TEMPO

APPLICATION OF AEROSPACE TECHNOLOGIES TO URBAN COMMUNITY PROBLEMS

GPO PRICE $ ________

CFSTI PRICE(S) $ ________

Hard copy (HC) 3.25

Microfiche (MF) 1.25

ff 653 July 65

65TMP-53

GENERAL ELECTRIC COMPANY
SANTA BARBARA
CALIFORNIA

FACILITY FORM 602

N66 31894	
(ACCESSION NUMBER)	(THRU)
185	1
(PAGES)	(CODE)
CR-76524	34
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

APPLICATION OF AEROSPACE TECHNOLOGIES TO URBAN COMMUNITY PROBLEMS

M.L. Feldman
L.A. Gonzalez
A.B. Nadel

RM 65TMP-53
23 September 1965

The research reported herein has been sponsored in part by the Western Operations Office of the National Aeronautics and Space Administration, Santa Monica, California under NASA Purchase Order No. 5177, dated 7 July 1965.

TEMPO Div.
GENERAL ELECTRIC COMPANY
SANTA BARBARA, CALIFORNIA

FOREWORD

". . . . Within the borders of our urban centers can be found the most impressive achievements of man's skill and the highest expressions of man's spirit, as well as the worst examples of degradation and cruelty and misery to be found in modern America. . . ."

President Lyndon B. Johnson
"The Problems and Future of The Central City and Its Suburbs"

This statement from President Johnson's message to Congress on March 2, 1965, summarizes the paradox of the modern American city—the widening gap between developing technology and its application to urban living. It also speaks of the imperative need to make man's knowledge the instrument of his efforts to solve the problems of his urban environment. It is axiomatic to this paradox that many cities face problems of an unprecendented nature and severity. Determining solutions to these problems requires a greater understanding of the nature of technology, cities, and man. NASA's efforts to discover and examine means to apply the technologies resulting from its aerospace programs to the solution of critical problems of cities is a decisive step toward obtaining such an understanding.

Programs to improve urban technology, however, must first identify current and future city problems before realistic and feasible areas of application can be determined. The purpose of this study was, first, to identify and isolate specific critical city problems amenable to technological solutions and, second, to determine and suggest technologies resulting from past and current NASA programs which can be applied to the solution of the identified problems.

No t . npt was made to identify all the major and critical problems of urban communities or to research and determine all areas of application of NASA aerospace technologies to the problems identified in the study. Instead, the study focused on the major problems deserving immediate attention. Of necessity, and principally because of the size of the study, the NASA technologies investigated were broad in scope, and suggested applications are concerned with the use of these broad technological areas.

Four individual concept papers (by members of the Professional Staff of General Electric, TEMPO) are appended to this report as examples of areas where programs could be initiated immediately to aid in the resolution of serious urban problems through the application of NASA technologies. These concept papers discuss the technologies required as well as the type and size of programs that would be involved in their application.

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

Cities throughout the nation are experiencing severe growing pains as America evolves from an overwhelmingly rural to an emphatically urban society. Undirected or misdirected growth has created problems of all types in the nation's cities, and today there is unanimous agreement that a severe urban crisis exists. When viewed in the context of future growth the crisis takes on an appalling sense of urgency. By the year 2000 over 80 percent of Americans will be living in the large cities and suburbs of the nation. By latest census figures and U.S. population projections this means that of 330 million Americans by the year 2000, more than 260 million will be crowded into urban areas. Today, of 195 million Americans, about 127 million are living and working in urban communities. Thus, in 35 years these cities will have to provide for 133 million more people.

President Johnson reflected the feelings of many, including scholars, officials, city planners, and laymen in his March 2, 1965 message to Congress when he expressed this sense of urgency: "For this is truly the time of decision for the American city. . . In the remainder of this century urban population will double, city land will double, and we will have to build in our cities as much as all that we have built since the first colonist arrived on these shores. It is as if we had 40 years to rebuild the entire urban United States." Thus, among the most certain events of the next uncertain century none appears more necessary and imminent than the building of vast new cities and the revitalizing of old urban communities.

It is an accepted fact that the dynamic movement and power of modern scientific technology offer challenging opportunities for solving many of the problems posed by the growth and decay of cities and for modifying the structure and processes of urban life. It is also recognized, however, that the blessings can become mixed as the modern cities that technology requires and helps us to build encounter new problems and needs that take on a new urgency.

To achieve a realistic balance between benefits which technology can provide and technological solutions to critical city problems demands as much systematic analysis and application of scientific and engineering skill as NASA's effort to place a man on the moon. As Carl Stover* has stated, "The claim that defense or space research and development will yield improvements in urban living is valid only to the limited extent that all advances in science and technology add to the general store of information and skill from which alternative applications can be drawn. If those applications are to be found and made effective, they must be pursued with the same intensive ingenuity demonstrated in the defense and space efforts."

