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# URBAN PLANNING AND ENGINEERING

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# 1. INTRODUCTION

During the past decade and a half, urban and environmental problems have moved to the forefront of public concern. Terms such as urban crisis, environmental degradation, resource conservation, energy shortage, and zero population growth have become part of the public dialogue that is carried on in the press and on television. At the same time, somewhat paradoxically, one of the professions that stands most to gain from this sudden public attention continues to find itself in an increasingly ambiguous position. Unsure of its societal role and confused about its mission, the urban planning profession once again is in the throes of an intensive re-evaluation and rethinking of its purposes, goals, and processes as it struggles with the perplexing questions of whom to educate, for what roles, with which skills, and with what mix of academic versus on-the-job training (see, for example, the published proceedings of the Chapel Hill Symposium on Planning Education, Godschalk, 1974).

Manifestations of the general malaise in the field have appeared in various forms, for example: the closing down of the planning department at Yale; the searching examination of the future of the planning Ph.D. at Harvard by a presidential committee; the absence of virtually any required courses in planning curricula at such established centers of planning education as M.I.T.; the large number of self-critical essays on the future of planning and of planning education that have appeared in recent issues of the Journal of the American Institute of Planners, and also in Planning, the journal of the American Society of Planning Officials; and various papers presented at the annual conferences held by these two organizations during the past decade.

Yet, at a time when the planner's perspective is being challenged and tested, one nevertheless finds governmental and private organizations calling for the implementation of policy analysis and the systematic programmed application of resources to guide social action toward the achievement of predetermined goals.

What then is the future of urban planning, and for what roles and responsibilities should planning schools be educating and training their students? These are vital issues that persistently appear in the planning literature of the 1960's and the early 1970's. I shall touch lightly on them in this paper in the course of outlining a proposed role for engineering schools in urban planning education and research.

The evolution of urban planning and the evolution of urbanized society have been intertwined since the birth of the profession. Thus this paper begins with a very brief historical view of the forces that have helped to shape urban planning in the past. This historical view then is extrapolated to suggest several probable future conditions and demands relating to the profession. The paper concludes with an argument in support of a particular mission for planning programs located in engineering schools.

## 2. THE HISTORICAL EVOLUTION OF URBAN PLANNING

The modern urban planning movement was born in the late nineteenth century as one of a number of reform movements aimed at ameliorating some of the worst features of industrialization and urbanization: e.g., slum housing, congested streets, high rates of crime and disease, and inadequate public facilities. At the same time, stimulated and dazzled by the grandeur of the 1893 Columbian Exposition in Chicago, upper and upper middle-class Americans returned home from the fairgrounds to join the planning movement and champion the enhancement of the appearance and amenities of their communities by fostering such civic improvements as monumental civic centers, extensive park systems, and major boulevards.

This was the "City Beautiful" phase of urban planning, and it brought together architects, landscape architects, and civil engineers who saw in physical planning a vehicle for providing better housing for the masses, breaking up the ethnic ghettoes, and creating middle-class neighborhoods which would recapture some of the lost charms of the rural towns that were the nation's heritage.

The first three decades of the twentieth century have been called the formative years in the history of modern urban planning. This period began with a flourishing City Beautiful Movement and ended with the publication of the influential Regional Plan of New York and Its Environs, a plan which emphasized economic, demographic, and governmental problems as well as the conventional physical elements of the community. In between, the first national conference on city planning was held in 1909, to be followed eight years later by the formation of the American City Planning Institute, an event which accorded city planners a professional status. The first comprehensive zoning ordinance was adopted in 1916 by

the City of New York and was followed a decade later by a Supreme Court decision that upheld the constitutionality of zoning in the landmark Euclid vs. Ambler case. Scores of voluntary civic organizations and semi-independent city planning commissions employed planning consultants to prepare "master plans" for their communities. These usually consisted of proposals for new civil buildings and plazas, parkways and recreational areas, thoroughfares, and, always, a zoning ordinance. They emphasized an "efficient" physical layout of the community, included a careful treatment of the engineering and financial elements of the proposal, and almost without exception were praised but never implemented. The City Beautiful was replaced by the City Efficient, but the net effects of both on city growth and development were equally negligible.

The Depression dramatically altered society's perception of public problems and public enterprise and, therefore, of public planning as well. The faltering economy stimulated a new wave of reform throughout the entire institutional fabric of the nation and with it dramatically broadened the scope of city planning to include socioeconomic concerns and enlarged the territorial scale of planning to include regional and national constituencies. Confirmation of the profession's redefinition of its role came in 1938 when the American City Planning Institute changed its name to the American Institute of Planners in order to recognize the greater breadth that the profession had recently acquired. In its statement of purposes the profession described its principal areas of concern to be "... the planning of the unified development of urban communities and their environs and of states, regions, and the nation, as <u>expressed through determination of the comprehensive arrangement of land uses and land occupance and the regulation thereof</u>," (Article II, A.I.P. Consitution).

While acknowledging the importance of a sensitivity to the social and economic aspects of planning, not until some thirty years later was the profession to formally commit itself to an expansion of its physical planning problem-focus to include socioeconomic planning, when in 1968 it deleted the underlined last phrase in the foregoing quote.

The perspective of city planning continued to expand during World War II and the postwar era. The forces of urbanization and suburbanization; the vast industrial and technological changes brought about by the war; the rising intensity of social problems in the nation's central cities; and the growing affluence of the population, all combined to make clear to community planners that intelligent physical planning could only proceed on the basis of adequate information about the social, economic, and political forces that were being played out in metropolitan regions throughout the country. Further broadening of the profession's role was occasioned by the increasing involvement of the federal government in urban development. This involvement came in the form of several landmark pieces of legislation: the National Housing Act of 1949, which set forth the goal of a decent home for every American family and gave birth to urban renewal; the 1954 amendments to the Act which required a "workable program" toward comprehensive planning and broadened the concept of urban renewal to include rehabilitation and conservation; and the 1955 Highways Act which ultimately released powerful forces for the reorganization of metropolitan areas by dissolving the previous barriers to transportation and communication.

By 1964 the fledgling 52-member American City Planning Institute of 1918 had evolved into a 4,000-member American Institute of Planners. With this sudden growth came disparate interests, opposing philosophies, and divergent views on the proper role of planners in society. The solidarity

that the planning movement carried with it in its earlier days was irretrievably lost. The final push toward a new style of planning came in 1966 with the passage of the Demonstration Cities and Development Act, also known as the Model Cities Act.

