbalance between revenues and expenses.

How, then, does the City Manager make decisions with such complex and diverse effects awaiting every move? The answer is disappointingly simple. He makes guesses based upon his mental perception (and sometimes the perceptions of his advisors) of how the system works.

Unfortunately, this procedure has two inherent limitations. First, virtually no one's mental model of any complex system is a complete one. The city is far too complicated to be fully reflected in a mental abstraction. Second, our predictions of the response of the "mental model" to various policy changes (call this the process of "mental simulation") are often woefully inaccurate. Man cannot keep track mentally of large numbers of interacting variables--he is a poor "mental simulator." All too often we note that decisions based upon hunches or short-ranged political considerations range between being neutral to counterproductive for cities. These decisions are normally the result of both an incomplete perception of the system and an incorrect prediction of the behavior of the parts that are perceived.

Lowell's officials, in perceiving a multitude of problems, are each trying to "solve" the problem as they see it. As a result, none are succeeding. The value of a tool such as Urban Dynamics is that it can help to organize efforts to solve urban problems realistically. By drawing administrators' attention to a formalized model, the inherent ambiguities and incompleteness of mental models can be avoided. Placing the resulting model onto a computer helps further in reducing the inaccuracies associated with mental simulation. While the computer cannot "think," it can perform detailed analytical simulations much faster and more accurately than man. The computer, when armed with a logic supplied by those most familiar with the urban system, can be an extremely effective weapon for the makers of public policy.

With such tools, planners and managers can gain new insights into the

realistic trade-offs and options that exist in the city. New solutions to the city's complex problems can be achieved without "more of everything for everybody." Instead, the city must allocate the resources it controls in such a way that the spending of funds is consistent with whatever goals it has set for itself. Urban Dynamics, better than any tool yet proposed, may help find the allocations which are most consistent. To even a casual reader of Urban Dynamics, the fallacy of current multi-lateral assaults on city problems should be evident.

Most organizations, be they corporations or cities, avoid explicit goals because goals imply commitments and, even more important, any clear goal favors one group over another. Most city planning groups refuse to take sides; they want to be all things to all people; they subscribe to all conceivable goals. But if separate steps are taken toward goals that are incompatible, the result may be failure in all of the goals. (19)

The agonizing frustration felt by each administrator in the city is partly the result of his efforts clashing unexpectedly with those of his compatriots. Lowell (and probably most cities) needs a mechanism which will align the objectives and efforts of city agencies and departments. As it currently functions, the city is composed of functional areas each of which have been set up to deal with specific problems, but none of which can solve those problems because of the counteractive efforts of the other functional areas. Goals need to be made more consistent with the realities of urban life. But we cannot hope to restructure city mechanisms in three months or even three years. All we can hope to do is provide strong evidence to the city for a change in priorities. The purpose of the summer project was to present some of this evidence.

Tax Assessment--Part of the Problem?

One of the city's three tax assessors helped to start building this body of evidence. He explained that the city's tax policies, like most other Massachusetts cities, fail to comply fully with state restrictions. For example, whereas a privately owned home is supposed to be assessed at "fair market value" (an unworkable term which is normally an approximation for purchase price), homes in Lowell are instead assessed at 37% of "fair market value." The owner of a \$24,000 home, assessed at 37% (or \$9,000), pays taxes on only that \$9,000 value. Upon further investigation, I found that income producing structures are taxed on the basis of gross yearly income rather than on fair market value. Apartments, for example, pay yearly tax bills of 23% of their gross yearly income.

The assessor also stated that abatements (a lowering of assessed value) have been given to most of the large mill properties. The mills, no longer as profitable as they once were, could not afford to pay taxes based upon the old assessed value. Trying to be fair, the city's assessors have frequently eased the tax burden of these faltering mills by reducing their assessed value. Rather than analyzing here the implications of these and other facts learned from the assessor, Chapter IV will summarize the apparent problems associated with observed policies and will propose new policy alternatives based on these insights.

It should be noted at this point, however, that because assessing is largely a local policy rather than an imposed federal or state policy, the city has control over how that policy is designed and used. Throughout the summer effort, it was important to separate those decision elements

over which the city has control from those over which it does not. Because the summer effort was aimed at helping Lowell "solve its own problems," it was necessary to isolate potential solutions which are free of the control or legislation of other governmental structures.

Housing--Problem or Solution?

Several of the city's officials mentioned housing as contributing to the city's problems in one manner or another. Perhaps the best argument to this effect was supplied by the city Solicitor. He stated that the city now contains over 4,000 substandard housing units (or nearly 13% of Lowell's 31,000 total housing units). This does not include units which have been condemned and forcibly vacated by building inspectors. A big problem, according to the Solicitor, is that this abundance of cheap housing destroys the economic balance of the city by drawing excessive numbers of poor into Lowell. This growing imbalance is placing extra loads upon the school system, the police force, the social welfare system of the city and, in general, is doing more harm than good.

The Solicitor wasn't out to infringe upon people's basic rights, nor did he want to make strong value judgments, but he felt that there was simply too much housing available for low income people who want to move to Lowell. These people bring with them the problems of the regions from which they came. He strongly urged that more stringent code enforcement was needed in the city. With stronger codes, substandard housing units would be either upgraded (and rents increased accordingly) or condemned and shut down completely. Either way, the influx of the very poor to Lowell

would be brought back into control. Evidence that the influx is currently disproportionately large is that the number of Black and Puerto Rican families has doubled in the past two years.

The City Solicitor felt that until one can control the processes which breed urban blight, the problems will worsen. Lowell, once a proud city with large one-family homes, is no longer proud, and its homes have been split into two- and four-family apartments. An increasing housing supply (not in quality, but quantity), when coupled with the city's weak economic base, lies behind Lowell's unemployment problem. The Solicitor was convinced that this unhealthy trend could be brought back into a better balance if the city's housing codes were strengthened and better enforced.

One promising development for the city is the recent receipt of a \$140,000 demolition grant from the Department of Housing and Urban Development which will help the city remove the worst of its blighted areas. Yet during the past 14 months, this money has hardly been touched. The primary reason is clearly a set of lengthy procedural delays involved with demolition. The city must put out bidding opportunities to at least three demolition companies; the city must relocate residents if necessary (which is also costly); and the demolition itself takes considerable time. Only after these delays and a series of complex reports does the city qualify for reimbursement.

Lowell Housing Authority--Solving the Housing Problem?

Whereas the City Solicitor blames the city's problems on too much low income housing, the President of the Lowell Housing Authority takes the opposite position. His agency's purpose is to maintain the existing 1,500 units of subsidized housing and to build more as it becomes necessary. While I was sympathetic to his statements concerning the lack of any good planning facilities in Lowell, I began to see that the Lowell Housing Authority stands as a clear example of an agency whose operating goals conflict strongly with those of other city functions.

The conflict is not the fault of the people within the LHA. Rather, it is an inherent problem of the social and governmental structures in nearly all cities. The city's evolving set of cause and effect mechanisms is evoking human responses which run counter to the long-run health of the community as a whole. As urban problems appear, agencies and departments are set up to control these problems. But normally the origins of the problem, as well as the eventual impacts of the newly created agency, lie well outside the limits of authority of that agency. The result is that the problem is often aggravated as a result of the agency's direct assault on the perceived problem. Designed to meet a city's critical housing needs at the end of World War II, the LHA is having a profound and dangerous effect upon present day Lowell. A short look at the operations of the LHA will reveal both the direct (first order) effects as well as the undesirable secondary effects which are being felt in the city.

The Lowell Housing Authority continually places residents of Lowell onto a waiting list for subsidized housing. These are people who qualify for

housing, but for whom it is not yet available. Currently the list contains 650 families. On the basis of the number of people on this list, the LHA applies to HUD for funds to construct additional units. Generally, an application will be to house 1/3 of the current list, or in this case approximately 200 additional units. In fact, during the summer an application for these 200 new units was approved by HUD.

This is all fine and good for the LHA, but what happens to the rest of the city? As the city's supply of good quality, low income housing is increased, there are bound to be families who move to Lowell to take advantage of the opportunity to improve their life-styles. Ninety-nine per-cent of those who move into the new subsidized housing are already Lowell residents, but the units which these people leave vacant are filled by people from outside the city. The inevitable result of adding subsidized low-income housing is to add to the number of poor in the city. And because the city is no richer for its actions (indeed, it is poorer, due to the increased load placed upon the city's services), the forces behind the deterioration of housing have by no means been reversed. Instead, they have been increased. Unless an increased demolition rate of such structures is initiated, the size of the pool of "bad" housing will grow, lengthening the LHA waiting list, and building more pressure to build still more subsidized housing. The dynamics of disaster are terribly clear in Lowell's subsidized housing system. Unfortunately, they are equally clear in most other cities.

To compound the problems, cities currently evaluate their housing authorities on the basis of how much housing is produced and how well it is

maintained. The limits of responsibility and evaluation of the LHA are presently drawn too narrowly. The effects of present LHA policies, if continued, will place increasingly severe strains upon the rest of the city's already faltering economic and social strength. The city must structure such major activities as these to take into account not only the immediate consequences of actions (more housing), but also the long-run consequences (higher crime, worse education, higher welfare costs, etc.). New priorities and evaluative criteria need to be developed in all cities with regard to subsidized housing. Until then, we cannot fault the city's Housing Authority for fulfilling its own (albeit potentially countereffective) responsibilities.

Industrial Space in Lowell--An Oversupply of Old Factories

One of the last interviews of the summer succinctly revealed the degree of economic decay in Lowell. The president of the Hub Hosiery Mills, one of the city's large mill structures, mentioned the fact that he rents his floor space for users at 60-65¢ per square foot. Meanwhile, a new Avco plant, recently forced to close, is renting at \$2.50 per square foot. The 60¢ per foot rental cost in a structure located close to the heart of the city illustrates the extreme degree to which the supply of manufacturing space exceeds the demand.

As a result, companies operating at very low margins and with very few workers can conveniently locate in this space. Upon entering a mill such as this, one can visually experience both the excitement of the early city and the pathetic conditions which have brought this activity to a near

standstill. The city's economic depression is manifest in the frequent bankruptcy of enterprise.

REAL ESTATE

**MORTGAGEE'S SALE OF REAL
ESTATE AT PUBLIC AUCTION**

LOWELL

FRI, SEPT. 24, 1971 at 11:00 A.M.
on the premises

**Beautiful
MANUFACTURING FACILITY**
(Zoned I.P.—Industrial Park)

Single story, concrete block, air conditioned, sprinkler system, double loading dock, within five years old, renewal area, minutes from Rtes 3, 495. Building covers about 60,000 sq. ft. on lot containing 211,000 sq. ft. Bounded by Aiken, Hall and Cabot Streets and by Northern Canal. (Recently occupied by Gambits Shoes Inc.)

TERMS: Fifty Thousand (\$50,000) Dollars deposit in Cash or Certified Check, other terms at sale.

HARRY J. MYERS JR.
AUCTIONEER
426-6422

FIGURE 5

BOSTON GLOBE REAL ESTATE ADVERTISEMENT (20)

These interviews left a number of impressions. Most important, nearly everyone interviewed was extremely cooperative. Each was genuinely looking to help his city. Enthusiasm for an approach such as Urban Dynamics was clear, and each volunteered his services should they be of use in the future. The city's problems are not the result of an unresponsive

or irresponsible administration.

Instead, they are primarily economic. Factories are being misused. Current assessing policies appear to inadvertently produce biases which are aggravating the problems of the city's economy. Industrial development is being stalled. The city's response to a shortage in the supply of good housing for its poor is also open to question. To fully develop the ideas of this chapter into a consistent definition of Lowell's problems they will have to be integrated and analyzed in such a way that the full range of the feedback mechanisms in a city can be considered. With such an approach, problems can be separated from causes; solutions will be identifiable.

Lowell's problems are deeply rooted in the city's complexity. To fully understand the problems, we would do well to find a tool which reflects this complexity. Preliminary efforts to develop this tool by refining the general Urban Dynamics model are reported in the next chapter.

CHAPTER III

MODIFYING THE MODEL TO DESCRIBE LOWELL

Can the Urban Dynamics model be adapted to describe a specific city? This question, even before it was raised with respect to Lowell, has been asked by people interested in applying the model to their cities and who feel that, as it stands, the model is too general. They want to see their city react to policy alternatives, not a hypothetical city.