Ecological studies of cities are contributing much to the understanding of the total urban system. The ecological approach views the city as a complex living organism whose many functions and processes are intricately entwined with interrelated environments. As a result, research concerning the ecology of cities has done much to identify critical problems of urban communities and to discern large-scale trends and tendencies which can lead to changes in urban life and urban environments. These identified problems and trends are the subject matter for a mounting volume of literature calling for action to determine and develop feasible solutions. The research reported herein was undertaken to determine and suggest some specific technological solutions to major city problems which have become critical in many of the urban communities† of the nation.

The opportunities for technological solutions to critical problems of the city are, to a large extent, dependent upon what is feasible with past, present and predictable technologies. Therefore, an analysis and evaluation must be made of the currently available technology inventory and the important technological trends that might furnish new capabilities for application to city problems. Feasibility of

*Carl Stover, "Technology for Cities," Speech delivered at the 49th Annual Conference of the International City Managers' Association, October, 1963.

†Although some of the problems identified in the study are common to all cities, an urban community, for purposes of this study, is considered to be one having a population of 100,000 and over.

each technological solution must then be examined, through further research, from the standpoint of the physical, social, economic, and political environments.

Figure 1 is an evaluative matrix relating the major (ecological) categories and subcategories of critical city problems to the major categories of NASA technologies. The classifications used for the technologies correspond to that used by NASA in their publication and bibliographic systems. The matrix is designed to summarize and classify the critical city problems identified in the study, and discussed in this report, and to present these problems in a framework of opportunities for applying technological solutions using NASA-developed technologies. Reference to NASA technologies applicable to each "problem/technology" category, represented by the cells of the matrix, occurs throughout the report.

The critical city problems under each major category are identified in the appropriate section of this report through discussions of the background, nature, and impact of each problem. Suggested technological solutions are discussed and related to appropriate NASA technologies such as methodologies, analytical techniques, research, systems development, equipment development, testing techniques, and management capabilities. No attempt was made, in preparing the matrix or in the discussions, to cover the complete spectrum of critical city problems or applicable technologies. These are left as tasks for a more comprehensive research effort for which this study can serve as a guide and useful starting point.

PROBLEM CATEGORY \ TECHNOLOGY CATEGORY	AERODYNAMICS	AIRCRAFT	AUXILIARY SYSTEMS	BIOSCIENCES	BIOTECHNOLOGY	CHEMISTRY	COMMUNICATIONS	COMPUTERS	ELECTRONIC EQUIP. AND ELECTRONICS	FACILITIES, RESEARCH & SUPPORT	FLUID MECHANICS	GEOPHYSICS	INSTRUMENTATION AND PHOTOGRAPHY	MACHINE ELEMENTS & PROCESSES	MASERS AND LASERS	MATERIALS (METALLIC & NON-METALLIC)	MATHEMATICS	METEOROLOGY
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
(A) URBAN PHYSICAL ENVIRONMENT																		
1. TRANSPORTATION	●	●	●			●	●	●	●		●			●	●	●	●	
2. WATER SUPPLY AND POLLUTION			●	●	●	●		●	●	●	●	●	●			●	●	
3. AIR POLLUTION	●		●	●	●	●	●	●	●		●	●	●	●		●	●	●
4. WASTE DISPOSAL		●	●	●	●	●		●	●	●	●	●	●	●		●	●	●
5. HOUSING FACILITIES AND SERVICES			●		●		●	●	●	●			●			●	●	
(B) URBAN SOCIAL ENVIRONMENT																		
1. JUVENILE DELIQUENCY		●	●				●	●	●	●						●		
2. RACE AND DEPRIVATION			●				●	●	●	●						●	●	
3. SLUMS AND URBAN RENEWAL			●		●	●	●	●	●	●						●	●	
4. WELFARE AND UNEMPLOYMENT		●	●	●		●	●	●									●	
5. EDUCATION AND SCHOOL SYSTEMS			●				●	●	●	●			●		●	●	●	
(C) URBAN ECONOMIC ENVIRONMENT																		
1. CITY ADMINISTRATION			●				●	●	●	●			●				●	
2. BUSINESS AND INDUSTRY			●		●	●	●	●	●		●		●	●	●	●		●
3. FACILITIES OPERATION			●				●	●	●	●						●	●	
4. LAND USE PATTERNS								●	●	●		●				●	●	
5. URBAN PLANNING			●					●	●	●						●	●	
(D) URBAN PUBLIC HEALTH																		
1. ENVIRONMENTAL HEALTH HAZARD	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2. ACCIDENTS AND PUBLIC SAFETY	●	●	●		●	●	●	●	●		●	●	●		●	●	●	●
3. ILLNESSES AND INFECTIOUS DISEASES			●	●	●	●		●	●	●			●				●	
4. HOSPITALS AND MEDICAL FACILITIES		●	●	●	●	●	●	●	●	●			●	●	●	●		
5. PUBLIC HEALTH DEPARTMENTS					●			●	●								●	
(E) URBAN SECURITY																		
1. INDIVIDUAL SECURITY			●		●	●	●		●				●					
2. COMMUNITY SECURITY		●	●			●	●	●	●	●		●	●		●	●		●
3. COMMERCIAL SECURITY		●	●		●	●	●	●	●	●			●		●	●		●
4. RIOTS AND ORGANIZED CRIME			●			●	●	●	●			●	●		●			●
5. POLICE AND FIRE PROTECTION	●	●	●			●	●	●	●		●	●	●	●	●	●	●	●
POTENTIAL RANKING (1 TO 25)	5	9	23	7	13	16	19	24	24	16	8	9	16	7	10	19	18	9