The Model Cities Act set forth several objectives: the renewal of slum neighborhoods by the combined use of both physical and social development programs; an increase in the supply of low and moderate cost housing; an expansion of job and income opportunities among the poor and disadvantaged; and the reduction of social and educational inequalities, crime, delinquency, disease, and ill health. The Act was a monumental piece of urban legislation and, together with reinforcing and supporting programs such as the Economic Opportunity Act of 1964, had a major impact on the planning profession by virtue of its demands for such new specializations as social policies planning, criminal justice planning, comprehensive health planning, and various other related human resource development activities.

The historical development of planning education mirrors that of the planning field itself. Until the end of the 1920's education in urban planning was confined to apprenticeships in offices of architect-engineer planning practitioners and a few scattered university courses taught by these same practitioners. Not until 1929 (at Harvard University) was a separate school of planning established to offer a specific graduate program of study for those who wished to become practicing professional planners. Harvard was soon followed by M.I.T., Columbia, and Cornell, and, later, in the 1940's, by the Universities of Michigan, Wisconsin, North Carolina, and California. Instruction during this period emphasized professional practice and the content came largely from the design provinces of

architecture, landscape architecture, and civil engineering. The emphasis was on design, and heavy reliance was therefore placed on instruction centered around the drafting board. Beginning in 1947, and extending through the early and mid-1950's, a remarkable program in planning flourished at the University of Chicago under the leadership of Rexford Tugwell and Harvey Perloff. The influence of this short-lived program on planning education was profound, and many of the current leaders in the urban planning field were associated with it either as faculty or as students. The principal impact of the "Chicago School" on urban planning education lay in the area of planning theory and in the application of social science analysis to what heretofore were thought to be primarily physical design problems.

Planning schools entered the 1960's hesitantly and unsure of their educational mission. The "comprehensive planning" of the past was increasingly held to be unscientific and insufficiently grounded in analysis. A major thrust to develop improved quantitative methods and analytical skills followed, spurred on by the growing availability of electronic computers, the development of new mathematically oriented disciplines such as operations research and regional science, and the proliferation of major metropolitan land use-transportation study efforts such as the Chicago Area Transportation Study and the Penn-Jersey Transportation Study. The increasing number of fledgling Ph.D. programs also influenced this shift toward a research orientation with its concomitant methodological consciousness.

The social crises of the late 1960's brought to planning schools a generation of students who were principally interested in the socioeconomic problems of urban populations and who were convinced that

a concern with human and not physical development should form the contextual core of planning education. Further, the idea of comprehensive planning validated by a "public interest" increasingly gave way to the notion of advocacy planning which reflected a "plurality" of interests and potential group conflict. As poverty and discrimination became central issues in American politics, value-neutral planning lost credibility, and the profession increasingly moved from a perspective of planning for the people to planning with them.

Looking back at the history of urban planning one is struck by three persisting trends that have characterized the development of the field. First, the planning function and its role in urban policy-making has been largely determined by forces outside the planning field. The opportunistic response of the field to the changing demands of federal urban programs and policies is especially notable. When housing programs and urban renewal were being heavily funded by Congress, planning schools and planning professionals developed an expertise in housing policy and redevelopment. When Washington called for urban modeling skills and data bank specialists, statistics, economics, and computer programming entered planning curricula. When the federal government declared a war on poverty, planners joined model cities agencies and government-supported community organizations. Criminal justice planning, transportation planning, comprehensive health planning, and environmental planning all were incorporated into the planner's domain under similar circumstances.

Because no single stream of intellectual development has consistently dominated the others in the evolution of urban planning, planners have never been overly confident about their proper function in society and, in consequence, have tended to continuously adopt ever-widening redefinitions

of their role. First came the professional stream of development which fostered the definition of a separate skill group, as in the case of doctors, architects, and engineers. Next, came the administrative stream of development which gradually gained momentum following the Depression years and led to the institutionalization of the planning function in local government. The 1960's ushered in several new competing streams of development into planning practice: the planner as advocate (the lawyer image), the planner as clinician-healer (the doctor image), and the planner as broker-mediator (the politician image). It is still too early to make any firm conclusions regarding the long-run significance of these later streams, but their influence on planning curricula in the late 1960's and early 1970's has been a strong one.

Finally, the third theme that one observes in the evolution of urban planning in America is the reluctance of society to meaningfully engage in planning. It is not a coincidence that the two major enlargements of the role of planning in socioeconomic affairs followed the two major periods of social upheaval in this century: the 1930's and the 1960's. The New Deal and the Great Society pushed planners into previously unplanned fields, as government assumed responsibility for social and economic development in areas where the efforts of private enterprise had failed. At other times society's interest in planning has waned, and the field's influence and power, accordingly, have been diminished. The abolishment of the National Resources Planning Board in the 1940's, the demise of state planning agencies in the early postwar years, and the dismantling of federal urban programs during the past several years are examples of leveling-off periods in the growth path of planning.

# 3. RECENT DEVELOPMENTS AND FUTURE DIRECTIONS

## 3.1 Urban Planning Practice, Education, and Research

### Practice

It is increasingly difficult to characterize contemporary planning practice. The field is growing too rapidly, becoming too diverse, and is diffused across too many planning bodies. Nevertheless, a brief cross-sectional look at what activities planning agencies and planning practitioners are engaged in today is instructive in that it gives one an impressionistic over-view of the field's principal lines of development.

It has recently been estimated that governmental planning agencies number close to 12,000, employ approximately 16,000 professional planners and, in the past year alone, have published close to a half million printed pages of output (Kaufman, 1974). These numbers are on the low side since they do not include planning in the private sector; in large public and non-profit institutions such as universities; in federal agencies; and in specialized staff roles created by elected officials of citizen-based community organizations.

On the governmental side, planners may be found in city and county planning agencies, on the staffs of state development planning bodies, in the federal government, and in various "councils of governments" at the metropolitan level. Planners also are increasingly employed by functional planning agencies such as community health organizations, economic development and manpower planning groups, and comprehensive transportation planning commissions.

Although their activities and responsibilities are varied, most would see their functions as being consistent with at least some of the following list of attributes of a model "progressive" planning agency--an agency which

"(a) has a far-ranging scope of concern including human resource, economic, and physical development;

(b) is sensitive to the needs of all people, especially the disadvantaged;

(c) employs sophisticated policy-making aids including computers, modeling techniques, and operations programming measures;

(d) has a prescriptive concern that embraces all actions of significance to the community that can be affected by government;

(e) makes forecasts with a high degree of probable accuracy;

(f) develops action proposals that are the result of systematic analysis of existing conditions and future action possibilities and are produced with a clear view to implementation by public and private enterprise; and

(g) involves citizen groups in an open and continuing way in the process of policy formulation and implementation."