This chapter is written to illustrate how preliminary efforts to "fit" the model to Lowell were carried out. Those seeking to refine the Urban Dynamics model to better represent particular cities may find the techniques used here helpful, or perhaps they will feel that the changes to the model are inadequate to do the job of making a general model specific. To a large extent this criticism is justified. Considerably more time and effort will be required before the model can fully address all of Lowell's important problems and help test many potential solutions.

The purpose of the preliminary modifications was to determine the advisability of extensive model refinements in the future. Does the general theory of Urban Dynamics appear relevant in explaining Lowell's past and present? If so, then our confidence in this general theory, and the potential benefits of adapting the theory to a real city, will be enhanced. Rather than an attempt to "prove" the validity of Urban Dynamics, the following pages describe a controlled experiment in which the general theory is tested. Theories cannot be proved; only the absence of disproof keeps theories alive. Yet scientific experiments can lend support to theories in specific circumstances. In this case, the test is whether Urban Dynamics can describe Lowell.

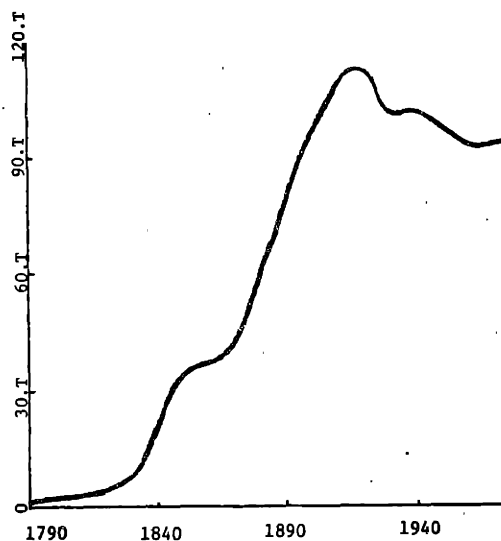
The theory of Urban Dynamics is manifest in the structure of cause and effect relationships in the model. The similar behavior of growth and decline found in most U.S. cities implies a common underlying causal structure. Variations within this behavioral pattern arise not because structures differ from one city to another, but because the parameters within the structure vary according to regional differences. Written originally to bring attention to this common structure rather than any special set of parameters, Urban Dynamics describes all cities, but none in particular.

This generality may be theoretically viable, but from a decision-maker's point of view, leaves too much room for doubt and misconception. From a pragmatic perspective, then, let us examine the question of whether a general model can be useful for studying specific cities.

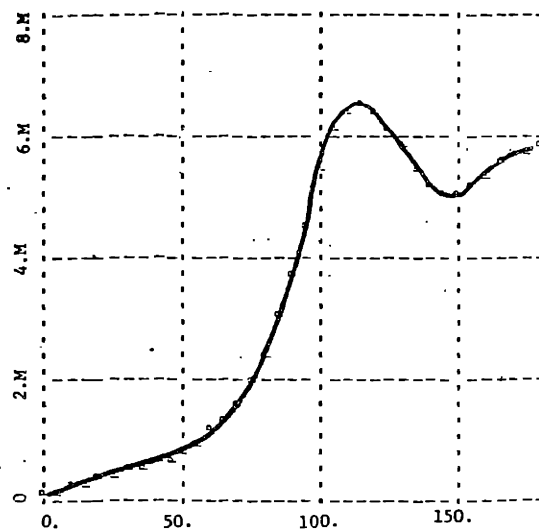
In looking for an empirical measure with which to gauge the Urban Dynamics model, one can begin with the population figures for the city. This data is easily obtained, and can be readily compared to the model's behavior as a test of its accuracy. This data, presented in Figure 2, is reproduced here and contrasted with the population curve from the original growth model in Figure 6.

The similarity of these two curves strongly suggests that the forces which have produced Lowell's history are also found in the model. The growth slope, the sharpness of the peak, and the amount of decline are strikingly similar.

Few people seem to realize the extent to which this exponential growth, stagnation, and decay behavior is characteristic of nearly all U.S. cities. In fact, several critics of Urban Dynamics have raised doubt concerning whether cities normally experience a falling off of population as they approach old



Lowell's Population History



Urban Dynamics Growth

FIGURE 6

LOWELL'S GROWTH CONTRASTED WITH URBAN DYNAMICS GROWTH

age. Figure 7 makes clear the fact that many major U.S. cities have displayed not only exponential growth, but also a declining population once they reach age 150.

Our familiarity with these major cities should be sufficient to preclude any lengthy discussion of the problems found in each. Yet it seems worth reiterating a point made in Urban Dynamics, which relates the severity of urban problems, in general, with the age of the city. The cities in Figure 7, some of our oldest, are also among our most troubled. Lowell, although vastly different in size, appears to have developed in much the same manner as these cities, and is today feeling the same pains as are being felt by our larger urban centers.

This common behavior stands as evidence that the cause and effect mech-

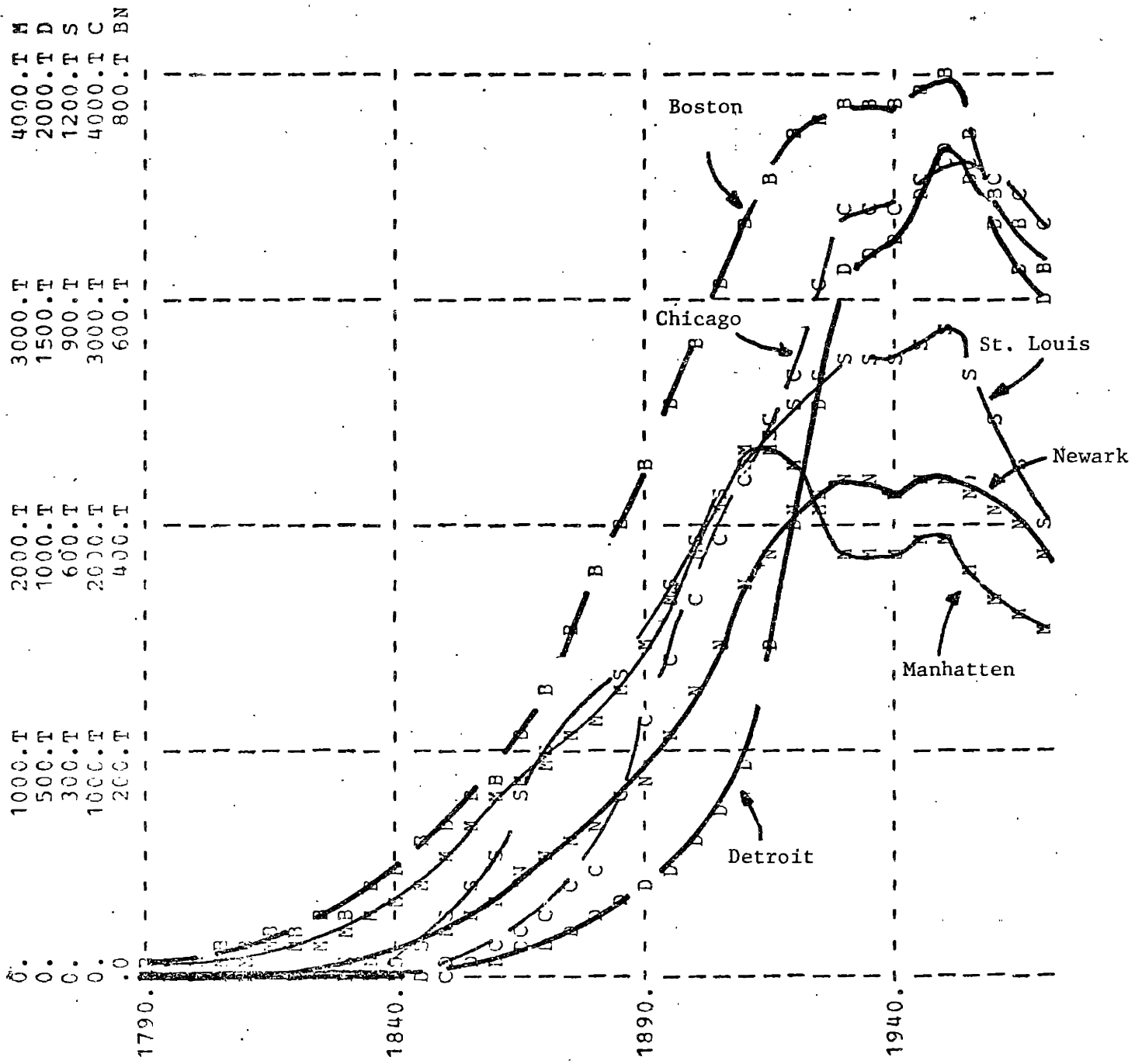


FIGURE 7

Growth Curves of other Large U.S. Cities

anism found in most cities, regardless of size or location, are fundamentally similar. As a result, there is hope that new programs and policies which help solve the problems of one city may also be useful for other cities. This was Forrester's initial assertion, and subsequent empirical findings have given additional credibility to the concept of a common urban structure.

LOWELL'S PARAMETERS

A brief comparison of the curves in Figure 7 suggests some obvious parametric discrepancies between Lowell and the Urban Dynamics "city". Looking first at the size of the population which inhabits each city at its peak, it is clear that Lowell has either a smaller overall area, or a lower living density, or both, than the model "city". This is an easy hypothesis to verify.

A recent land use inventory taken by the City Development Authority proved helpful in defining both Lowell's total and effective land area. Whereas the city's legal boundaries encompass an area of 14.1 square miles (or 9,000 acres) only a fraction of this total land is "usable" in the sense of its being built upon by either housing or industry. Only the "usable" or, as it will be called here, "effective" land area, is important from the standpoint of the Urban Dynamics model. Let us define Lowell's effective land area.

Residential land use in Lowell is approximately 3,200 acres. Manufacturing land use is 256 acres, while land in use by Trade firms is 236 acres. An additional 5.8 acres are occupied by "Vacant Buildings". Of the re-

maining 9,000 acres, 2,351 are taken up by Roads, Utilities and Parking Facilities. Another 725 acres are Recreational and Quasi-Public. 620 acres are Public Service and Charity. Land covered by water is 160 acres. Finally, agricultural land is 1,420 acres. Hence, Lowell's land-use breaks down into two major categories: (1) land upon which people live and work:

| | |
|---------------|-------------|
| Manufacturing | 256 |
| Trade | 236 |
| Residential | 3,200 |
| Vacant | <u>6</u> |
| | 3,698 acres |

and (2) land which provides amenities, but which is less essential to the city's job market and tax base:

| | |
|-------------------------|--------------|
| Right of way | 2,351 |
| Public | 620 |
| Recreational & Cultural | 725 |
| Water | 160 |
| Agriculture | <u>1,275</u> |
| | 5,276 |

TOTAL

8,974

Forrester, in the original Urban Dynamics model, implicitly included roads as part of the city's land. I have chosen to remove roads from consideration, since it is difficult and misleading to try to define whether roads should be considered part of the land used by production units or by housing, or how it might be divided between the two. All cities have roads, and in all cities, roads take up approximately 25-30% of the total

land. It is normally a simple matter to find the exact area taken up by roads, and one does not normally think of his house or business as including a portion of the city's streets. For these reasons, it appears both natural and possible to exclude streets from the city's effective land area. Because the other land uses in category (2) are clearly not reflective of the land uses described in the Urban Dynamics model, it should be evident that the effective land area of Lowell is 3,698 acres.

The original model contains an area of 100,000 acres. Our hunch that this area would be smaller for Lowell is certainly correct.

A survey of the 1960 Population by Census Tract data for Lowell revealed an additional set of discrepancies between the original model's parameters and those of Lowell. The family sizes in Lowell are smaller than those used by Forrester. Soon after the publication of Urban Dynamics, one of the members of the Urban Dynamics research staff pointed out the fact that the national average family size is approximately 4.1, whereas Forrester had postulated values of 5 for Managerial-Professional, 6 for Labor, and 8 for Underemployed Families. Some of this difference can be attributed to a difference in definition, but Forrester's figures continue to seem high. The figures for Lowell appear to be close to the national average.

To determine the parameter values for each of the respective population categories, I first separated Lowell's 25 census tracts (a tract is a geographical unit which normally contains about 4,000 people) into 3 income groups. It was assumed that the three or four upper income tracts contain primarily Managerial-Professionals, while the tracts with a family income

near the city-wide average contain Labor families, and finally the tracts near the bottom on the income scale contain mostly underemployed. By examining other characteristics of these same tracts, I was then able to determine the family sizes (total population of the tract divided by the total number of families) for each income category.