Figure 1. Evaluative matrix for relating the application of

FLUID MECHANICS 11	GEOPHYSICS 12	INSTRUMENTATION AND PHOTOGRAPHY 13	MACHINE ELEMENTS & PROCESSES 14	MASERS AND LASERS 15	MATERIALS { METALLIC & NON-METALLIC 16	MATHEMATICS 17	METEOROLOGY 18	METHODOLOGIES & ANALYTICAL TECHNIQUES 19	NAVIGATION 20	NUCLEAR ENGINEERING 21	PHYSICS { GENERAL, ATOMIC MOLECULAR NUCLEAR 22	PHYSICS { PLASMA, SOLID-STATE 23	PROPELLANTS 24	PROPULSION SYSTEMS 25	SPACE RADIATION 26	SPACE SCIENCES 27	SPACE VEHICLES 28	STRUCTURAL MECHANICS 29	THERMODYNAMICS AND COMBUSTION 30	PUBLIC INFORMATION SERVICES 31	HUMAN FACTORS 32	POTENTIAL RANKING (1 TO 32)
●			●	●	●	●		●	●		●	●	●	●		●	●		●	●	●	23
●	●	●			●	●		●		●	●				●	●		●		●		19
●	●	●	●		●	●	●	●		●	●	●	●	●	●	●	●		●	●	●	27
●	●	●	●		●	●	●	●		●	●				●	●	●			●	●	23
		●			●	●		●		●	●					●		●	●	●	●	17
																					TOTAL	109
					●			●									●			●	●	11
					●	●		●								●				●	●	11
					●	●		●		●	●					●		●		●	●	16
						●		●								●		●		●		11
		●		●	●	●		●								●		●			●	13
																					TOTAL	62
		●				●		●												●		9
●		●	●	●	●		●		●	●	●	●		●		●	●	●		●		21
					●	●		●		●	●					●				●	●	13
	●				●	●		●			●											8
					●	●		●	●		●			●		●				●	●	13
																					TOTAL	64
●	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●	●	●	●	28
●	●	●		●	●	●	●	●			●	●	●		●	●	●		●	●	●	25
		●				●					●				●	●					●	13
		●	●	●	●			●		●	●	●				●		●		●	●	21
						●		●							●					●		7
																					TOTAL	94
		●																			●	7
	●	●		●	●		●	●				●								●	●	17
		●		●	●		●	●				●						●		●	●	17
	●	●		●			●	●	●			●	●					●		●	●	16
●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●	27
																					TOTAL	83
8	9	16	7	10	19	18	9	22	6	10	14	9	6	5	7	17	7	11	6	21	19	

-or relating the application of NASA technologies to city problems.

SECTION 2
CONCLUSIONS AND RECOMMENDATIONS

The results of the study presented in this report will serve to clarify the manner in which NASA-developed technology can be used to help existing cities to improve their physical, social and economic environments by resolving some of the more immediate and critical problems in these environments and to aid in the planning and development of new urban communities.

In general, this study has shown that NASA can contribute to the solution of urban community problems through the application and transfer of technologies from a wide segment of its technological inventory. Thirty-two broad technology categories applicable to twenty-five critical problem areas identified in the study were analyzed for potentiality of technological solutions. Within each of the five broad problem categories a variety of technological contributions to solutions of specific city problems were determined and those offering greatest potential for immediate application were selected for discussion in Sections 3 to 7 of this report.

CONCLUSIONS

1. The evaluative matrix of problem/technology areas (Section 1, Figure 1) indicates the NASA technology categories with the greatest potential for application to the solution of critical city problems identified in the study.