(Kaufman, 1974, p. 116)

Along another dimension, the planner's professional association, the American Institute of Planners (A.I.P.), has undergone a number of changes in the course of its recent expansion to some 9,000 members. With the deletion of the phrase "as expressed through the determination of the comprehensive arrangement of land uses and land occupancy and the regulation thereof" from the AIP Constitution, the planning profession officially recognized its broadened scope and in 1968 moved to implement this revised perspective of its mission by offering the following 12 areas of specialization in its membership examination:

1) administration for planning and development,

2) comprehensive physical planning,

3) social planning,

4) transportation planning,

5) urban design,

6) research methodology,

7) economic planning,

8) environmental sciences planning,

9) renewal planning,

10) planning law,

11) programming, and

12) budgeting.

According to most indicators, then, the practice of urban planning has changed dramatically over the past years. Whether measured in terms of numbers of planners, planning agencies, or planning programs; or in the characteristics of those entering the field; or in the changes that have taken place in the American Institute of Planners and its journal; or in the increasing levels of support from the federal government--the unequivocal conclusion is that planning has arrived. Urban problems have moved to the forefront of society's attention and planners, capitalizing on their historical role as custodians of orderly and progressive urban growth and development, have taken the lead in efforts to cope with these problems.

Education

According to the most recent annual school survey conducted by the American Society of Planning Officials, there were some 4,000 full-time and 1,000 part-time planning students enrolled in planning schools in 1973 (Corby and So, 1974). Of this total, about 3,700 were enrolled in masters degree programs, about 1,000 were seeking bachelors degrees, and just under 300 were pursuing their doctorates. (The latter figure may be compared to the approximately 220 Ph.D. degrees that have been awarded since 1960.)

The comparison of 5,000 students in 1973 with the 1,000 students in 1963 and the less than 600 students in 1958 points to the phenomenal growth in student numbers that has occurred during the past decade or so. A similar picture is drawn by statistics on the number of planning schools. Less than 20 universities offered graduate programs leading to the masters degree in 1953 and only one (Harvard) had produced a Ph.D. in planning. In 1963, 28 schools offered advanced degrees in planning and 54 offered the degree in 1973.

Most planning schools today seem to be offering a modified version of the generalist with a specialty solution advocated by the University of Chicago's planning program of the 1950's. Specifically, many of the major schools (e.g., M.I.T., U.C.L.A., U.C. Berkeley, North Carolina) appear to be developing several sets of specialties or concentrations (such as urban-regional planning, social planning, public service systems planning) and linking these with a set of core courses in planning theory and methods and courses in the structure of urban systems. Usually at least one course in quantitative techniques is also included.

The tremendous expansion of planning schools and of graduating planning students (e.g., 1,000 masters degrees in urban planning were awarded in 1973) has recently led educators to examine more carefully the probable future job market in planning and the potential hazards of an oversupply of professional planners.

It is exceedingly difficult to predict the future job market for planners. On the demand side the picture is complicated by the heavy dependence of the job market on federal programs. New federal initiatives such as model cities and the antipoverty program created jobs for planners. Many of these programs have since been dismantled and the jobs have disappeared. Financial support for the more traditional types of planning jobs has also declined. On the other hand, environmental protection agencies and other related agencies

concerned with our land, water, and air resources have generated an increasing demand for planners. Moreover, the state land-use planning assistance legislation now pending in Washington will, if enacted, create a substantial number of state planning related jobs.

It is equally difficult to predict the future supply of planners, because planning schools are no longer the sole suppliers of planning professionals. Scores of undergraduate and graduate programs in urban and public affairs are graduating thousands of students each year, an unknown fraction of whom enter the planning profession. Schools such as Carnegie-Mellon's School of Urban and Public Affairs, Berkeley's School of Public Affairs, and Harvard's Public Policy Program in the Kennedy School of Government; interdisciplinary programs such as Stanford's Engineering-Economic Systems Program and Stonybrook's Urban Science and Engineering Program; and dozens of Urban Management Programs in business schools are providing stiff competition for planning programs, both with regard to student enrollments and to job placement. And it is becoming increasingly difficult to argue that urban planning programs have a built-in comparative advantage over their competitors.

Research

The evolution of a science from a practicing art is the result of a cumulative process of minor transitions in which contributions to a theoretical structure gradually transform a relatively crude practice into a science. This has been true of the transformation, for example, of astrology to astronomy, of alchemy to metallurgy, and of moral philosophy to economics. Since the practicing art of urban planning grew out of a desire to rationalize the growth and development of the physical environment, the spirit of that movement has always had a scientific outlook if not a

scientific practice. However, the conscious development of a theory and method of planning through research is a relatively recent phenomenon.

Since the early postwar years, planners have recognized that the increasing complexity of urban development problems demands a higher level of sophistication in planning theory and method than were once acceptable. As early as 1949, members of the American Institute of Planners submitted a statement to the Ford Foundation calling for support of a large-scale program of research focusing on the urban environment. That statement foreshadowed much of the research that was to be undertaken during the subsequent decade. It included proposals for studies of the influence of city size on the costs of service provision, research on new community development, zoning, and sub-division controls, studies of land value and industrial dispersion, studies of the relationships between traffic and land use, and much more. The Foundation responded in the mid-1950's with the first grants to universities for urban and regional research. The rapid proliferation of university urban research centersfollowed shortly thereafter.

Yet, despite the recognized need for an expanded urban research activity and despite the growth of urban research centers, institutes, and government and foundation sponsored research programs, the field's scholarly development has been relatively unimpressive. This may be at least partially a consequence of the strong professional biases held by the early members of planning faculties. Until the 1960's, few planning professors engaged in serious academic research. Most of the older faculty had been recruited from governmental agencies or private consultant firms and their credentials were, in consequence, a demonstrated competence in professional affairs not scholarship. By temperament and by training, planners such as these were ill-equipped to develop a theoretical foundation for planning practice.

However, the recent growth of doctoral programs in planning departments across the nation may well introduce an ideological research bias into planning education that should significantly contribute to the state of the art in the future.