For example, tracts 14, 15 and 25 have the highest median family incomes (\$6,909, \$7,700 and \$7,471 respectively) and contain a total population of 11,660. These three tracts also contain a total of 3,042 families. Simple calculation reveals the fact that, in these upper income tracts, there are 3.8 persons/family. This is contrasted with a figure of 5 persons/family in the original model.

To find the Labor Family Size parameter, exactly the same procedure was used, only this time for the three tracts whose average family income was closest to the city-wide average. In these three tracts there were 12,001 total population and 3,126 families--yielding a Labor Family Size of 3.9 persons/family.

For Underemployed Family Size, I picked the 6 tracts with the lowest income, and then dropped the two lowest in order to avoid any extreme conditions. I disregarded, for example, tract 10, whose median income was \$2,144 (almost half that of the next lowest) and concentrated upon tracts 1, 9, 11 and 24, which had median incomes of \$4,683, \$4,512, \$4,668 and \$4,573 respectively. Total population in these tracts was 9,464, while the total number of families was 2,222. The value for Underemployed Family Size, then, is 4.3 persons/family contrasted with 8 persons/family from the original model.

Summarizing, the following family sizes for Lowell and the original values found in the model are as follows:

| | Lowell | Original |
|------|--------|----------|
| MPFS | 3.8 | 5 |
| LFS | 3.9 | 6 |
| UFS | 4.3 | 8 |

It should be quickly pointed out that there is no reason to believe that these values have remained unchanged throughout Lowell's development. During Lowell's early years, for example, single girls worked in Lowell, and by the model's definition, the family size might have been smaller than it is today. But, since the purpose of the model is to test policy alternatives for the period 10-30 years hence, the model should most closely reflect the present and future of the city rather than its history. The values computed above are apt to prevail for the foreseeable future and should be used during policy-testing.

What about the normal housing densities in Lowell? Again, members of the research group have pointed to the fact that the living densities found in Urban Dynamics seem to be too high. Is this true for Lowell? Using the same tracts as were used earlier, but this time drawing upon Housing statistics from the 1969 Census Tract data, some observations were made.

As might be expected, the highest proportion (nearly 75%) of the housing structures in the low income tracts were "multi-family." Since in many cases this means more than two units per structure, it was assumed that, on the average, there are two units per structure in these tracts. Equivalently, each low income structure is assumed to house 2 low-income families, or

about 9 people. This is considerably less than the 12 persons per structure proposed in the original model.

In the middle income tracts, the percentage of structures which are multi-unit dropped to 60%, which is the city-wide average. These figures indicate a slightly lower number of units per structure. A reasonable guess is that 1.75 units per structure is characteristic of middle income housing in Lowell. This yields a normal Worker Housing Population Density of 7 people--close to the 6 persons per structure used in Urban Dynamics.

The number of multi-unit structures was low (30%) in the most affluent tracts. With this in mind, a housing density of 5 people (or about 1.25 families) per Managerial-Professional housing structure is assumed. The differences between the original model and Lowell with respect to normal housing densities are summarized below:

| | Lowell | <u>Urban Dynamics</u> |
|------------------------------------|--------|-----------------------|
| Premium Housing Pop. Density | 5 | 3 |
| Worker Housing Pop. Density | 7 | 6 |
| Underemployed Housing Pop. Density | 9 | 12 |

During the process of studying Lowell's housing, it became clear that the 1/10 acre per housing structure (LPH) in Urban Dynamics is too low to represent Lowell. Reflective of a city with an extremely high living density, this 1/10 value is accurate for Manhattan, perhaps, but not Lowell. There are, for example, 11,000 single-unit homes in the city. Simultaneously, 2,196 acres of land are currently occupied by single-unit structures. This yields a figure of almost exactly 2/10 (0.2) acres per housing structure.

If the land per housing structure is considerably higher in Lowell,

isn't the land per productive unit (LPP) also apt to be greater? Figures for Lowell indicate that there are approximately 27,000 workers in the city. With 491 acres in use by manufacturing and trade, Lowell has a normal worker density of approximately 55 workers per acre. Urban Dynamics, even if it were to contain 100% Declining Industry, indicates a minimum of 80 workers/acre (there are 16 workers in a Declining Industry which, in the model, occupies 0.2 acres). The difference between 55 (Lowell) and 80 workers per acre suggests that productive units occupy considerably more space in Lowell. Changing LPP from 0.2 to 0.3 acres would make the employment characteristics associated with productive units in the model come far closer to representing Lowell. With an LPP of 0.3, the minimum worker density of the city drops from 80 workers/acre to 53 workers/acre--a good approximation to the actual city.

A Summary of Parameter Changes

| Parameter | Lowell Value | Original Value |
|-----------|--------------|----------------|
| AREA | 3,698 | 100,000 |
| MPFS | 3.8 | 5 |
| LFS | 3.9 | 6 |
| UFS | 4.3 | 8 |
| PHPD | 5 | 3 |
| WHPD | 7 | 6 |
| UHPD | 9 | 12 |
| LPH | .2 | .1 |
| LPP | .3 | .2 |

These nine parametric changes, when inserted into the model, produce the computer run shown in Figure 8. The actual population curve for Lowell

has been superimposed onto Figure 8 to facilitate a comparison between model behavior and the city's history. While by no means perfect, the "first order" of fit between these curves is significant.

By "first order," I am referring to the growth pattern, the nearly identical peaks (both in time and magnitude), and the decay to a nearly identical value in 1970. From 1900 until 1970, the model and the city are never more than 10 years apart. There is reason to hope that the model will be at least as accurate over the next 50 or so years.

Further similarities between the model and contemporary Lowell can be seen if we take a closer look. Instead of losing accuracy as the inspection gets more precise, the model reflects important detail. For example, the model tells us that in 1970, 44% of Lowell's workers are underemployed. According to a recent urban planning commission report (21), there are 3 underemployed people for every unemployed in our cities. The model thus indicates that Lowell's unemployment rate in 1970 was about 11%. In fact, the yearly average unemployment rate in Lowell during 1970 was 10.9%.

The previously mentioned land inventory indicated that 17.4% of Lowell's total land is currently undeveloped. The model, as can be seen in Figure 9, yields a Land Fraction Occupied which is 83%--also indicating a 17% fraction of total land undeveloped.

Numerous other similarities between the model and the city can be found, while there are also notable behavioral differences. The model is by no means detailed enough, nor have its boundaries been so drawn, to capture every fluctuation and movement found in Lowell's history.

UHR=U, LHR=L, UHR=1, LR=1, UR=2, UR=3, LF0=0, TRN=*, TR=T

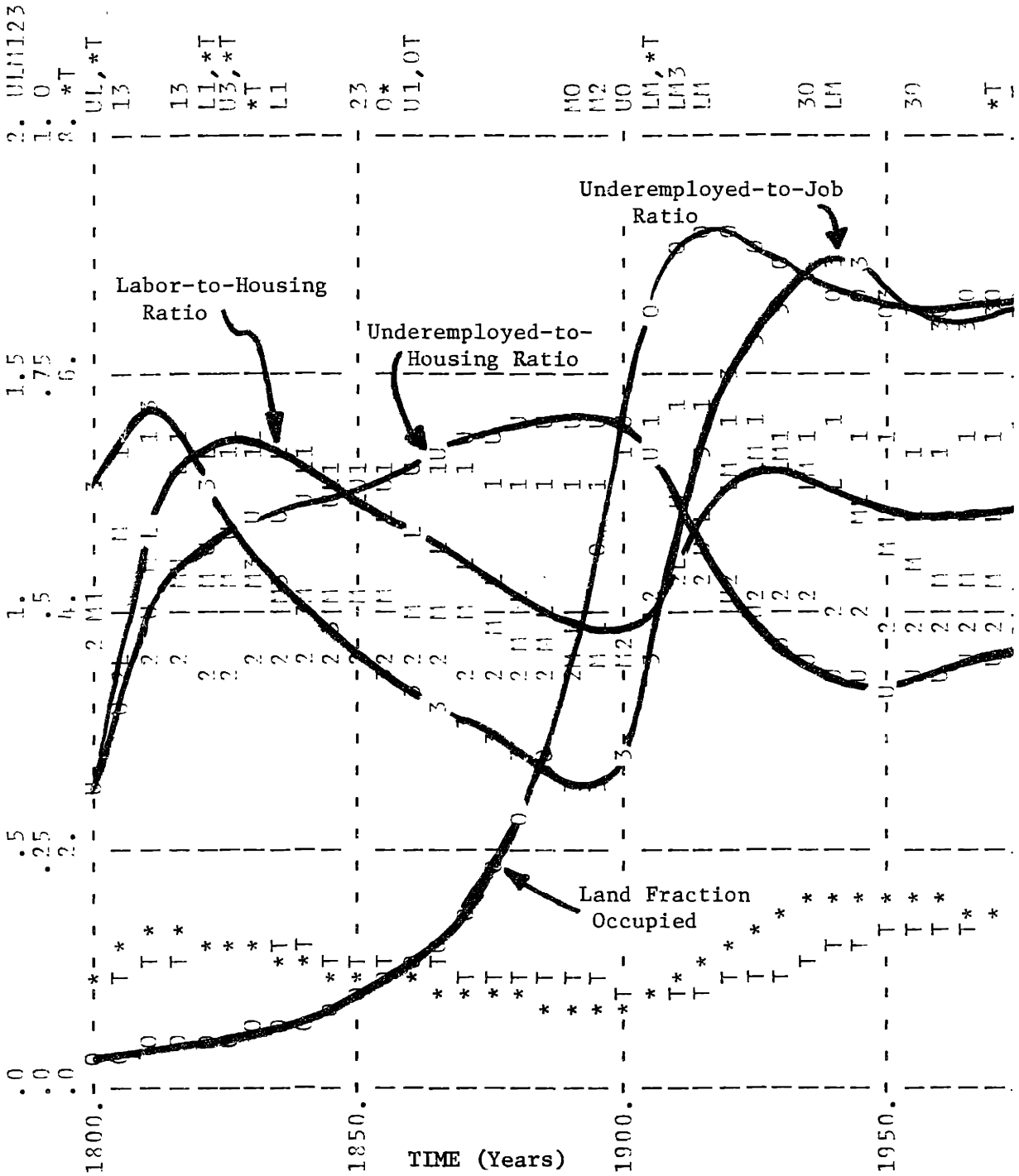


FIGURE 9

ECONOMIC INDICATORS FROM SAME RUN

Consider, for example, the substantial gap between actual history and the model's behavior during the early growth phase of the city (1830-1850). This discrepancy may seem unreasonably large to someone who considers historical accuracy to be the main criterion for model validity. Yet it is fundamental to System Dynamic modeling that this behavioral evaluation not be given unwarranted importance, for if the empirical differences are the result of exogenous forces acting on the real system rather than internal dynamics, then we would not expect the effect of these forces to appear in the behavior of the closed-loop model.

Why did Lowell grow by over 300% (from 6,000 to 20,000) during the period 1830-1850, while the model grows by only about 30% during this same time span? The primary reason seems to have been a unique match between the city's geographical characteristics and the technological needs of the textile industry in the early 1800's. With huge reserves of water power and good access by river for the shipment of raw and finished goods, Lowell was an ideal site for the construction of large textile mills in a period where water power and water transportation prevailed. Within a ten-year span, more than 10,000 jobs were created in Lowell. Simultaneously, factory-owned housing was created in order to better attract workers to the area.

The forces which were responsible for Lowell's early growth were not caused by Lowell. Lowell benefited from the match between its resources and the needs of industry, but as technology advanced, Lowell's geographical attractiveness fell back to that of other nearby regions. There is no place in the Urban Dynamics model's permanent structure for these transitory

influences. Because we would not expect Lowell to develop today (if it were empty) as it did originally, we should not expect a model designed to help explain and improve contemporary Lowell to perfectly reproduce that unusual development.

System Dynamics models are used to analyze and improve feedback (or closed loop) systems. Unless a force which influences the system is also caused by the system, then it does not belong inside the model boundary. This general modeling philosophy insures that System Dynamics models contain only the decision mechanisms influencing the system over which the system has jurisdiction. The Urban Dynamics model is no exception.

The most valid modeling action aimed at improving behavior (reducing gaps) of the Urban Dynamics model in this case would be to introduce the early effects as exogenous variables and keep a clear understanding that the model's accuracy as depicted in the run in Figure 8 is not enhanced by the presence of these exogenous variables.