   (a) The five NASA technology areas with the highest potential ranking (indicated by a number between 1 and 25) are:

      (1) computers, including the information sciences (24)

      (2) electronics, including electronic systems and equipment (24)

      (3) auxiliary systems including control, monitoring and life support equipment (23)

(4) methodologies and analytical techniques for research, planning and management (22)

(5) public information services, including education, publications and promotion (21).

(b) Critical city problems identified as the most amenable to technological solutions (indicated by potential rankings between 1 to 32) are those of:

(1) the urban physical environment including air pollution (27), transportation (23), and waste disposal (23)

(2) urban public health including environmental health hazards (28) and accidents and safety (24)

(3) urban community security including commercial and community security (17)

(4) the urban economic environment including attraction and retention of business and industry (21)

(5) the urban social environment including housing and urban renewal (16).

2. NASA's methodologies and anlytical techniques such as systems analysis, operations research and management planning can offer many contributions to solutions of major city problems. Problems such as the movement of people and things, the protection of people from hazards, illness and disease, providing adequate security measures, and the creation of a climate in which mixed ethnic groups with varying degrees of affluence can live together are examples of complex problems requiring a systems approach and the talents of interdisciplinary teams for their effective solution.

3. NASA's work in the fields of remote sensing and the telemetering of sensed data to a control station or a system of receiving stations is of great significance in contributing to solutions of urban problems. Many of the solutions to the problems of cities will require remote sensing and viewing and rapid and accurate transmission of information to control and monitoring centers. Examples of feasible applications are remote instrumentation for the location of troubles in water and gas mains and sewers, and for maintaining communications with city employees sent into hazardous areas during fires and riots.

4. NASA's computer, information storage and retrieval and allied experience represent another significant technological area. NASA's contributions in this area can be of great value, since many city problems require inexpensive, reliable, small, lightweight and rapid computer capabilities for their resolution.

5. The area of public information and education represents an area where a NASA-developed competence can result in a sizeable contribution. Obtaining popular and social acceptance of change is one of the most difficult tasks facing those concerned with the solution of city problems; programs to effectively communicate with the public concerning constructive solutions to problems will be of significant value.

6. NASA's technological developments in electronics and electronic equipment is another important area of contribution. Advances in this category offer great potential for the improvement and cost reduction of existing systems and equipment and for the development of new systems for police and fire protection, hospitals and medical facilities and educational facilities.

7. The NASA technology area of auxiliary systems offers potential for solution to city problems in all the five major problem categories identified in the study. Feasible applications range from telemetry systems for monitoring hospital patients' physiological responses and data gathering to a plasma gun system which provides an economical means of coating many common materials to extend their useful applications and increase their durability.

8. An incidental finding of the study was the need for expanded research in the ecology of cities and the processes of the total urban system. Analyses and mathematical models of urban processes need to be enlarged and improved. Urban research of this type can contribute greatly to the identification of city problems and to discerning large-scale trends and tendencies which may have significant impact in the urban system. It also became apparent during the study that technology transfer from the aerospace field is a complex and poorly understood process requiring more research before its influence is determined. Future research in this area should concern itself with the mechanisms of technology transfer and effective means to promote transfer.

RECOMMENDATIONS

At the 1965 United States Conference of Mayors, Vice President Hubert Humphrey expressed the urgency of seeking technological solutions to city problems in these statements from his address: "We have huge industries in America in which specialists and scientists design and figure out total systems, weapon systems, structures of defense. One of these days—and I think the days are here—we ought to take some of that brain power, that confidence, and start to feed information into the computers, just as we do on industrial problems and management problems, and come up with some answers for our cities. We need not just a place in which you shove people, crowd them in, but a place in which man blends with his environment and environment blends with the man. This requires research and development in our areas. I don't know what the full answer is, but something can be done and needs to be done."

The research reported herein was an attempt to find some of these answers and the following recommendations are submitted for consideration as programs of constructive action:

1. It is recommended that a three-pronged assault be launched against the critical city problems identified in this study and that it be structured as follows:

   (a) The first prong would consist of many small-scale studies (from 5 to 10 man-months each) to determine solutions to segments of larger problems requiring a systems approach. Examples of such studies include the development of simulation equipment to stimulate, challenge, and train teenagers who are potential delinquents; automatic equipment to perform routine hospital and medical laboratory tests; and more effective instructional materials and equipment for teaching all types of students.

   (b) The second prong would have as its objective the solution of larger-scale city problems requiring the systems approach and project funds amounting to hundreds of thousands of dollars. This would entail the application of techniques such as systems analysis to such problems as the municipal police system (see Appendix A), the urban community medical system (see Appendix C), air and water pollution and waste disposal (see Appendix B), and the community transportation needs.