In summary, from an early emphasis on esthetics and the efficient functioning of the city system, urban planning has over the past years widened its scope and broadened its dogma, while, at the same time, enlarging its domain from project planning to city, metropolitan, state and, indeed, national planning. The field in the mid-1970's is acting increasingly like a maturing profession--maintaining a lobby in Washington, accrediting planning schools, and examining prospective members seeking entry into the guild. Yet, clearly, the profession is still in the process of transition, and only time will tell if it will ultimately equip itself to assert its own influence on future events--as have, for example, the legal, engineering, and medical professions.

## 3.2 Future Directions

The evolution of urban planning and planning education has been inextricably intertwined with society's perception of urban problems and public responsibilities. The historical pattern that has persisted is clear. New situations, directions, and perspectives in society establish new professional opportunities which, in turn, induce the academic community to provide specialized training to prepare individuals to assume the responsibilities created by the new professional opportunities. There is little reason to suppose that this historical pattern is going to change in the future. Thus, in considering the future directions of urban planning, one is well-advised to begin by extrapolating society's probable future outlook on public problems and public enterprise.

Perhaps the most fundamental projection that needs to be made concerns the degree to which out post-industrial and service-dominated nation is moving toward a planned society. Are we moving toward an era of increased public intervention in and management of our urban and national affairs? For example, are there going to be increasing controls over the pace and distribution of population growth, migration, and development? Or are we moving toward increasing decentralization of formal authority, deprofessionalization, and a return to the market system with subsidies to ensure equity? For example, are we going to reprivatize public service systems that fail to perform in an efficient and cost-effective manner by means of allowances, vouchers, and various forms of performance contracting?

Both scenarios have been sketched out in recent years and, at different scales of planning, both are probable. The pressures generated by population and economic growth on the stock of our natural resources, on the quality of our environment, and on our supplies of energy, for example, are not going to decline in the near future, and this situation is not likely to produce

a devolution of societal planning. On the contrary, planning will very probably become the normal mode of future societal decision making in environmental affairs. Yet, as Mel Webber has pointed out:

> "The post-industrial age will be marked by increasingly diverse publics having increasingly diverse wants and being increasingly involved in political affairs. The combination of diversity with political participation will engender vocal demands for widening arrays of services and facilities ...." (Webber, 1969, p. 294)

And this will undoubtedly contribute to some decentralization of power and deprofessionalization in certain areas of local planning, possibly with centralized system-wide resolutions of the external effects of private decisions.

Suppose we accept the proposition that our society is indeed moving toward increasing public intervention in the form of planning. Where is the attendant growth in new professional opportunities most likely to occur: in traditional departments of planning or in the various operating agencies of government? During the past decade most of the new professional opportunities have occurred among the latter, leading some planning educators to suggest that by

> "1980, while the planning function at all levels of government will probably be vastly greater, it is quite possible that no state will have an agency which is labeled a planning department... Instead, the planning function will be performed in a large variety of operating agencies. Coordinated planning of a comprehensive nature will be carried out by a unit of some central agency such as an office, bureau, or department of budget, planning, or management." (Jones, 1972, pp. 187-188)

But consider a parallel trend: the renaissance of state planning and the "new mood" in America that seeks to preserve and protect our environment and avoid urban problems by avoiding uncontrolled growth. This new mood is reflected in the increasing number of land use regulation bills that have been enacted or are pending in state capitals and in Washington. The State of Hawaii, for example, has for over a dozen years followed a state land use control policy that has served as a model for the other 49 states and recently has revised its State Land Use Law to improve its effectiveness. Californian voters, by a substantial margin, not long ago approved new stringent land-use controls over a zone a thousand yards back from their entire coast. Florida's Environmental Land and Water Management Act of 1972 recaptures a significant portion of the land use control authority previously delegated to local governments and prescribes new regulations in this field. And, finally, during the past years several important land use bills have been pending in Congress, all of which call for state planning and intend that states actively engage in land-use planning and regulation.

It appears, then, that future professional opportunities in planning will expand in both of its historical traditions: the tradition growing out of a concern for "place planning" and the tradition that has emerged out of an increased involvement in "program planning." Both traditions, will continue to generate demands for planners with particular sets of analytical competencies and conceptual skills. The demands will be for individuals who are capable of developing policy guidelines on how to cope with the urgent problems of the city and of urbanization--problems of poverty and segregation, traffic congestion, financial crises, environmental degradation, and resource exploitation. Such policy analysts, spatial planners, and program designers will assist governmental and private

organizations to explicitly state the goals of their various programs; to explore alternative courses of action for accomplishing such goals; to estimate the social costs of each alternative considered; to measure the probable effectiveness of each alternative for accomplishing the goals; and then to articulate such program proposals in budgetary language.

These developments will require planners trained in systems analysis and simulation, cost-benefit analysis, budgetary and financial management, program formulation and development, and in a variety of specializations such as regional analysis and development planning, public service systems design, land use planning, environmental management, and both human and natural resources planning.

Given the rapid growth of competing urban policy programs in universities today, what comparative advantages do urban planning departments have in producing such individuals? How well do their curricula stack up against the competition in the new schools of public policy, in civil and industrial engineering departments, in urban affairs centers, in business schools, and in departments of economics? As the technological dimensions of planning education increase do we face the possibility that schools of planning as they currently exist will be replaced by schools of administration, as their functional planning specializations gradually become absorbed by schools of engineering, social studies, and the like? No one knows, and it is still too early to make reasonable extrapolations of current trends. Yet what does seem to be indisputable is this. The training of soundly educated planners will increasingly require qualities and quantities of resources that will be beyond the means of all but a handful of large and diverse planning schools. Smaller planning departments and planning programs in other academic settings will be forced to reassess their curricula, particularly those that tend to be too highly emulative of the programs in

the larger schools. Specialization and division of labor will need to be developed and fostered. Perhaps all programs should cover a similar core curriculum focusing on how cities work and how societal decisions are made and implemented. Beyond that planning programs in architecture schools could emphasize urban design, those in engineering schools focus on systems analysis and simulation, and those in urban affairs settings stress socio-political systems planning. Training for urban planning will no longer be the private preserve of city planning departments, and students will increasingly elect to study planning in programs offered in other academic settings, such as engineering schools, for example.

# 4. URBAN SYSTEMS ENGINEERING AND PLANNING

## 4.1 Engineering and Planning

Engineering has long exerted a powerful influence on the evolution of urban planning. Some of the first courses in city planning were offered in civil engineering departments. The earliest was taught in 1910 by Leonard S. Smith at the University of Wisconsin, only a year after Harvard established the first lecture course in the United States specifically focused on the then emerging field of city planning. Smith's efforts were soon followed by those of Frederick Bass at the University of Minnesota and George Damon, the Dean of Engineering at the California Institute of Technology. By 1930, 11 civil engineering schools were offering instruction in city planning--a number exceeded only by landscape architecture departments, which accounted for another 12 out of a then grand total of 33 (Adams and Hodge, 1972).