Figure 10 contains one potential set of exogenous influences upon the normal industrial and residential construction rates. Assumed is that from 1824-1839, industrial construction in Lowell was five times as great as it would have been without its particular geographical advantage. Similarly, a five-fold increase in housing construction is assumed to have taken place from 1826-1844. Figure 11 shows that these modifications accomplish the objective of making the model and the city behave more closely. The model which generated Figure 11 represents exactly the same model structure as Figure 8, only the forces which induced Lowell's tremendous growth have been introduced as exogenous variables. The model has not been made more

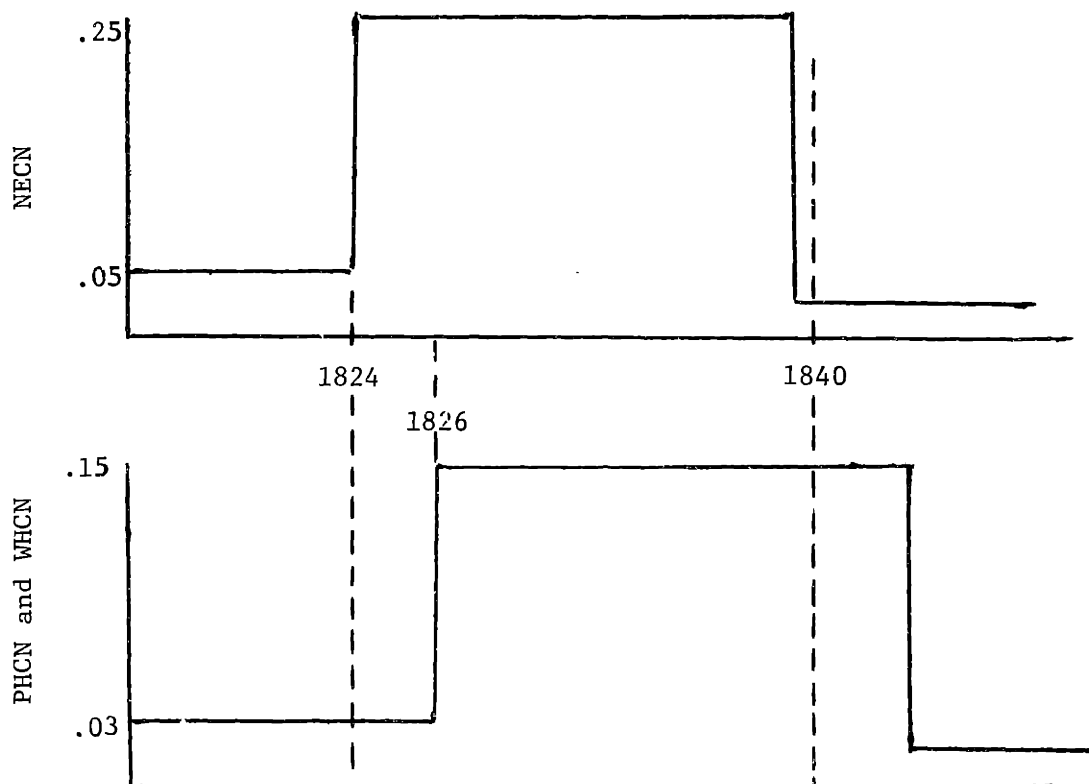


FIGURE 10

CHANGES MADE TO NECN, PHCN, AND WHCN

TO BETTER DESCRIBE EARLY LOWELL

accurate; instead, our understanding of the city in light of the model's structural requirements is such that the forces behind the city's rapid development have been represented, only exogenously.

Additional refinements of exogenous forces could, of course, produce a model whose behavior perfectly traced Lowell's history. But this model would afford no more precision in designing new policies for Lowell than that which generated Figure 8, since no internal structural changes have been made. At this early stage of model development, it seems that the "first order" manner of fit found in Figure 8 is support for the hypothesis that

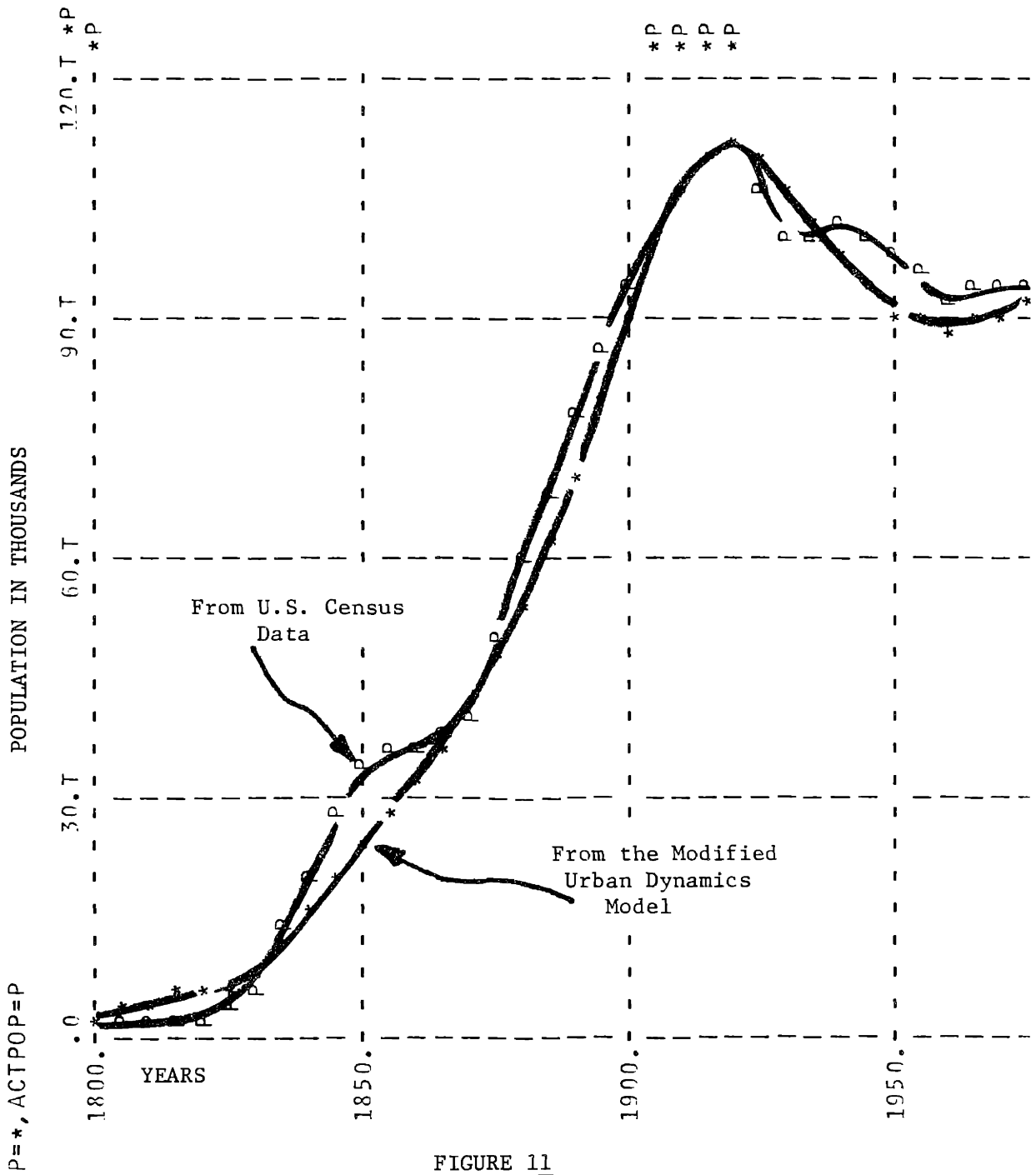


FIGURE 11

FURTHER MODIFICATIONS TO THE LOWELL MODEL

the lasting and important characteristics of the city have been incorporated in the original model. As work to further modify and refine the Urban Dynamics model continues, it is done so with the conviction that the model's basic structural framework is the proper one for describing and, eventually, improving Lowell.

CHAPTER IV

SOME NEW DIRECTIONS FOR AN OLD CITY

In order to revive a city, one must first understand its illness. Treating symptoms in biological systems has often proved fatal (consider the early medicine man who placed his fever victim in cold water). It now appears that treating the symptoms of urban problems may be no less dangerous.

Chapter II has pointed out that city officials' good intentions are not alone sufficient to guide the city through its troubled life-cycle. The fundamental parallels between Chapter II and the assumptions underlying the Urban Dynamics model point to the inherent problems of managing and designing change for cities. Cities are complex, whereas the human mind is poorly equipped to fully trace the dynamics of this complexity. As a result, projects and programs often fail to achieve their desired objectives. Our best guess (based upon our mental perceptions) of the reaction of the city to policy changes is often incorrect. In the next few pages, some current policies of Lowell will be scrutinized with the aid of the Urban Dynamics model. A dynamic analysis will show how the city's present assessing, demolition, federal housing, and zoning policies may be having undesired and unforeseen effects. Changes to such policies, based upon preliminary insights (rather than a complete computational examination) from the model's logical framework will then be proposed. The purpose of this chapter is only to illustrate the scope of policy testing that can be carried on with a simulation model. Considerably

more research will be necessary before these, or any other set of policy changes, can be fully analyzed and assessed for Lowell.

It should be emphasized that new policies can, at this point, be only qualitatively presented. A more detailed model will be required before policies can be quantitatively specified and their results fully simulated. The next chapter will specify some areas of the model where detailed refinements may be useful for designing new policies with precision.

Keeping in mind not only the present state of the model, but also the political realities in Lowell, an important qualifier should be added to the type of policies to be treated. They should be ones which not only appear promising, but which are also relatively painless to implement. "Relatively painless" refers in this case to three basic factors. First, the amount of disruption which the change will impose upon the city must be considered. People will not change long-followed traditions overnight. Policy changes which rely upon altering well-entrenched social norms have little chance of real or early acceptance.

Second, any changes must minimize the degree to which those in power (overtly or covertly) will feel threatened. If jobs are jeopardized, or potential revenue sources taken away, there will be strong opposition by those sectors of the city which come under attack. A practical reality limits the type of programs worth considering.

Finally, the cost of the change to the city (in dollars and cents) is critical. Programs with great promise are apt to be overlooked in favor of superficially appealing plans if the cost of the former greatly

outweighs the latter. Lowell's skyrocketing tax rate is evidence of the critical financial shortage facing the city. There are simply no funds to be offered to even the most impressive plans. Because each of these three constraints are present in Lowell, the problems to be faced must first be studied under these limitations.

Direct Mill Demolition

An example of a potentially good policy which falls down in one or more of these three practical criteria is the demolition of old mills. If demolished, the vacated land could be offered to new industrial developers which would, with near certainty, put the land to more efficient use. Part of Lowell's problem appears to be that the good land in the city is nearly all developed. Old mill structures are choking off new, more productive development. These old mills also offer very little to the city's tax base because, as the assessor stated, nearly all of the mill owners have received substantial abatements.

Because the mills do house some industrial activity (and employ some workers), demolition will initially mean higher unemployment for the city. In addition, mill owners are apt to strongly oppose forced demolition or major renovatiovation since none have chosen to follow this practice voluntarily in the last several years.

The most compelling argument against a mill demolition policy, however, is financial. The mills are large, well-built (at their base, many are 6 feet of brick thick), and incredibly costly to demolish. Private owners cannot be expected to absorb this expense, nor can the city afford to do so. Federal or state money for industrial demolition does not

exist except as a portion of an Urban Renewal plan. In short, the mills are apt to be around a while longer.

With the city convinced that the mills have outlived their usefulness, new firms are discouraged from locating in the mills because of an ever-present threat that the structures will be removed in the near future. It seems likely that public criticism of the mills is a major force which virtually guarantees their low marginal contribution to the city. To reverse the city's self-fulfilling negative approach to its aging industrial base, new perspectives are necessary.

Old factory buildings can be primary spawning grounds for new products and new firms. Such structures can make great contributions to an industrialized urban area. Yet in Lowell, the mills have apparently lost their rejuvenating capability. New investment in these old structures might be both desirable and possible if there was strong confidence that this investment would not be wasted on a soon-to-be-demolished factory.

One possible approach to the question of the future of Lowell's mills might favor the conversion and subdivision of existing large plant facilities to several smaller industrial condominiums. These condominiums would offer a number of alternatives not presently available to developers in Lowell. First, small-scale (perhaps one floor or less) development, rather than factory-wide renovation, will make it financially possible for small new firms to locate in these structures. Second, the potential exists for expansion as additional units become available. Finally, since the condominiums will be set up in such a way that none of the units can be demolished without the consent of the other occupants, the threat of

forced relocation in the near future is significantly reduced.