(c) The third prong would be aimed at testing the entire community as a system and would be concerned with the design and construction of a new city. The study and design programs comprising this type of project would cost millions of dollars, but the cost of the construction phase to the government would be minimized by the availability of private capital, the sources of which could be determined during the study programs.

2. It is recommended that projects be undertaken through this three-pronged attack on city problems because:

(a) Immediate action is necessary to halt a deteriorating situation

(b) Small-scale projects are necessary for immediate application to existing cities because the larger the project the more difficult it will be to fit the solution into an existing environment

(c) Complete systems studies are required for the new communities being planned and for the new cities that must be built

(d) A complete new city must be designed as an integral project if all of modern technology is to be made available to it and if the cities of the future are to be free of the problems that are critical in existing cities.

SECTION 3

TECHNOLOGICAL SOLUTIONS TO PROBLEMS OF THE URBAN PHYSICAL ENVIRONMENT

PERSPECTIVE

The physical environment of an urban community profoundly influences and conditions the lives of its residents. It affects many aspects of city life through its inhabitants' immediate perception and daily use of it. Deficiencies in the physical environment contribute to the monumental and notorious urban problems and are largely responsible for making cities less than satisfying as places in which to live and work. Many cities are too noisy, too ugly, too confusing, with air unpleasant to breathe and the sensations experienced from the environment go beyond the limits of comfort or even tolerance.

It is possible to shape the character and processes of much of the physical environment of urban communities. The population explosion provides the need and technology provides the means. The basic forces which determine the distribution of population in any nation—technological, economic, social, and political—also produce the urban pattern of living and contribute to the complexity of problems of the urban physical environment. These forces led urban communities to absorb 80 percent of the total population increase of the United States during the first half of this century and will be the impetus for about 70 percent of the population to be living in urban areas by 1970.

A body of knowledge is accumulating from research into the ecology of cities which will provide a better understanding of urban problems in areas such as housing, transportation, water and air pollution, waste disposal, urban decay and land use and their interface with the urban physical environment. This knowledge is necessary to guide city planning, renewal and building programs and to make it possible to understand the processes and pressures at work in the urban environment. The greater our understanding of the urban environment, the greater the chance that we will be effective in our efforts to improve the city.

Starting with the results of ecological research as the data base, a more systematic understanding of the urban environment and technology's revelance to it can be obtained. From this understanding, and through analyses of problems of the physical environment, particular areas of technological transfer and application can be determined. The problems of the urban physical environment selected for discussion in this section are representative of the more critical problems facing urban communities throughout the United States.

The problems of the urban physical environment amenable to technological solution and selected for discussion in this report are representative of the more critical problems facing urban communities today. For purposes of discussion they are classified under the following problem categories:

- Transportation
- Water Supply and Pollution
- Air Pollution
- Waste Disposal
- Housing, Facilities and Services

TRANSPORTATION

The complexities involved in matching our rapidly-advancing technology to the changing needs and wants of society are great in every sphere of human activity, but perhaps nowhere more challenging than in the field of transportation. This is partly due to the enormous size of the transportation business—a hundred billion dollar industry that pervades every phase of our economy. It amounts to about twenty percent of our gross national product and consumes about forty-five percent of our total energy production. The fact that transportation systems and facilities spread out across city, state and national boundaries, and include a multiplicity of interacting and competing businesses adds to the difficulties. Obsolescent equipment, business organization, labor practices, and government institutions, subsidies, regulations, and tax structures further complicate transportation problems.

The most difficult, and at the same time, the most basic challenge facing the nation's urban communities is the task associated with providing and maintaining a transportation framework within which modern transportation networks can efficiently and economically move people, merchandise, materials, and food under desirable and acceptable conditions within the metropolitan areas and between urban and rural areas. This framework must also provide for interactions with national and international networks to permit the unhindered flow of people and things.

An interwoven network of transportation systems now exists, but conditions such as rapidly increasing numbers of trucks and automobiles, increasing urban sprawl, declining public transit services, burgeoning numbers of travellers and inadequate technologies are interfering with its efficient operation. These inefficiencies are reflected in congestion on freeways and urban streets, decreased quality of rail passenger service, overloading of airports, and the complete failure of some systems during adverse weather conditions.

It is risky to even attempt to predict the future of urban transportation because it is a vital function that is deeply enmeshed in uncontrollable variables such as emotional reactions, opinions and attitudes, and vested interests. It is also subject to constant analysis by the public, researcher in the field and pseudo experts, and to political pressures exerted by individual citizens, small groups and powerful lobbies.