But civil engineering's more profound influence lay not in the number of city planning courses offered but in the provision of the problem-solving perspective adopted by the planning field:

> "In seeking to confront market insufficiencies, city planners early adopted the techniques of civil engineers rather than those of economists. In so doing, they were remarkably inventive. Their major social inventions were the technical standard, which set minimum permissible levels of quality; the master plan, which set forth overall system design; and the land-use regulation, which constrained the locational decisions of individual establishments. These techniques were derived directly from civil engineering; the innovation lay in translating the language of engineering manuals and contracts-and-specifications into governmental laws and

> regulations. The aim was basically to accomplish in the market place the sorts of deliberate outcomes that are readily accomplished in the centralized decision-setting of an engineer-client relationship or a centrally controlled government enterprise." (Webber, 1969, p. 284)

The requirements and standards approach of early comprehensive planning has fallen somewhat into disrepute in recent years. The growing recognition of cultural pluralism has turned the notion of comprehensive planning based on a "public interest" into an increasingly untenable perspective and has pushed distributive, or equity, considerations to the forefront. The usefulness of standards, with their built in emphasis on input evaluations, has been questioned by planners who like Mel Webber are calling for a focus on output evaluations instead. Yet while it is certainly true that ideally a planner's evaluations should be guided by the outputs of actions and not by their inputs, it is quite another matter, given the current state of the art, to put this perspective into practice. This is why educational planners, for example, still focus on student-teacher ratios, hospital planners count numbers of beds and compute doctor-patient ratios, and librarians measure stocks and flows of books. We simply do not know how to specify and estimate realistically the various production functions that are involved. So, I would submit that, however crude their methods, the engineer's predilection to work with what is available to get the job done is an attribute that planners should emulate. In their role as problem-solvers engineers draw upon whatever data and theories that are available to develop an answer for the job at hand. When such data and theories are unavailable, engineers use empirical correlations, approximations, and assumptions, and perform basic research. It is precisely these attributes which lead me to believe that engineers

once again are in a particularly strong position to provide another powerful shot in the arm to urban planning.

As an applied discipline, planning derives from many diverse fields, but its unique contribution comes from an analytical systems (holistic) perspective of social change and a synthetic (design) perspective for planning programs and policies to guide such change in humane and equitable directions. The development of tools for systems analysis and synthesis in urban planning is an activity that is especially appropriate for planning programs located in engineering environments. Engineering schools are the sources of technological education in the traditional civil engineering areas of transportation, pollution, waste disposal, hydrology, and public health. Engineering schools are the academic seats of departments of industrial engineering and operations research, with their wide range of course offerings in optimization theory and stochastic processes. Engineering schools house the growing number of computer science programs and are, therefore, especially well-equipped to provide training in the use of this all-important technological tool. Finally, engineering schools can draw on a ready supply of analytically inclined and mathematically well-prepared undergraduate students.

So far, I have argued that engineering schools can make an important contribution to urban planning education. Let me now balance the equation by suggesting that urban planning with its central focus on social concerns has much to offer engineering education.

The growing power of the professions in post-industrial American society makes it vital that the social implications of their activities be recognized. The social ramifications of technological change need to be diffused throughout engineering curricula and social scientists should be

brought into engineering schools. Planning programs can contribute toward the development of a social consciousness among engineering students and can provide a home for social science oriented faculty.

Engineering has a history of involvement with the social sciences. Public works engineers, for example, have long enjoyed a fruitful relationship with economists; and it was Dupuit, a French engineer, who first developed the economist's concept of consumers surplus. Industrial engineers have often collaborated with psychologists to develop more effective designs and uses for equipment and they have made important contributions to the practice of industrial organization. But despite historical links such as these, most engineering curricula still do not seriously confront their students with questions of social values and goals, of cultural pluralism and social costs, and of social interaction and societal change. Consequently, engineers have often subordinated equity effects to efficiency considerations. Mel Webber put it best in a recent paper:

> "Every public action generates both efficiency effects and redistribution effects. Engineers have traditionally been alert to the former--the influence of highway alignment on travel costs, the effects of building materials on construction costs, the effects of separating sanitary from storm sewers on the costs of operating a treatment plant. (But) ...every public action also shifts the distribution of benefits and costs among the various segments of the population.... The current attention to community values in the western world is being largely generated by the external distribution effects. It is not a debate over whether a new motorway ... or a new airport conflicts with some holistic objective of the 'metropolitan community'.

> That community is largely mythical. Rather, it is a debate over which publics are to pay and which are to profit from the government's action." (Webber, 1969, p. 286)

A number of engineering schools have moved to integrate social analysis, in a significant way, into their undergraduate curricula. A notable example is the interdisciplinary Program in Engineering and Public Affairs at Carenegie-Mellon University--a program which merges its engineering school's curricula and students with those of the School of Urban and Public Affairs. The distinctive characteristics of that Program are, according to its co-directors:

> "First, it is an undergraduate program. It is built on the belief that the best way to train people in the solution of sociotechnical problems is to start from the beginning to develop skills in both social and engineering analysis, rather than in graduate programs where disciplinary constraints have been developed. Second, the program is a dual track. The program does not aim to produce engineers with a veneer of social science or social scientists with a veneer of engineering but graduates who are familiar with the basic tools in both areas and who are capable of doing professional analysis in both areas. Third, the program provides integration of the dual educational tracks through experience on real problems, both in the internships between the junior and senior years and in the projects on actual problems with both social and technological components." (Dunlap and Lewis, 1973, pp. 16-17)

## 4.2 The Multidisciplinary Professional: The Urban Systems Engineer - Planner

### The Generalist with a Specialty

Extrapolations of current trends, I have argued earlier, suggest that future urban problem-solving and societal guidance activities will increasingly involve multidisciplinary teams of generalists with a specialty--individuals who collectively share a common perspective of the structure of urban systems and of planning (as a conscious process for guiding social action), but who individually are also expert in different substantive specializations and sets of skills. That is, although such professionals will, first and foremost, be urban planners, they also will be experts in at least one related substantive field.

If this extrapolation is nearly accurate, planning programs in engineering schools will be in a particularly advantageous position to train engineer-planners whose special contribution to such multidisciplinary teams will lie in their highly-developed ability to provide scientific technological intelligence in both method and substance.