The current mill situation is not an easy one for Lowell to endure. Potentially valuable central city land is being under-utilized. Low industrial rents, a small assessed value, and minimal worker densities now characterize these aged buildings. Many feel that the key to improving the city's land use is through direct demolition. Others insist that demolition is unfeasible. The latter group contends that the problems and costs associated with demolition are excessive while there may be reason to keep some of the city's mills intact. Because of the confusion and frustration surrounding the future of the mills, it seems inadvisable to advocate any demolition plans without a more complete analysis of the impacts of such action. An Urban Dynamics approach may prove useful in this investigation. Should it become clear that some demolition is critical to the city's revival, the model may also be helpful in directing a more effective attack (through indirect causal chains) on those leverage points in the city system which influence demolition. Current proponents of demolition have failed to locate these leverage points. Yet common sense (and a look at other cities) tells us that these points exist. Lowell needs the tools to find such points. Urban Dynamics may be the tool.

Service Tax Plan

Another policy espoused by urban administrators both in Lowell and elsewhere is a "service tax" on currently untaxed property in the city. Officials complain that while churches, charities, private schools, and all other non-publically owned properties pay no taxes to the city, they

receive police, fire, waste disposal, and other services from the city. The "service tax" plan calls for properties currently not paying local taxes to begin paying a service charge to the city as a reimbursement for services received.

The Service Tax issue might seem to hold significant promise from the practical perspective, since it is not a drastic change, nor would it directly penalize many people, although the tax would place greater burdens on hospitals and schools. In a financial light, it is asserted that the adoption of the plan would ease some of the city's overworked revenue sources. On the surface, many people see the service tax plan as a major step in narrowing the disparity between city revenues and expenses. In the long-run, however, there may be results which make this an extremely dangerous policy.

A compelling argument against looking to a service charge as a panacea for the city is the fact that the charge, in all likelihood, will do more harm than good. The Urban Dynamics book repeatedly cites a short versus long-term dichotomy in the response of the urban system to policy changes. Policies which relieve pressures and make life easier in the 0-5 year time span often are accompanied by side effects which are far more severe than the short run benefits (22). Unfortunately, the uncertainty of the future often compels decision-makers to choose policies with short run (certain) benefits. City officials indicated that with a better understanding of long-run impacts, the city might instead adopt policies which are only marginally effective in the short run, but which come closer to the heart of the city's problems--hence make a more significant impact over the long run.

The proposed Service Tax plan appears to be an example of a policy which exhibits long run effects which are counter to its short run positive impacts. This, like other proposed schemes to alleviate the financial plight of the city, overlooks a deeply-rooted mechanism of the urban system. Forrester describes this ubiquitous urban mechanism (and the consequences of failing to recognize it) and cautions that to consider more money as the "cure-all" for a city's ills can be extremely dangerous:

In demanding more money as the solution to urban problems, people overlook the fundamental dynamic process now at work in the city. That process: as the city expenditures rise they reduce the pressures for fundamental solutions and allow the underlying causes to generate further demands to match the growing expenditures. In other words, the basic control process is for demands to rise to meet the available revenues. Is it not curious that all of the older cities are in approximately the same degree of difficulty regardless of their physical size or the magnitudes of their budgets? None are amply funded. None are conspicuously more desperate than the others. There must be a reason for this uniformity of distress that is independent of the size of the budget. The answer is that the problems and the budget grow hand in hand, neither can outrun the other. If the revenue resources get ahead, they are spent in such a way that they generate matching problems. If the troubles get ahead, the pressures rise to increase revenue, or fundamental steps are taken to alleviate underlying causes, or enough population moves elsewhere to reduce the pressures within the particular system. Perhaps the quickest way to force a recognition and correction of the fundamental causes of urban decay would be to remove all expectation of future financial assistance to the cities by state and federal governments. (23)

The best argument against a Service Tax plan is that it may inherently work to the city's detriment over the long run. The people of Lowell pay the cost of running their city, whether through direct property tax-

ation or through indirect contributions to charities which, in turn, pass part of the contributions on as taxes. The tax burden of the city may shift more toward those who support charitable and religious institutions. Should these people be the ones penalized for a shortage of revenues in Lowell? There are less obvious effects of such a plan which need to be investigated more fully before adopting it. Otherwise the city may find itself reacting to the policy in an unexpected and perhaps undesired manner. To trace the full impacts of this plan, an analysis requires representing Lowell's various tax forces and tax payers in a realistically complex cause and effect relationship. With such an analysis one could determine which shifts in the community would most likely result from a Service Tax. Preliminary indications are that such a plan may end up in a neutral, or even a negative category of urban policies.

The summer project was intended to discover policies which might hold significant promise of having a positive long-run effect upon Lowell. The elusive "leverage points" for improving the city do not, however, appear to lie within the realm of a Service Tax plan. Where, then, do they lie? Judging from the lack of success of urban experts to find them, the areas of important urban trade-offs appear to be extremely difficult to locate. Urban Dynamics points to one area of possible sensitivity in the urban system--housing. The book shows how changes in a city's housing policies may have important positive impacts upon the area as a whole. Proposed here is that the preliminary insights of the book can help to develop new policies to attack the causes of Lowell's interlocking problems. Because several Lowell officials also

consider there to be a "housing problem" (each with his own different definition) in the city, there is the strong possibility of a change in city policies which impact upon housing.

The housing market in Lowell is similar to that of most other medium-sized cities. There are slums. There are abandoned and condemned buildings. The central city area contains mostly high-density rental units in the lower income category. These are also the oldest residential structures. The filter-down process (the normal conversion of aging upper-income homes into multiple lower-income apartments) is evident in Lowell. The growing pool of cheap, substandard housing created by this process has been cited by several city officials as being responsible for the rapidly growing in-migration of poor to the city (24).

A continuation of this trend will produce undesirable results which are already becoming apparent. Traffic patterns, crime rates, social conditions, retail trade, the unemployment rate, the quality of education, and nearly all other indicies of the city will be affected by a growing number of poor in any given urban area. Many of the new arrivals in Lowell are now joining the welfare rolls and are increasing the financial burden of the state as well as the city. With fewer state-wide reserves due to increasing welfare costs, aid to cities drops accordingly. As the tax rate rises in the city to accomodate increasing costs, the vitality of the area suffers as a consequence. New economic development is further depressed, while those most sensitive to rising taxes, namely the upper-income groups, continue leaving Lowell in search of areas with lower taxes. The worsening imbalance between rich and poor, between

old and new in a city will almost certainly widen the gap between the city's needs and its resources.

The following paragraphs describe a set of policy changes which, together, may be strong enough to reverse the course of Lowell's decline. They will not be expensive, nor are they impractical. Designed from a qualitative analysis of the city and the Urban Dynamics model, they are necessarily only a "first cut" at providing the city with policy alternatives which will raise the quality of life in Lowell.

The first policy concerns the current imbalance between residential and commercial assessment. A second policy treats a similar assessing imbalance between homeowners and apartment dwellers. The third policy deals with establishing new priorities for demolition (both residential and industrial). The fourth policy deals with the problems associated with the city's traditional approach (as defined in Chapter II) to subsidized and public housing. Finally, a fifth policy suggests that Lowell's current zoning procedures may be inconsistent with the city's long-term goals, and points to new directions for zoning. Because these policies are the result of a city-wide systems approach, rather than the commonly used segmented or sub-system approach to problem resolution, they differ substantially from past practice.

1. Commercial and Industrial versus Residential Assessments

There is a strong chance that current assessing policies in Lowell are subtly contributing to the city's major problems. One possible example is found in the difference between residential and commercial assessing. Experience with one of the city's assessors revealed that

residential structures are assessed at 37% of their "fair market value." In Lowell, a house purchased for \$24,000 would be assessed at \$9,000 or 37% of its fair market (purchase) value*. The current tax rate (\$156.00 in 1971) is then multiplied by the assessed value to determine a homeowner's yearly tax bill to the city.

For commercial and industrial structures, assessing is performed differently. Instead of working with the vague "fair market value" concept, the city taxes income-producing structures on the basis of gross yearly income. The results of the income taxation plan have been, in the assessor's words, to "penalize commercial and industrial activity by making it pay a relatively large share of the city's taxes." In other words, if a comparison were possible, it would show that industrial assessments run well above 37% of fair market value to perhaps 45-50%.

Nearly all Massachusetts cities, for a variety of reasons, exhibit this same type of disparity between residential and industrial assessing. Perhaps the primary reason is that all homeowners feel directly the effects of property tax increases, whereas only the upper management of firms feel the direct effect. As a result, city officials, following the "path of least resistance" have, through the years, been placing more and more of the local tax burden upon firms. Yet an analysis of the effects of this policy from a city-wide perspective raises some thoughts that perhaps a more equitable balance in assessing (taking some of the tax burden off industries) would be good for everyone concerned. Why?

* The 37% figure on housing assessments is typical of most Massachusetts cities. Several cities in the Commonwealth are, however, beginning to comply with a state law requiring that housing be assessed at 100% of its fair market value. Lowell will probably follow these cities and re-assess, but not for the next few years, at least.

Lowell, and most other Massachusetts cities, may be discouraging the construction of commercial and industrial buildings because of the relatively higher taxes which must be paid here. Another city in another state may be assessing differently, such that the tax bill for the same building in that area is significantly lower. If Lowell and this other city are similar in all other important respects, then most of the time the construction will take place in the other city.

At the same time, if the two cities have equal revenue needs, then Lowell's assessing policy on housing will favor its construction in Lowell for the same reasons that industrial construction would be favored in the other city. The resulting pressures on new development from Lowell's current assessing, if continued over several years, could produce a significant imbalance in the number of people that the city can house, versus the number of people that its industries can employ. By-products of **this** imbalance might include a rising unemployment rate, an increasing tax rate, and a general economic worsening of the city. With a less healthy economy and fewer jobs for its inhabitants, the city offers fewer opportunities and freedoms to its poor. The middle and upper classes, meanwhile, may choose to leave the city as conditions become less tolerable. These potential out-migrations may serve to aggravate Lowell's problems still further. There is a downward economic spiral effect which seems to be predominant in most seriously depressed cities. We need to better understand the forces which produce this negative spiral, and then contain this trend with new, more effective policies.

A change in assessment practices in Lowell could help generate a

positive impact on the city's quality of life. As taxes are lowered on commercial and industrial structures, the area will become a more attractive site for development. The cost associated with this policy change is, of course, a higher assessment on residential structures. But as industrial development progresses, additions to the city's tax base will begin to offset the increased tax burden placed upon the homeowner. Within a few (perhaps 5-10) years, the city may find that the cost of reducing commercial taxes is totally financed by the additional local taxes received from new industrial development.

Over the short run, the increased property taxes on housing may discourage new housing construction. Cutting back on housing expansion may help the city to curb **the** influx of people which presently seems to be placing greater and greater demands upon the city's limited resources. A combination of industrial expansion and diminishing in-migration may help push the city in the healthy direction of balancing the ratio between housing and jobs. As unemployment drops, the costs of providing social welfare to the city will also diminish, adding to the list of positive results of the policy change. Because city costs may be lowered by this assessing change, the city will become less constrained to seek other potentially significant problems.

There is an imbalance between housing and industry in nearly all older cities. The forces in Lowell do not appear unique. Meanwhile, the social and economic pressures which have forced this imbalance are likely to get still stronger as decay worsens. It is no accident that a city such as Lowell has a bias in assessment which favors housing and simul-

taneously houses more people than it employs (resulting in high unemployment).

Housing availability may draw people into an area where, if they can't find or lose their jobs, they receive compensation at the public's expense. The fact is that jobs in Lowell are becoming fewer, while the housing stock is increasing. In 1960 there were 29,861 housing units in Lowell proper (14.1 sq. mi.), whereas in 1970 there were 31,474 units--an increase of 5.4%. At the same time, the number of jobs in the city dropped by 4% (from 24,037 in 1960 to approximately 22,000 in 1970). The increased unemployment rate (from 8% to 11%) is the result. An important point to note is that while jobs in the city declined over the ten year period, the population of the city actually increased slightly (by about 1%). This can only be explained by the fact that enough housing was built to offset the area's falling attractiveness due to the poor job picture. Because housing appears to play an important role in determining a city's major characteristics, further examination into the housing trends in Lowell will be useful.