In many parts of the United States well-planned and extensive state highway systems have made vehicular type of transport the dominant transportation mode. For example, motor vehicles operating on the California highway system have contributed significantly to California's explosive growth. The role played by this highway system cannot be expected to diminish in the foreseeable future. However, the explosive growth has created weaknesses in the very system that made it possible. For the most part these weaknesses are associated with the downtown or urban distribution of people and things. Ways of attacking these weaknesses are proposed continually. Usually, they are rail dependent systems.

Rapid transit systems, inter-urban routes and subways were effective solutions to the transportation problems existing from the turn of the century until the early 1930s. However, widespread acceptance, availability and attainability of the automobile resulted in what has become known as "urban sprawl." Planless sprawl of urban communities is constantly increasing the distance people must travel to get where they want to go. It is becoming increasingly evident that rapid transit and urban sprawl are incompatible because the latter has come to mean expensive long transit lines and low passenger densities. Future systems must provide specialized transportation for individuals, not crowds. For example, a sophisticated study of California's transportation problems might indicate a need for a high-speed railroad from San Francisco to Sacramento, a hydrofoil from the San Francisco airport to the Embarcadero and a Carveyor system around downtown Oakland.

People have become accustomed to and enjoy the freedom of movement. choice and schedule permitted by the automobile and this will make them resist returning to rapid transit. The citizens of California, probably more than the residents of any other state, are accustomed to freedom of choice in their travel. Their choices are related to time of departure, route traveled and fellow travelers. It would be difficult to get them to accept a transportation mode where they sacrificed this freedom. Therefore, any long-range plans for the development of other transportation modes should consider the choices and preferences of the traveler.

One of the basic needs to which technology must respond in the next several decades is for a radical improvement in personal transportation in metropolitan areas. By 1980 it is estimated that ninety percent of our population will live in cities, and the present inadequate rail, bus and auto systems will long since have outlived their usefulness This presents a major challenge that requires bold new technological advances. The city of tomorrow will be as dependent upon automatic transportation systems in the horizontal plane as today's modern skyscrapers are dependent upon their automatic elevator systems in the vertical plane.

City planners can meet urban living needs only by carefully integrating adequate transportation facilities into civic plans, just as architects now integrate elevator systems into building designs. New standards of safety, convenience, comfort, speed, and esthetics must be set by systems development engineers working closely with civic planners, architects, and transportation agencies.

The need for a more sophisticated systems approach to the many-faceted problems of transportation is obvious to every traveler who has whisked halfway across the continent by jet air transport, only to find the time he has saved is consumed at both ends of his journey by the inadequate ground transportation between the urban airport and his destination in the city. The supersonic transport will bring new problems and enlarge existing ones. One of these problems is the lack of adequate land transportation systems to serve airports. Not one of the major cities of the nation has a fully coordinated link between the main lines of air travel and the myriad systems supporting it. Private automobiles, taxis, trucks, buses, trains, helicopters, and feeder airlines are independent units, delivering passengers and freight to and from air terminals on a helter-skelter basis. This problem is further compounded by local traffic problems and the necessity for building larger airports to handle larger-density air traffic further away from central city areas.

The coming of the supersonic jet will certainly force a transportation revolution during the next 5 to 15 years unless traffic congestion forces it earlier. NASA's planning methodologies and analytical techniques can be applied to this critical problem of making faster air travel compatible with more efficient local travel. Operations analysis and systems engineering are methodologies that can be brought to bear on the problem, permitting it to be studied as a total system in all of its complex facets to arrive at alternative technological solutions amenable to the objectives of the urban centers, the public, and the transportation systems involved. NASA can also make a substantial contribution to the solution of the urban transportation problem by making it possible for its systems management and systems engineering personnel to apply their talents to the problem in cooperative programs with other federal and local government agencies.

The air traveler's plight is no different from that of a load of freight being trans-shipped from ship to dock to truck to warehouse to train to truck to—with lengthy delays and paper handling all along the way. Another needed technological solution involves the automation of freight handling. Much is being accomplished now with modular containers, roll-on, roll-off shipping containers, piggyback trains and automated warehouses, but it is apparent that much more has to be done to make the handling of freight more efficient. NASA can make a sizeable contribution to this application area through the transfer of its data processing and program control skills to this phase of the problem.

Transportation requirements for the movement of things are less dependent upon emotion, personal attitudes and subjective preferences than transportation activities related to the movement of people. The movement of things, however, is complicated by vested interests and a myriad of obsolete federal regulations and restriction Present transportation networks are based largely upon the intermixed movement of people and things utilizing all modes. The future may bring with it a stronger trend in favor of the separation of modes for the transportation of people and things. Evidence in support of this can be seen in the increasing use of pipelines for the movement of things. The interference of modes for the delivery of things with the modes for the movement of people on city streets will be a powerful force contributing to this trend.