In common with planners trained in most non-engineering settings, such urban engineer-planners will have a focused substantive competence in some specialization of the field along with a broad and general competence in: 1) the theory and practice of planning, and 2) the structure and behavior of the various social, economic, and political urban systems that are of paramount importance in urban policy analysis. In contrast to most planners trained in non-engineering settings, urban engineer-planners will, in addition, possess highly developed methodological skills in both urban systems analysis and simulation. That is, they will be expert not only in the use of the computer for econometric, sociometric, or psychometric

studies, but will also be technically proficient in the use of the computer to carry out simulations of complex, interdependent urban processes.

The Holistic Systems Perspective

As our perception of the full size and complexity of the societal problems that confront us improves, we increasingly recognize that energy, resources, population, and environmental quality are interrelated components of broad urban-regional systems and therefore cannot be dealt with individually and independently. Programs aimed at a single component may produce unanticipated changes in several others and cause side-effects that are detrimental to the achievement of system-wide goals. Consequently, actions that seek to guide aspects of urban life need to be carried out with as full an understanding of their system-wide effects as possible, including a proper recognition of their probable long-term impacts. This requires a methodology that can effectively deal with urban problems in their rich complexity--that is, as higher level systems.

Important contributions to the development of such a methodology have in recent years come out of urban systems engineering research. A fundamental virtue of such engineering research efforts--of which metropolitan land use-transportation studies and water resource planning studies are outstanding prototypes--is their attempt, however crude, to deal with higher systems levels of design than normally are considered in strictly disciplinary social science-based efforts. Moreover, such engineering studies typically produce numerical estimates of systems parameters and performance. Both features are of considerable importance to planners since planners have historically sought to view urban problems holistically and have generally looked to numerical forecasts of systems loads and societal demands as a means for scaling their spatial plans and systems designs.

The Multidisciplinary Approach

The time constraints under which most planning programs operate make it imperative that their core curricula be taught in a multidisciplinary manner and not through interdisciplinary collaboration. By that I mean that the teaching responsibility should be vested not in a team, with representatives from each of the relevant fields, but in meta-disciplinary individuals who have internalized a number of disciplinary approaches and theories relevant to a particular set of urban problems and who, therefore, are capable of addressing these problems in a multi-faceted but coherent manner. The difficulties associated with the interdisciplinary recipe have been well-documented by William Alonso (1971), for example, and therefore need not be catalogued here. I share his view that especially in the hard social sciences, but also in the soft ones, "there has begun to develop a meta-disciplinary competence that rests in particular individuals, and that this provides a better model for the incorporation of the social sciences into the planning process than does the idea of an inter-disciplinary team. The key difference is that members of a meta-disciplinary team share a common ground, while members of an inter-disciplinary team are brought together because of their diversity." (Alonso, 1971, p. 172)

At least in the core areas of planning theory and urban systems structure it is now possible to develop courses that in a relatively brief span of time engage the student in a multi-disciplinary confrontation with questions of planning <u>process</u> and of planning <u>substance</u>. Unfortunately the same cannot be said of planning <u>methods</u>; these still tend to be taught in the interdisciplinary mode. All too often planning students are sent to the operations research department to get their only exposure to optimization theory, to the statistics department to get their "music appreciation" course in

statistics, and to the economics department to learn some location theory. Typically these topics are then never reinforced in substantive departmental courses. I believe that these efforts are futile and would instead recommend the training of planners with metadisciplinary competence in urban-regional analysis and whose major task would be "not to do something new but to do something well. In these circumstances, the professional's role is to identify the class of problem before him and to apply the best techniques known for solving that class of problem." (Alonso, 1971, p. 172)

And on this score we in planning education are doing a poor job. A quick survey of the current situation suggests that we are still teaching methods of urban and regional analysis in a primitive "disciplinary" rather than "multidisciplinary" fashion. For example, instead of focusing on techniques known for dealing with a class of problems defined structurally, e.g., growth of stocks; changes in flows; aggregation problems; fitting lines, curves, and surfaces to scatters of points; solving simultaneous equality and inequality systems and so on, we still tend to follow the technique-by-technique road and in the process all too often offer analysis courses that are <u>about</u> skills rather than being in themselves skill-building.

My personal experience in teaching methods of urban and regional analysis leads me to advocate a perspective that focuses on the structural similarities in the substantive problems that are addressed by different methods--emphasizing the commonalities of these methods instead of their fundamental differences. In this way the student is able to efficiently apply much of what he has learned about one method to the study of another, that is, to solve one problem by transforming it into another one which was previously solved. For example, it is a simple matter to demonstrate that the process of projecting a population using the conventional cohort-survival process is

intimately related to the process of projecting the outputs of an economy using the input-output model. Conversely, it can be shown that the literature in input-output analysis dealing with the thorny problems of aggregation and stable growth can easily be applied to the cohort-survival population model. And, in turn, the conventional method of short-circuiting the iterative solution of an input-output model by inverting a matrix can be carried over to a simplified version of the Lowry land use model called the Garin-Lowry model. Analogous transfers can be identified in statistical modeling techniques and in optimization theory.

Systems Simulation

Engineers have increasingly recognized that the planning and design of public works, such as water works, transportation facilities, waste disposal and treatment systems, and pollution abatement programs, depend on an intimate interplay of social, economic, political, and engineering considerations. None of these several disciplines can effectively contribute to the planning and design process, however, without the active collaboration of the others and programs that have successfully harnessed them in a common effort often have revolved around a computer simulation modeling study (e.g., Hamilton et al., 1969, Maass et al., 1962, Roberts and Kresge, 1968, and Robinson et al., 1965).

Computer simulation models have been particularly appealing in studies of public investment decisions involving broad social goals, wide external system effects, and long-range planning horizons. Urban highway and mass transit plans, water resource development programs, and large-scale urban renewal projects all have fostered computer simulation studies. The system complexities inherent in the sociophysical systems being analyzed almost always involve nonlinear relationships and feedbacks that make traditional

analytical methods somewhat ineffective and force the analysts to use the vast computational and logical capabilities of the digital computer.