Are these trends good or bad for the city as a whole? Discussions with Lowell officials indicated that excessive housing availability was shifting the problems of other areas (Boston, New York, and Puerto Rico) to Lowell as large numbers arrive from these areas. They complain that Lowell's inability to accommodate a rapidly growing number of poor is worsening conditions not only for the poor already in Lowell, but for the rest of the city's inhabitants as well. If a good measure of a city's viability is its ability to accommodate the needs of all its people, then the current status of housing in Lowell may be undermining that viability.

In order to avoid unwarranted criticism, it is emphasized that by no means is any of the blame for Lowell's problems to be placed on its assessors. Their work is as complex and ambiguous as that of any agency of any city. The fact that nearly all Massachusetts assessors are currently following this same dangerous approach is evidence that Lowell's assessors are consciously looking for guidance , but are getting very little. No one could argue that the assessors are intentionally working to the detriment of the city--my own opinion was very much the opposite. Unfortunately, tried and tested assessing practices are no longer sufficient. There is good reason to believe that a city's tax structure influences its future development and that its past structure has influenced today's problems. New assessing policies should be designed with a recognition of their potential future impacts. Current assessing policy appears to respond to financial and political pressures in such a way that unhealthy long-term trends are produced. While the exact details of a more appropriate assessing balance between commercial and residential structures cannot yet be determined, the need for change in assessing as an influence upon this balance is clear.

2. The Trend Toward High Density Living--Assessing Rental Living Space versus Privately Owned Homes

Lowell (again, like most cities) has been moving consistently in the direction of high-density rental apartment living. The downtown section of Lowell is now nearly 100% renter occupied, and the percentage of total housing units in Lowell has reached 57%. The rental housing stock in Lowell grew 8% from 1960 to 1970, while the number of private homes

grew by only 3%. This may be another unhealthy trend produced by the forces normally operating in urban areas.

The growth figures for homes and apartments in Lowell illustrate how the housing market in the city has reacted to current demands and pressures. It is doubtful whether any conscious policy has ever been established to oversee the construction of the city's housing. Instead, a loose implicit policy of "let the chips fall as they may" pretty well summarizes the average city's housing policy. As before, a closer look at the situation reveals that more careful planning and control of housing development may have promising long-run effects for Lowell. Where residences do not exist, people will not and cannot live. It may be better, at times, for this highly effective control on urban growth to be utilized.

The trend toward high density living allows still more people to live in a fixed geographical urban area. To the extent that problems in our cities are created by people, these problems are usually aggravated by increasing the living density in an area. As was just shown, cities do not necessarily enjoy a perfect relationship between housing and industry. In fact, the number of people living in a city may be increasing while the number employed there is dropping. Unless the city is in a very healthy economic situation, increasing housing densities may be partly responsible for increasing unemployment. Why does this trend predominate?

Population densities in both residential and commercial zones are allowed to rise in response to the fallacious argument that rising land prices require more intense use. But land prices reflect the permitted use. Under rigid zoning, with no hope of relaxing the restrictions, land prices could not rise too high for the

allowed use. But instead, we allow a land-price-population-density spiral to continue until excessive loads are thrown onto transportation, pollution, and psychological trauma, and other factors of the urban environment. (25)

Many strong arguments exist for the need to control the extent of high-density living in a moderate-sized city such as Lowell. The simple fact is, however, that the financial incentives for residential construction strongly favor apartments. Again, this stems from an assessment practice which taxes the average homeowner far more than the renter. The result is higher profitability in apartment development than in home construction. To illustrate this point, a direct comparison will help.

It is difficult to equate a home and an apartment, since different advantages are associated with each. The current real estate practice is to equate a \$200/month apartment with a \$24,000 home in Lowell. The home gets assessed at 37% of its "fair market value," or \$9,000 while the apartment gets taxed at 23% of the gross yearly rental income. With Lowell's \$156 tax rate, the homeowner pays $(\$9,000)(\$156)$, or \$1,400 per year in local taxes, while the landlord pays $(.23)(\$2,400)$, or \$600 per year in taxes on the equivalent apartment. Even though the homeowner can deduct his local taxes on his federal and state income tax returns, not until he reaches something like the 50% tax bracket does the inequity vanish. The average citizen will find himself paying a 25-30% higher local tax bill if he owns his own home. This difference helps explain the rapid growth of apartments in Lowell, as well as the lack of capital investment by the renter. Designed to aid the assessor, the income-taxation plan on residential units is producing a strong bias which makes

high density living an attractive financial alternative to homeownership.

In the previous section, it was shown that penalizing industrial and commercial activity in favor of homeownership may be dangerous in the long-run. This section suggests that other current policies are acting to compound that danger. By readjusting the assessments between apartments and privately owned dwellings, the city will begin to gain control of another potential problem. The details of this plan remain unclear, but the proper direction of action is evident. Efforts to realign the balance between homeownership and rental living may also require changes in zoning policy which will be discussed later in this chapter.

It is unlikely that current housing trends in Lowell are working to the city's benefit. What is needed now is a more cautious look at rental assessments which could help redirect the city's future. Instead of taxing 23% of a unit's gross yearly rental income, we may conclude that the figure should be considerably higher, perhaps 35% or more.

Rebalancing the tax burden between homeowners and renters will also ease the short-run problems encountered with the residential versus commercial assessing adjustment. It was pointed out earlier that taxes would have to be raised on residential structures to meet the short-run cost of reducing corporate assessments (and to keep city revenues constant). However, this second proposed policy change suggests that most of this extra tax load should be placed upon the renter rather than on the homeowner. These first two policies, if implemented together, may produce far better results than either alone.

3. New Priorities for Demolition and Code Enforcement

A. Housing

The preceding two policy recommendations are designed to alleviate two observed possible problems:

1. Too much housing is being built in Lowell
2. The housing being built is of the worst possible sort for the long-term best interests of a city.

Implicit in the recommendations is that the city must gain control over the amount and type of housing being developed. By controlling this development, eventually the city's housing stock will fall back within viable limits which define a healthy city. But there is another equally effective mechanism for regulating the size of the city's pool of housing. Not only can the inflow be lessened, but the outflow of undesirable housing can be accelerated through increased demolition. This latter alternative is normally considered inferior to the former, since demolition is costly, destructive, and full of negative connotations, whereas new development is looked upon as constructive, optimistic, and exciting. The unfortunate fact is that increased demolition may often be both cheaper and more effective in bringing about a city's revival.

Many of Lowell's problems can be blamed upon the normal aging process. The most run-down housing in the city is also the oldest. The worse this housing gets, the less there is for the landlord to recover from his investment. As a result, rents are extremely low. Usually near the central business district, these properties could be extremely

valuable, but their decayed condition renders them worthless. They contribute nearly nothing to the city's tax base or to its socio-economic vitality.

In Lowell, there are presently 4,000 substandard housing units (26). Of these, almost 1,400 are vacant. This 1,400 represents a full 10% of the total rental units in the city.

The large body of substandard housing, coupled with a significant number of low-entry-point jobs in the city provides a strong pull on low-income families from other nearby cities (Boston, Providence, New York, Montreal) who learn about these opportunities from their peers already in Lowell. The recent upsurge in the number of Blacks, Puerto Ricans, and French Canadians lends support to this hypothesis. As long as some unskilled jobs and cheap housing are available in Lowell, this influx is likely to continue. Unhappily, these people often lose enthusiasm for their jobs, since upward movement in these industries is extremely limited. They look for other opportunities, find none, and go onto unemployment and welfare rolls. This process is currently imposing a significant burden in direct and indirect costs for both the city and the state.

Accelerated demolition of Lowell's substandard housing would not only prevent these migrants from living in utter desolation, but would also help keep the pool of substandard housing from remaining at the presently unhealthy level. The city's current demolition rate is well below the rate at which formerly good housing "filters down" as it ages to become housing for middle- and lower-income families. As a result the size of the pool of inadequate (if not substandard) housing grows daily.

This growth threatens to draw increasing numbers of poor into the city. Demolition of the vacant units would place a natural constraint on immigration. Because vacant units are nearly always concentrated in individual structures and blighted neighborhoods, a program of accelerated demolition would require a minimum of cost and hardship due to family relocation.

The benefits of demolition do not end with having controlled immigration. In fact, this control is only a means to a far more important and promising end. Demolition opens the land upon which this housing stands to new development. An increase in housing quality, without an increase in housing quantity will be a more positive contribution to the city's poor. New structures will provide valuable additions to the city's tax base which will ease the city's tax burden. As taxes fall, further industrial development may take place which would begin to reduce unemployment. Demolition may not only erase one problem; it also paves the way for a solution to other problems.

The prime factors behind the lack of adequate demolition to date appear to be: first, a lack of public awareness of the need for more demolition; second, the reluctance to tamper with housing because of the difficulties involved with relocation; third, the lack of funds. To illustrate that money is not the only factor, however, it should be noted that Lowell has used only \$40,000 of the original \$140,000 demolition grant received from H.U.D. in the fall of 1970.

An extremely subtle factor which inhibits the removal of a building by either the owner or the city is the use of tax abatements. In an

effort to ease the burden on the owners of old decaying structures, the city has frequently granted abatements (a one time lowering of the assessed value) which significantly reduce the local taxes paid by the owner. These abatements have side effects, however, which are of serious consequence. Because taxes are lower, owners can afford not to demolish. It may be easier for an owner to incur a small loss (made smaller by an abatement) than to pay the substantial costs of demolition. If taxes on apartment structures were maintained at their original level, losses might often be severe enough to induce voluntary demolition by the owner. Should the owner fail to demolish, at least the more rapid build-up of back taxes would warrant the city taking a lien on the property before it loses all of its market value. Delaying private demolition or city taking is likely to be poor urban policy. New and better quality housing is kept out of the city because space is blocked by the old, while the value of the old continues to slide. Abatements may in fact have the effect of reinforcing this trend.

In an effort to ease the tax burdens of landlords with aging housing, the city often prolongs the burden, making things worse for everyone concerned. The city, rather than the landlord, ends up the biggest loser. Substandard housing is extremely harmful to the city once it proliferates beyond a small limit. After that limit, abatements only allow landlords to try to "milk" their buildings for a few more years. During these last years, the buildings do the most harm to the city. Long past the point of renovation, these structures often receive absolutely no maintenance. They exist as havens for addicts, rats, criminals, and other social outcasts.

Encouraging accelerated demolition may tempt some readers to conclude that the concept of controlling urban in-migration through the pressures supplied by limited housing availability are unethical and prejudicial against the poor. In fact, it is instead more likely that the policy changes outlined in this chapter will have benefits for the city's poor which are far more significant and enduring than are resulting from current urban policies designed to directly help the poor.

Until conditions are restored to a point where the poor have the financial freedom to choose their own life-style, then the city is imposing a cruel and undeserved penalty. With a revived economy the poor may not necessarily change their life-style, but will at least be given the economic liberty to choose among viable alternatives. Most poor in our cities today do not have such a choice. Man's most fundamental freedom is his right to think as he pleases, yet poverty conditions men's thoughts in such a way that the lack of economic alternatives is no less a restriction on thinking than are prisons a restriction on physical mobility. Many of our past urban programs appear to have done very little to free up the goals and aspirations of the poor.

Critical to the argument of accelerated slum demolition is the distinction between driving out the poor (or in some way limiting their freedom) and limiting the influx of more poor to an area. Our goal in solving Lowell's problems is not to force its poor elsewhere; rather it is to produce viable plans for helping the city to meet the needs of its present population. Experience tells us that such positive programs may require that inflows to the city be constrained. In general, urban pro-

grams which improve the quality of life for the city's poor have a secondary effect of drawing more poor into the city from outside. These improvements contain the seeds of their own destruction. The immigration will continue until the city, on the average, falls back to the level of attractiveness of other nearby urban areas.

In order to solve Lowell's unemployment problem, the city not only needs to create new jobs, but it also needs to establish some "negative counterbalance"--some constraint or limitation on the city's overall attractiveness. This chapter suggests that the city's most effective negative counterbalance may be its housing supply. Demolition of the city's 1,400 vacant substandard housing units will force no one from the city. Further demolition, when coupled with traditional renewal plans, will help raise the average quality of housing throughout the city--again, with no forced out-migration. Such a policy will not limit anyone's freedom of movement or thought. By helping to raise the average quality of life in Lowell, this policy will, in fact, have the opposite and positive effect.