The one unanimous conclusion of those who seek to remedy the ills of transportation is that no real progress will be made until present research efforts cease to concentrate on the improvements of the vehicles of transportation and instead concentrate on the organic functions of the system. Transportation, too, is a complex systems problem requiring the application of many technologies and the coordinated efforts of people of many disciplines. Again, NASA's systems management capabilities probably represent the source of the greatest contribution that NASA can make to the transportation problems of the nation's cities. Certainly, specific technologies can and will make large contributions toward the development of solutions to these problems. but the ability to analyze this complex problem, to break it into its component parts and to structure technological solutions to specific problems can be a major contribution to be made by NASA.

New modes of travel will be required for the transportation of things and for the movement of people. Perhaps a major breakthrough might be the development of a mode that serves for the movement of people during the rush hours and for the movement of things during off hours. Another breakthrough should come about through the development of a mode that permits the destination-to-destination movement of things and people without requiring that the transportation mode be changed. Perhaps, computer control of a transporter system would permit this flexibility. Perhaps, new prime movers, air bearings, linear motors, will also make contributions to the technology of these new systems.

The transportation problems of urban communities will not be solved by high-speed vehicles. They will begin to be solved when the automobile is removed. The physical size of the automobile, coupled with the concepts that each individual must own one and that the vehicle is a status symbol, causes more space to be consumed for individual transportation than cities can afford. The taxi is a move away from these concepts, but a society that can't afford a motorman in a 10-car rapid transit train cannot afford to pay for a driver in each two or four passenger vehicle.

Therefore, new concepts must be developed, and the public must be educated to accept them. NASA has the communications and public relations expertise to accomplish this educational task. NASA's laudable and successful efforts in educating the American people with respect to space programs and in stimulating their interest in the programs is a striking example of good communications oriented to the public. The public information services provided by NASA should be evaluated on the basis of effective programs and procedures which may be applicable to similar large-scale public-education programs, such as urban transportation.

Batteries that are being developed for NASA can be used as power sources for individual "electric vehicles" in urban centers. The electric transporter concept may contribute to the alleviation of urban traffic congestion resulting from too many large automobiles. These electric vehicles could be owned by the city, a private utility or a taxicab company. Logistic studies could be performed to determine the optimum number of vehicles required for the best service. In such an arrangement the vehicles could be operated by passengers who would either pay-by-the-ride or lease by the month or year. A lease would cover the use of any of the vehicles and not a specific one.

NASA technologies relevant to reliability and maintainability design and quality assurance which have contributed to the lengthening of spacecraft lifetimes from a few weeks to over a year can be transferred readily, through the engineering and scientific community, for the development of urban transportation vehicles and systems capable of operating without maintenance or repair for periods of many months and even years.

WATER SUPPLY AND POLLUTION

As the population of the United States continues its rapid growth, preservation of the ecological balance between man and his environment will become more precarious as we near the end of this century.

Except for some arid sectors in the western states, fresh water has almost always been abundant in the United States. Occasionally there have been dry periods which have led to short durations of water use restriction, but on the whole, this has been unusual. Yet, today, and for the next 30 to 40 years, there is and could be a serious water shortage in various sectors of the country unless prompt and effective measures are taken towards conservation, towards protection of purity, and towards the development of new water supplies. Pollution is the greatest threat to our water supplies. This is due both to industrialization and to population growth and the constant dumping of industrial wastes and raw sewage into streams and rivers.

With the continued spread of urbanization extending the size and population of our cities, a rigorous effort is needed to counter pollution and to compensate for drought. Estimates projected for 1975 anticipate that water usage will amount to about 40 percent of the nation's average daily retained precipitation. This could result in an insufferable inbalance in regional location of population and industry. In some sectors of the country, drought has recently become a real threat. An extended drought is a hazard that can interfere with the refilling of reservoirs, streams and rivers. Polluted waters may become stagnant and breeding sources for disease carriers.

Septic tanks are still being installed at the rate of some 250, 000 per year. Estimates also show that some 450, 000 each year fail in operation and necessitate major repairs. Overloaded drainage fields can pollute wells as well as nearby streams. Another home sewage disposal factor that may result in problems is the tying of 25 to 30 percent of new residential construction into existing sewer lines. In this case, there is the danger of overloading sewer line systems; in the former case, there is the potential health hazard associated with the continuing installation of septic tanks and cesspools.

Processes are needed to remove poisonous chemicals and other troublesome materials from industrial wastes before they are emptied into our rivers, or methods must be developed to neutralize or otherwise make them innocuous.