A Comment on the Critics

As large-scale urban simulation models have grown from the relatively simple allocational methods used in, say, the Chicago Area Transportation Study (C.A.T.S., 1960) to the increasingly more complex and costly system simulations of which the housing model developed at the National Bureau of Economic Research is the current prototype (Ingram, et al., 1972), they have been subjected to increasing criticism. Some critics, for example, point out that the increased complexity and costs of such models is not being matched by increased predictive accuracy. In light of the infancy of this modeling technology, this is not at all surprising. The same problem appears in many other disciplines. For example, Professor Frederick Sanders of M.I.T.'s meteorology department reports in a recent Bulletin of the American Meteorological Society that over the past six years the success of meteorologists at M.I.T. in predicting the weather has not improved; on the contrary, their ability to predict rain and snow has deteriorated during this time (Newsweek, March 25, 1974, p. 65). This deterioration has occurred during a time in which the tools of the weather forecasting trade have been greatly improved with the introduction of weather satellite photographs and large high-speed meteorological computers.

Another persisting theme in many of the learned criticisms is that of complexity and attempted comprehensiveness. Alonso, for example, suggests:

> "build several simple models... not one master model of the real world, but rather a set of weak models.... I am questioning whether we have arrived at the design of skyscrapers but we have only lumber for construction material." (Alonso, 1968, p. 252)

Similar views are offered by Lee:

> "Build only very simple models. Complicated models do not work very well if at all.... The skill and discipline of the modeler is in figuring out what to disregard in building his model." (Lee, 1974, p. 176)

Our inadequate knowledge about the behavior of the systems we wish to model and the excessively "messy" and "murky" complexity of the models that have been implemented so far, appear to be the two most persisting criticisms leveled at recent urban systems simulation efforts. My response to the first criticism is to point out that the history of applied science is a history of technologies developed on the basis of imperfectly understood scientific principles. Indeed, since technology predates science, the earliest technological advances had a minimal scientific content. Throughout history man has used observation and ingenuity to develop tools, mine metals, and build roads, bridges, and buildings. Lacking any scientific idea why the materials behaved as they did, he has instead relied on hunch and observation, trial and error, hypothesis and experiment.

The second criticism is a valid one. Because so many of the early computer simulation models have been the products of interdisciplinary and not multidisciplinary teams, they have tended to carry considerable amounts of excess baggage brought in by the various contributing disciplines. We still have not learned the cardinal principle of systems modeling which is: include only those parts of the internal structure of the subsystems being simulated that are absolutely vital to a useful abstraction of the entire system.

Simulating the behavior of complex systems on the basis of the presumably known behavior of their component interacting parts is not a

trivial problem and does not consist of simply combining the various component submodels. The skill of the systems modeler derives from his ability to view the simulation holistically and to identify subsystem level behavior that is crucial to the understanding of the behavior of higher level systems. In a recent brilliant essay, Herbert Simon develops a persuasive argument for approaching this problem in the context of hierarchical systems:

> "...my central theme is that complexity frequently takes the form of hierarchy and that hierarchic systems have some common properties that are independent of their specific content. Hierarchy ... is one of the central structural schemes that the architect of complexity uses." (Simon, 1969, p. 86)

## 4.3 Urban Systems Engineering and Planning at Northwestern

During the past three years, the Technological Institute at Northwestern University has been moving to develop the multidisciplinary engineer-planner described above. In 1970 the National Science Foundation awarded the Institute a substantial developmental grant to mount an interdisciplinary research and educational effort directed at urban systems engineering and planning. In May of the following year, the Graduate School approved our proposal for a graduate program in Urban Systems Engineering and Policy Planning leading to the masters and doctorate degrees. The first students were admitted in the Fall of 1971, and in 1974 the program graduated its first masters and Ph.D. students.

Northwestern's Urban Systems Engineering and Policy Planning program strives to infuse its students with a holistic, systems perspective of urban-regional phenomena and with a programmatic planning approach to change. It therefore aims to develop in all of its students a solid competence in applying the two principal fields of inquiry that together delineate the field: the nature of urban and regional systems and the character and potentialities of planned and programmed intervention in such systems. This competence is developed in a set of core courses, which are augmented by directed readings and an ongoing weekly seminar.

But this is not all. Each student is expected to become a generalist with a specialty. Consequently, the program requires every student to acquire, in addition to the core, both a substantive technological competence in at least one of the major focal areas of urban systems engineering and planning and a general expertise in urban and regional systems modeling.

Doctoral and masters candidates prepare for examinations in three major areas: (1) Principles of Urban Systems Engineering and Policy

Planning (i.e., the core); (2) an Area of Concentration (i.e., the substantive specialty); and (3) Analytical Methods (i.e., systems modeling). Courses and seminars are offered in all of these areas, and doctoral students normally elect approximately one-third of their total credit units within each. Five Areas of Concentration are currently offered: Environmental Engineering and Management, Urban and Regional Development Policy, Urban and Regional Transportation Planning, Public Facility and Service Systems Design, and Urban Sociopolitical Systems Analysis.

The principal purpose of the Ph.D. degree program is to develop the future intellectual leaders of the field. The primary purpose of the masters degree program was, until this year, to prepare students for the Ph.D. program. That is, it was fundamentally a research masters program. However, we currently are in the process of establishing both a two-year professional masters program and an undergraduate program, which has an option for obtaining both degrees in five instead of the normal six years.

The small group of students who have completed all coursework and have graduated or, having been admitted to candidacy, are currently writing their dissertations provides a representative cross-section of student backgrounds and interests that are currently served by the program. Their previous academic backgrounds, their elected Areas of Concentration, and their dissertation topics are outlined in the table below. Note the preponderance of engineering-science backgrounds (a consequence of the program's calculus prerequisite), and observe that all but one of the students have a previous masters degree. Academic advisors for these students were drawn from the departments of civil engineering, industrial engineering and management sciences, and economics.

TABLE -- Student Dissertations and Academic Backgrounds in the Urban Systems Engineering and Policy Planning Program

| Area of Concentration | Dissertation Topic | Academic Background |
|---|---|---|
| Urban and Regional Transportation Planning | | |
| M.B. | "The Evolution of the National Transportation System Under Future Constraints." | B.S. Physics<br>M.S. Physics |
| M.O.<br>(masters student) | "Effect of Headways and Service Reliability on Transit Passenger Arrival Patterns." (masters thesis) | B.S. Civil Eng. |
| Urban and Regional Development Policy | | |
| Y.K. | "Interdependence between Employment Growth and Interregional Migration: An Empirical Study of U.S. Metropolitan Areas." | B.A. Econ.<br>M.A. Econ.<br>M.S. Transp. |
| J.L. | "Demographic Variables in Economic Models of Regional Growth." | B.A. Math.<br>M.A. Econ.<br>M.S. Civil Eng. |
| D.S. | "Tests of Urban Function and of Inter- and Intra-Urban Migration Effects on SMSA's." | B. Arch.<br>M.S. Econ. |
| Public Facility and Service Systems Design | | |
| R.R. | "A Dynamic Approach to Central Facilities Location." | B.A. Math.<br>M.S. Civil Eng.<br>M.S. Transp. |
| Socio-Political Systems Analysis | | |
| B.K. | "Evaluation of Community Abortion Clinics in Chicago." | B.A. Chem.<br>M.S. Chem. |

Although the USEPP program is only three and a half years old it has experienced, from the very beginning, many of the tensions that are so often part of interdisciplinary programs in general and planning programs in particular. In commenting on such tensions, Harvey Perloff recently observed that because they tend to be built into the system, they do not get "solved" but can only be resolved for the given set of circumstances that occur in a particular setting (Perloff, 1974, p. 173). Thus I list them here, not to suggest that we seek to solve them in any fundamental sense, but simply to acknowledge their presence in our program with the caution that they seem likely to persist in the future.