A program of accelerated demolition would also help control the spread of blighted housing. One decaying building in a neighborhood is often enough to prompt the most responsible members of the neighborhood to move out. They leave behind a growing problem which finally emerges as a slum. Early demolition is easily seen to be more effective (and a good deal cheaper) than massive rehabilitation later on.

Suppose, for example, a healthy urban housing situation is defined as one in which less than 6% of the total housing stock is substandard. Lowell's current housing situation, with 4,000/31,000, or 12% substandard

housing, is well beyond this limit. In order to move back to a healthy housing ratio through new construction, the city would have to fully double its housing supply. On the other hand, the city could reach its objective by demolishing half of its already existing substandard housing. There is not enough vacant land in Lowell to double the housing stock, nor is there reason to expect developers to want to undertake such an effort. The latter alternative (demolition) is a far more plausible one.

Present thinking in most cities, however, seems to favor "diluting" urban blight through a wave of new development. Less costly and more effective may be a new plan which "extracts" rather than "dilutes." Like a malignancy, urban blight will not be cured until the source is removed. Any other action may postpone the day of reckoning, but will not cure the disease. Immediate demolition is far more desirable than the social and economic ills (higher crime, unemployment, and lower quality of education) which promise to result if current attitudes toward demolition in Lowell continue.

Should the city decide that such a program would be beneficial, accelerated demolition of substandard housing can evolve if any or all of the following policies are adopted: first, a reduction in the delay involved in processing demolition papers (often 6 months or more). Presently, getting a building demolished by the city is an extremely slow process. Second, a set of more rigid codes should be enforced. The current practice of code enforcement in the city uses condemnation as a "last resort" rather than a move which, in the long run, is better for everyone. Third, a policy of not granting abatements to aging housing

structures should be strictly adhered to. Fourth, a policy which combines demolition of substandard or condemned housing with new construction would allow the city to gain control of the growth of low-income and substandard housing in the city.

B. Industry

Industries, either in Lowell or other cities, behave according to one of three basic patterns. One pattern is growth. Growing firms need space. Cities, by definition are seldom able to provide unlimited room for growth. As a result, healthy firms continually leave the city to expand elsewhere.

A second pattern is decay. Dying industries also take up valuable land, but only temporarily.

Thirdly, firms can stagnate. Neither increasing nor decreasing in sales, employment, or benefits to the urban community, this third behavior is the one most common to urbanized industry. This behavior also appears to be the least desirable for most cities. The stagnating firm is normally a marginal operation with small profits. Worker densities have been lowered to raise the marginal productivity of labor to its maximum. No longer healthy, seldom capable of offering their workers any significant advancement, these firms add little to the city's economic base. Unlike the dead firm, the stagnating firm continues to occupy nearly all of its former space. The development of new firms and the expansion of healthy ones is blocked by this stagnation.

Changes in local taxation policy and in industrial code enforcements may be able to control the spread of stagnating firms. The results: a

city with a more healthy economy--one in which a larger percentage of the total industrial base is growing. With a better blend of newer industries, Lowell would reap better harvests from its industrial land.

In much the same way that aging housing, when uncontrolled, harms the city, the same is true of aging industrial structures. Why is this process apparently out of control in Lowell, when the downtown district is nearly choked by ancient (and nearly useless) factories? Forrester points to a general explanation which seems accurate for describing Lowell:

The property and income tax laws favor old buildings. The aging of buildings is an intimate part of the urban decline process. Shifting taxes off from real estate and onto incomes means that the old buildings and the land they occupy need not be used effectively and can be allowed to decay with little tax penalty. Real estate taxation proportional to market value means that taxes decline as the property ages. This reduces the pressure for replacement of buildings. The income tax laws allow a building to be depreciated several times against current income, this gives an old building value and helps to keep it in place until it contributes to urban decline. (26)

Lowell's current practices of assessing industrial and commercial properties on the basis of gross yearly income and of granting numerous abatements are having the undesirable long-term effects of smothering new growth. Instead, assessing doctrines must change to require more effective use of the city's land by its firms.

4. Federal Housing Programs

One of the most perplexing paradoxes of today's urban life is the coexistence of a shortage of adequate housing for the poor (a tight housing market) and a high vacancy rate (over 10% in Lowell; nearly 20% in Harlem). A better understanding of this phenomenon can be gained as we study the effects of low income subsidized and public housing construction. Devised in an attempt to ease the housing shortage in our cities, sections 221.d.3, 235, and 236 of the Federal Housing Act* are now beginning to be blamed for aggravating rather than alleviating the housing problem.

The conditions which cause a housing shortage and a simultaneous high vacancy rate run to the very heart of the area's economic and social functioning. The lack of good jobs, perhaps more than any single factor, produces slums. The tenant who loses his job can no longer continue to pay his former rent. When whole neighborhood populations

* The Magna Carta of American housing legislation (27), the Housing act of 1949 provided for a greatly expanded federal low-rent housing program.

The subsidy mechanism was a simple one. Local public authorities were to be formed. They would issue bonds to raise the funds needed for the new housing, and the federal government would make annual subsidy payments to the local governments to cover the interest and bond repayment obligations. Rents collected from tenants would pay the operating costs, and these rents would be scaled to the incomes of the tenants. Since the subsidy was so substantial, severe income limits were imposed to assure that only the truly poor benefited from the subsidy.

The 1961 program, known as Section 221.d.3, involves a significantly lower rent than ordinary FHA mortgages.

The Housing Act of 1968 took another step to lower housing costs to occupants, and thus the target income level, by subsidizing interest costs. The act's Sections 235 and 236 (the former for homeowners, the latter for rental housing) provide for federal subsidies that, at a maximum, reduce the interest cost to the equivalent of a 1 per cent mortgage. (28)

lose their jobs (because of a large cutback of a nearby firm, perhaps), landlords are compelled to lower rents to keep tenants from moving out and creating costly vacancies. To help finance his rent drop, the landlord stops pouring money into maintenance. Soon the area deteriorates, and those who can afford to move out will do so. The character of the neighborhood shifts, and attitudes toward education, crime, and community pride rapidly decay. The lack of opportunities in an area is a sad reality for many of the city's poor. Caught in an economic trap, the poor cannot afford to move to other areas with more promise.

Federal housing programs have attempted to bring better housing to the poor in these areas. The programs assume that more and better housing will convert this trap into a revitalized area. But one must ask whether these housing programs are in fact drawing more poor into the city, worsening the conditions of job competition, crime, social alienation, and the like. If so, these programs actually contribute more to the forces behind housing decay. In Lowell, there is no question that the major impact of public housing programs has been to open up low-income units into which the poor from outside the city can quickly move (See Chapter II, p. 30). Mentioned earlier, the sharp increase in the number of poor in the city is a pressing and growing piece of evidence of the negative side effects of subsidized and public housing construction.

Federal housing is cheap--construction often costs the city nothing. Yet subsidized housing is non-taxable, so the city's tax base is not increased. Meanwhile, the city must furnish police, fire, and other services to the housing; from a purely financial perspective, subsidized

housing is a poor investment from the start. The Lowell Housing Authority pays the city of Lowell only 3% of its gross yearly income (renters, remember, pay 8 times that amount). Though exact figures are not available, the city spends at least \$10 on LHA properties for every \$1 received. Lowell cannot afford to make such expenditures if it is to meet the other growing needs of its people. The city can find better ways to spend its money than on public and subsidized low-income housing. Yet Lowell today has 1,600 units of such housing (65% low-income, 35% elderly) and plans for 200 more.

Subsidized housing has been built in Lowell because nobody ever asked the crucial question of whether or not it would solve the city's housing problem. Federal funds provide an alluring short-run incentive for cities, but in reality the long run costs to the city often far outweigh the benefits of the inexpensive construction. Lowell must soon answer its question of housing needs. The housing situation is nearly out of control in the city, while building subsidized housing may only be compounding the problems manifest in the city's decaying housing.

A period of limited construction, when coupled with the above policy changes, may further give the city a means for controlling its in-migration. Land which would otherwise go to public housing could now be used for playgrounds, for schools, for parking, or best of all (and with the proper zoning changes), for commercial or light industrial activity. Not building housing is an economically viable policy in Lowell, since it means "don't spend money." The city finds itself confronted with the happy possibility that spending less money will be better than spending more.

5. Another Promising Alternative: Zoning

The time constraints of the summer project did not permit a thorough investigation of Lowell's present zoning policies. Yet very preliminary data suggests that Lowell's zoning policies may also be moving the city in unforeseen directions. Lowell is the center of a growing metropolitan region. As such, its role as a primary source of jobs is critical. But

Whatever the reasons, the fact remains that apartments are permitted only in the City of Lowell, in Dracut, and in Pepperell [2 of Lowell 8 surrounding towns]. (29)

Throughout the metropolitan region

One acre zoning prevails, while Lowell is the only community permitting dwellings on less than 20,000 sq.ft. Furthermore, Lowell has absorbed most of the multi-family construction in the region and a great disparity exists between suburban and city housing patterns. (30)

Land-use statistics for Lowell indicate that while over 36% of the city's total land is residential, less than 7% is in commercial and industrial use. These figures seem to be in strong conflict with the notion of a balanced ratio of housing and jobs in Lowell. Present zoning ordinances seem to suggest the desire of the city to be primarily residential, yet the directors of the City Development Authority indicated that the city should contain at least as many jobs as housing units.

Zoning regulations place strict limits on the city's future development. Unfortunately, cities appear to evolve in such a way that a zoning balance between residential and industrial land-use may appear perfectly adequate today, but inhibits the normal development of the city in the future. The pressures supplied by zoning can be unhealthy ones.

Zoning has in the past divided land into blocks that are too large and too homogeneous. A large area with housing built all at one time and of a similar quality deteriorates as a whole into a substandard condition. If such an area is large enough, it is avoided by new construction and becomes a slum.

Zoning also allocates too much area for residential use and not enough for industry; this is especially critical when the area begins to age with the concurrent decline of employment and increase of population. The ratio of residence to industry was satisfactory when the area was first being developed but becomes imbalanced with age. Unless there is rezoning to reduce residence and increase industry, or unless land is held empty initially for latter commercial use, the aging area lacks economic vitality to maintain all of its housing stock and the area begins to deteriorate. (31)

New zoning policies for Lowell will remove existing pressures and open the city to more flexibility in its future development. Zoning has critical city-wide impacts, yet has traditionally been controlled by the self-interests of neighborhood groups who have not taken an overall perspective to the city and its long-term needs. Cities are dynamic-- they develop new needs and problems as they develop. Zoning ordinances, however, are difficult to change and become quickly outdated. With tools such as Urban Dynamics, changes in zoning policy can be quickly and inexpensively tested. A more complete understanding of the city may lead us to conclude that quite different zoning policies are in order.

The Urban Dynamics model is the first step in the development of a tool which will help urban policy makers to design and plan for the total urban system. Its ultimate value in testing zoning, assessing, demolition, and a variety of other new urban policies stems from its

ability to transcend city interest groups to look at the entire set of policy-generated consequences. This chapter has shown how a number of present city policies, when examined from the general perspective of the present Urban Dynamics model, show signs of inconsistency with the city's needs and objectives. To move beyond this cursory analysis to more fully understand the effects of Lowell's present policies as well as to begin designing more appropriate alternatives is the logical next step in this effort. The time and skill required to make this step will, however, be substantial. The next chapter outlines how efforts to improve upon the model's general structure may yield a strategy for solving Lowell's problems as well as a tool applicable to the problems of many other troubled cities.

CHAPTER V
GOALS FOR FURTHER EFFORT

The ideas emerging from dynamic studies of urban systems are so contrary to contemporary thought that they will be accepted only after extensive examination. The Urban Dynamics book has already led enough people to doubt the wisdom of present urban policies that a far more serious reexamination of the issues becomes an obligation. (32)

A. Refining the Urban Dynamics Model

Preliminary evidence is that an Urban Dynamics approach to Lowell will make significant contributions to the city's revival. Official support and enthusiasm in Lowell for an extension of the preliminary analysis summarized in the preceeding pages is developing rapidly. Further research into both Lowell and the Urban Dynamics model will make possible more precise and complete analyses of current problems and proposed solutions. While the general accuracy of the present Urban Dynamics model has proven sufficient to point toward promising new policies, the details of those policies cannot be specified until a more complete model, reflecting important structural detail, is developed. Some areas in which further research will yield this essential detail are presented here.

1. Refining the Model's Tax Structure

The original Urban Dynamics model portrays a more idealized property tax system than exists in Lowell. Both housing and industry in the model are assessed at 100% of their fair market value. No biases, such as those observed in Chapter IV, are currently represented.

As a result, the prevailing tax rate alone affects new housing and industrial development in Urban Dynamics. Only in the case where residential and industrial assessments are perfectly balanced, however, will this be the case in an actual city. The current model erroneously predicts that an increase in assessed valuation of industrial properties will stimulate (rather than depress) new industrial development due to a resulting lower city-wide tax rate. This strange behavior is the result of an incomplete (insufficiently detailed) model structure. Proposed here is that additional structure be added which allows the modeler to represent current assessing biases and the full (accurate) effects of changing the biases.

By talking to Lowell's assessors and other city officials, the mechanisms which have caused the assessing bias can be explicitly identified. Developers either in Lowell or elsewhere can help specify the chain of impacts which assessing biases will have upon residential and industrial development. Once the complete set of cause and effect of assessing biases has been represented in the model, new policies, focusing upon changing or eliminating the bias, can be quantitatively analyzed. Ultimately, research will allow us to specify exactly the proper balance between industrial and residential assessments.

2. Disaggregate the Model to Differentiate Between Rental Units and Privately Owned Homes

The trend toward high density in Lowell deserves close attention. Not only may this trend be dangerous, but it may also be out of control. Apartment dwellers are different from homeowners in several respects, most of

which, from the city's standpoint, favor the homeowner. While homeowners have a permanent interest in the welfare of the city, renters have less at stake. Having invested no personal equity in the city, the renter can (and does) move out as conditions in a city worsen. His mobility allows him to choose short-sighted gains for the city, even if these gains come at the expense of long-run hardship. The homeowner's interests are more aligned with the long-term good of the city.

Crowding more people into Lowell by developing high density apartments will not solve any of the city's problems. Extra burdens are placed upon the city's resources, while the extra benefits of apartment housing to the city are few. Yet the crowding trend in Lowell is moving full-speed ahead.

Forrester's aggregation of housing is a viable one in the context of a general model. The similarities between homeownership and apartment dwelling are far greater than their differences. Yet these differences deserve treatment in a more refined model, since between the two types of housing may lie an important leverage point.

Structural additions to the model should include not only rental housing, but also the forces determining its development. The assessing biases outlined in Chapter IV appear to be inadvertently stimulating apartment construction. If this perception is accurate, then close attention should be directed toward understanding and changing assessing. The proper assessing balance required to control any undesirable current housing trends can be identified with model refinements which dig beneath the aggregated general structure to include some of the city's more specific decision points.

3. Understanding and Modeling the City's Tax Abatement Policies

Abatements may be doing far more harm than good in Lowell. Lowering the assessed value of aging housing and industrial structures tends to prolong their existence. Instead, the city would be better off if its sub-standard housing and most of its marginal industrial structures were not given abatements. With high tax bills, many owners will voluntarily demolish their structures. The more rapid build-up of back taxes will hasten the taking of these structures by the city (while they still have some value) if the owners fail to demolish, yet can't pay taxes. Still another possible result of sustaining original tax assessments is that owners may renovate more extensively and effectively. In order to keep a building (prevent a city taking) and at the same time make a profit, owners will be forced to maintain higher quality of living or industrial space in order to receive higher returns from their properties.

Because the causes and effects of current abatement procedures are potentially important influences upon the city's development, they should be made a part of a Lowell model. The mechanisms which determine abatements could be best outlined by further discussions with Lowell's assessors. The effects of abatements could be isolated by talking to mill and apartment owners, both in Lowell and in cities in which abatements are less frequently granted. Comparing Lowell to other cities can be misleading, but there is the possibility that careful analysis will reveal a good deal about the effects of a change in Lowell's current abatement policy.

In this same vein, the process by which Lowell takes a lien on (appropriates) private property for non-payment of taxes needs clarification.

Present policies should be represented, and future policies designed to speed the process could also be tested. There is little to be gained from allowing a factory to accumulate back taxes. The city would do better to take properties while they still have value. Further investigation will help to define the city's attitude, as well as federal or state controls, on the lien process. Building this process into the model will help to clarify better than any verbal argument the costs and benefits of early action. As a result, better policies can be designed and tested.

4. Define (Empirically) the Determinants of Industrial and Housing Development

What are the forces which attract industries to an area? Why do firms locate in one city and not in another? The efforts in Lowell must attempt to answer this question and make Lowell more attractive to industrial developers than it is today. How important are taxes? Land availability? Labor availability? Because Lowell is at near equilibrium with its environment, a significant improvement in any of the determinants of industrial development will have potentially positive effects. The question is: "How much effect?"

The question will be difficult to answer. But to fully anticipate the future effects of any policy change designed to stimulate industrial growth, the nature of this growth needs to be clarified. Several firms are currently considering Lowell as a potential site for new plant facilities. Others have already decided that Lowell is unsatisfactory. By talking directly to these firms, it may be possible to determine why Lowell was ruled out and what factors, if changed, would induce development.

Similar questions need to be asked with respect to the housing market. Which conditions attract housing developers? Which conditions repel them? General answers are available, but specific information defining Lowell's current situation might help in predicting the immediate response of the city to new policies.

5. Define and Represent the City's Current Zoning Policies

While not treated extensively in the preceding chapter, zoning policies strongly influence a city's future. Fixed limits on various land uses inhibit the city from adapting to its changing needs. "Zoning policies can come back to haunt you." (33) The pressures which cause too much of a city's land to be zoned for residential use could be made a part of the model. New approaches to zoning could then be tested.

Dividing the model's current land area into two variable pieces--residential and industrial--appears as a simple and constructive modeling exercise. Representing the forces which determine the ratio between the two land uses is also a relatively simple task.

B. The Future of the Lowell Dynamics Project

It is likely that the application of Urban Dynamics to Lowell will become a major effort within the near future. Both the Urban Dynamics Group at M.I.T. and City Hall in Lowell give this effort high priority. City officials have shown more than ordinary interest in the extension of the summer project into a full-time project in which they will become a major part. This encouraging indication of official support is the prime reason for believing Lowell to be the ideal city in which to test the application of Urban Dynamics.

While official support for a Lowell Dynamics project is necessary to gain access to the city's decision structure, community-wide support and participation will be necessary if the city's administration is to continue to explore its application. One important means of stimulating public support may come through articles written for the city's newspaper, the Lowell Sun. Articles designed to bring city-wide attention to the complexity of Lowell's problems, the countereffectiveness of attempting to solve all of Lowell's problems simultaneously, and the need for a more comprehensive planning tool would appear early in the stages of an attempt to bring a full-scale implementation of Urban Dynamics modeling to Lowell.

The ultimate impact of the Lowell Dynamics project will be better decision-making brought about by greater citizen understanding. Rather than an elitist tool, the greatest strength of the Urban Dynamics approach is in the potential community-wide understanding of its basic approach. The model will not become a substitute for community debate over policy issues. Rather, it will tend to focus the city's attention on the more important issues and set the limits for that debate. Rational discussion of alternatives should be enhanced. For example, the multiplicity of city officials' problem definition in Chapter II can be narrowed down with the logical framework of an analytical model. Currently each citizen thinks according to a "mental model" of the city which has different boundaries, different structural relationships, different parameters, and a resulting different behavior than Urban Dynamics. Future efforts will help focus the city's various models into one unifying set of cause and effect relationships. From this model will come a large measure of new understanding of the city

which in turn will allow its citizens to better select future programs and policies.

C. Developing New Urban Priorities

Lowell's problems are characteristic of many other aging U.S. cities. In their desperate search to regain a lost vitality, cities face not only a growing set of problems, but also decreasing resources with which to meet these problems. Despite our nation's growing concern over the urban crisis, programs capable of solving the problems of urban employment, housing, and education, to name only a few, have been slow to materialize.

A growing number of urban scientists are beginning to realize that traditional "trial and error" solutions to the problems of our cities are no longer adequate. The complex city virtually defies our best efforts to improve it. Harold Finger, Assistant Secretary of the Department of Housing and Urban Development (HUD), states:

We all recognize the crisis in our cities, and it cannot be glossed over as a temporary issue. This crisis is apparent in any objective examination of the trends of many factors that measure vitality and confidence of our cities. Almost all measures indicate a decline; they indicate negative trends; they indicate deterioration, dissatisfaction, disinvestment. The truly serious element of the problem is that there are no apparent motivators or stimuli for reversing these negative trends.

But much of this [downward urban] movement was encouraged and even stimulated by national social programs and policies that had side effects that were totally unanticipated. In saying so, I do not criticize the programs and policies. In fact, I believe they were sound policies but their side effects were not adequately considered in the process of implementation. (34)

Mr. Finger appears to be saying that policies designed even with the best of knowledge and intentions are often not adequate for solving complex problems. In fact, they may aggravate the problems through secondary (and unseen) feedback loops. The only practical means for achieving solutions, according to many urban experts, is to transfer relevant engineering and scientific principles from physical systems to the urban system to better understand and improve it.

What we still need is the social technology equivalent of engineering in the physical and natural sciences. Social science now tends to be historical and does not help us in assuring a desired outcome in particular problem circumstances. We must develop the application of social sciences to the solution of our real problems.

Urban processes are not so random as many people think. Even more important, effects of detailed development decisions on our cities and metropolitan areas should be fairly predictable. A systems approach...can be developed in urban areas with the assembly of the necessary analytical resources. Although promising research is under way in these areas, much work needs to be done. (35)

The lessons learned in Lowell will have nationwide applications. Because Lowell's problems are similar to those of many other U.S. cities, future research into the dynamics of urban behavior may yield guidelines for a new approach to urban problem solving and priority-setting which would benefit nearly all cities in the future.

FOOTNOTES

1. The Record of a City, George F. Kenngott, p. 7
2. Loweli, L.S. Bryand and J.B. Rae, p. 24
3. Kenngott, p. 7
4. Ibid., p.7
5. The History of Lowell and Its People, Frederick Coburn, p. 1
6. Ibid., p. 2
7. Ibid., p. 168
8. Ibid., p. 168
9. Ibid., p. 352
10. From an interview with the Model Cities Director, June, 1971
11. Coburn, p. 353
12. Ibid., p. 306
13. Ibid., p. 307
14. Ibid., p. 352
15. Ibid., p. 352
16. Annual Report of the City Auditor, 1970, p. 61
17. "Towards a National Urban Consensus," J.W. Forrester, p. 4
18. Ibid., p. 6
19. Ibid., p. 7
20. From the Boston Sunday Globe, September 19, 1971
21. Plan for New York City, City Planning Commission, Vol.1, 1969
22. Urban Dynamics, J.W. Forrester, pp. 7, 10, 112
23. "Towards a National Urban Consensus," p. 7
24. From an interview with the City Solicitor, June, 1971
25. "Towards a National Urban Consensus," p. 8
26. Ibid., p. 8
27. The footnote on p. 80 is taken directly from Economics and Urban Problems, Dick Netzer
28. Economics and Urban Problems, Dick Netzer, pp. 80, 82, 89
29. Zoning Policies, Northern Middlesex Area Commission, p. 5
30. Ibid., p. 8
31. "Towards a National Urban Consensus," pp. 8-9
32. Ibid., p. 9
33. In the words of the City Solicitor, June, 1971
34. From the text of a speech given by Assistant Secretary Finger to the Semi-Annual Meeting of the Regional Advisory Committee of the Program for Advanced Study in Public Science Policy and Administration, p. 3
35. Ibid., p. 7-8

BIBLIOGRAPHY

- L.S. Bryant and J.B. Rae, Lowell: An Early American Industrial Community, Technology Press, Cambridge, 1950.
- City of Lowell, Annual Report of the City Auditor, 1970.
- Frederick Coburn, History of Lowell and Its People, Lewis Historical Publishing Co., New York, 1920.
- Harold Finger, text of a speech given to the Semi-Annual Meeting of the Regional Advisory Committee of the University of New Mexico, September 24, 1971.
- Jay W. Forrester, Urban Dynamics, MIT Press, Cambridge, 1969.
- Jay W. Forrester, "Towards a National Urban Consensus," Memo D-1291 of the System Dynamics Group at MIT's Sloan School of Mgt., 1970.
- George F. Kenngott, The Record of a City, MacMillan Co., New York, 1912.
- Dick Netzer, Economics and Urban Problems: Diagnosis and Prescriptions, Basic Books, Inc., New York, 1970.
- Northern Middlesex Area Commission, Zoning Policies: Implications for Housing, Land, and Public Service Costs, Lowell, July, 1971.