1. Generalist versus specialist. Many have argued that for urban planning to prosper as a profession, it must develop a central focus and a corresponding technical expertise that is not found in other fields. Some, for example, suggest that the spatial dimension of public policymaking should provide the focus, while others assert that the principles and practices of planning as a generic activity should form the central theme around which all else would then revolve. Still others, however, point to the need for generalist planners to lead, or orchestrate, the specialist skills of others. The crux of the problem would seem to be how to provide a general, holistic, understanding of the increasingly complex workings of our post-industrial society while, at the same time, fostering in the student the development of a set of specialist skills in sufficient depth to transform him into a more useful participant in activities directed at societal guidance. Educational curricula such as ours which revolve around a core set of courses and emphasize the development of areas of specialization are a compromise effort to resolve this fundamental tension.

2. Professional versus scholar. Following the evolutionary path traced out by most professional schools, planning programs have been gradually diminishing the importance of practice in their curricula, as former practicing professionals are increasingly replaced by Ph.D.-trained scholars on the faculties of the major schools of planning. The emphasis on "studio courses," for example, courses in which real-world conditions are simulated in the classroom for pedagogical purposes has been largely replaced by a focus on theoretical, methodological, and lecture oriented courses. During the past few years, however, planning faculty have come to realize that this shift in emphasis has had the unfortunate effect of isolating students from real-world concerns at a time when their interests are so strongly directed toward action. Moreover, some believe that "teaching and research are glorified at the expense of doing a first rate job in the field" (Perloff, 1974, p. 175). Among the several schools which are struggling with this problem, U.C.L.A.'s "practice arm," the Urban Innovations Group, and Harvard's Regional Field Service are particularly interesting prototypes of how practice and service can be combined with education and research in planning curricula.

3. Hard versus soft. Most "scientific" professions seem to pass through a period of heightened self-consciousness during their adolescence at which time their scientific base is questioned and closely scrutinized. This was true of sociology in the 1920's, psychology in the 1930's, and public administration in the 1940's. It has been true of urban planning since the late 1950's, and the quantitative-versus-qualitative tension still persists in most planning schools today. The tension is generally between those who see modeling as the principal mode of theory building in the field and those who argue that most of the important variables can

never be quantified and that, therefore, modeling often lends spurious authenticity to ill-conceived plans and actions.

4. Competing intellectual frameworks. During the past decades, three competing intellectual traditions have been introduced into planning thought and planning curricula. The first, the physical tradition, sees public works programming and space utilization as the central organizing principle of urban planning. Its focus is spatial in character and so are the outputs of its efforts. Maps, zoning ordinances, and circulation systems are fundamental concepts in this tradition. The second tradition, the economic framework, grew out of planning's increasing contact with social scientists in the late 1950's and early 1960's. Those who adopted this point of view saw allocation of scarce resources to be the central theme around which all else revolved. The focus was on optimal systems performance as defined by marginal conditions that needed to be satisfied for efficient system functioning (rather than on a detailed specification of systems outputs, behavior and spatial configurations). Finally, the social activism of the late 1960's elevated the importance of sociopolitical considerations in planning thought, bringing with them the emerging theories of social structure and community political processes. The allocational perspective was still held to be of fundamental importance, but the process by which such decisions were made became central. Who benefits, who pays, and who decides became all-important considerations.

5. Interdisciplinary versus disciplinary. Interdisciplinary programs are orphans in most academic institutions. They generally are short-lived, with the more successful ones becoming departments or schools and the less successful ones slowly declining in spirit, as those faculty who initiated them begin to accomodate other competing interests. The reasons for the

inherently unstable character of most interdisciplinary efforts are largely institutional and stem from the ways in which rewards are extended, budgets are allocated, and faculties are appointed in universities today. In all these matters the tensions that arise over the allocation of limited resources tend to pit disciplinary departments against interdisciplinary programs in an unequal combat. Rewards to faculty members and faculty appointments normally are made through departments; interdisciplinary curricula are generally subject to the essentially voluntary compliance of departments; tenure decisions usually orginate in departments; and so on.

## SUMMARY

In summary, the principal themes of this paper are the following. Urban planning has evolved from an early concern with the implementation of ideologically defined physical spatial arrangements of human activities in urban areas to a more general professional concern with societal guidance. This expansion in scope triggered a realization that "everything is connected to everything else" in the urban systems with which planners have to deal. The traumatizing effect of this discovery, together with the demands brought about by the incredibly varied interests that have become part of the movement during its past decade of growth, have burst the boundaries that previously contained and identified the field. And, not surprisingly, planners are having difficulty fitting all of the pieces together.

No longer is it realistic to imagine that planning schools have the sole responsibility to train planning professionals. Nor is it credible that planning schools can transform an undergraduate from virtually any discipline into a competent professional in just two years, when it takes law schools three, and architecture and medical schools anywhere from five to six years. It therefore seems very likely that in the future different planning schools will increasingly specialize in the development of professionals possessing particular sets of capabilities and will strive to expand the educational process in planning both before and beyond the two-year masters degree by means of undergraduate curricula and continuing-education programs.

I am suggesting that engineering schools can make an important contribution to this process by offering planning programs that aim to develop skilled policy advisors who are especially competent in urban

modeling, computer systems simulation, and technological planning and impact assessment. The curricula for training such engineer-planners will need to emphasize coursework in urban policy planning and in urban systems structure, while in addition requiring both a technical competence in computer modeling and a substantive specialization in at least one of the major focal areas of the field. A workable prototype of this idea is the current Program in Urban Systems Engineering and Policy Planning at Northwestern.

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