In 1900 the volume of municipal wastes reaching streams was equivalent to the raw untreated sewage from 24 million people. By 1959 this had grown to the equivalent of sewage from 75 million people If this trend is not reversed by 1980, it will reach the equivalent of 150 million people. Present day sewage treatment plants for the most part are obsolete. They were designed to handle the loads and wastes as much as 40 years ago. Most waste responsible for water pollution is oxygen demanding. Appropriate treatment of industrial, as well as human. waste for removal of oxygen-demanding pollutants prior to disposal into a water system could alleviate much pollution. Research and development is needed to develop new processes capable of treating effluent streams before effluents reach and pollute the larger streams and rivers into which they flow and to design better treatment facilities. If this is not done, it will be necessary to reprocess and redistribute treated, polluted river water. The latter is a psychological problem to people in light of their attitudes and beliefs about using reprocessed polluted water

The water problem should be approached with a flexible outlook—to include consideration of individual home treatment, subdivision or community treatment, and city-wide treatment. A systems approach to water requirements is needed because of the complexity of the problem and the wide variety of products offered to the market. This has resulted in the lack of any integrated water industry and consequently a meager and uncoordinated industry approach to research and development, since different companies are concerned with different segments of the industry and with the manufacture of different products. An integrated approach to true water management is needed to handle the water cycle from fresh water to re-use.

Planned re-use of waste water could doubtlessly alleviate and probably remove the threat of a water shortage from most areas of the United States For example, the largest single use (40%) of water in the home occurs in bathrooms. Simple recycling of water for water closets could go a long way toward alleviating many shortages.

A demonstration desalinization program is only a partial solution to the forthcoming water problem. Due to recent technological development, the cost of desalting sea water is decreasing: according to statistics of the U.S. Department of the Interior in 1952 the conversion cost was $4.00 per 1000 gallons of sea water at lowest-cost plants compared with present cost of $1.00 per 1000 gallons. Desalinization costs of $1.00 per 1000 gallons are much too high for agricultural use, however. and the cost of moving water precludes the possibility of pumping fresh water very long distances from seaside desalinization plants.

With the application of newly-developed technologies it is estimated that the conversion cost will eventually decrease to 25 cents per 1000 gallons. In the United States, natural fresh water costs individual consumers from 25 cents to 45 cents per 1000 gallons. Farmers cannot afford to pay more than 5 cents per 1000 gallons for irrigation water, although the cost of desalted sea water will become more nearly competitive with natural fresh water. Within a decade, the President has predicted, desalting of water "will be the cheapest and in some cases the only way to obtain new water supplies in many areas of the nation."

Inland cities with brackish—or slightly salted—water supplies will benefit from many desalinization developments, but additional progress is needed to bring down the costs of smaller scale plants (with capacities below 10 million gallons a day) to convert brackish water The Department of the Interior has estimated that as many as 1000 cities in the nation may be forced to convert brackish or saline water for drinking purposes within the next decade.

Many types of businesses, from builders to suppliers of construction materials and parts will be involved in the water desalinization programs. Major industries, including steel, copper, concrete, chemicals, and electrical equipment, will be affected. Pipelines will be needed to bring sea water to desalters and carry water to customers. NASA research and development in waste liquid processing, corrosion, fluid flow, and flow and pressure instrumentation can contribute to the development, design and reduction of the cost of systems and equipment for desalinization plants.

An effective water management program could alleviate the water supply problems of the nation to a large degree. For some obscure reason, however, water management is not a politically acceptable solution to the problem. Therefore, it is reasonable to expect the search for technological solutions to continue. This represents an opportunity for NASA to apply its aerospace technologies to a problem with high probability for immediate payoff.

NASA studies of metal corroding bacteria are relevant to the development of equipment for improved municipal water and sewage systems An understanding of metal corroding bacteria could contribute to longer service life and less maintenance costs for equipment used in water and sewage systems.

NASA-supported and developed technologies can also contribute to the development of solutions to many other problems of water supply and pollution. Some of the solutions which could be sought might include: (1) reclamation and re-use of waste through a sequence of treatment, evaporation and condensation; (2) recycling atmospheric gases similar to a space capsule system, which could produce water by dehumidification; (3) more widespread utilization of fuel cells which produce water as a by-product, and (4) the development of more sensitive detectors for locating new water sources These detectors could be based on NASA sensor developments.

NASA-supported studies have successfully produced devices capable of processing human waste and recovering potable water. This is technically feasible today but could doubtlessly require several years before the economic feasibility for large scale commercial application could be demonstrated. Other projects have been successful in eliminating noxious and toxic agents from enclosed atmospheric systems. Utilizing the fuel cell as a source of water represents an interesting solution if attainable. It is attractive as a closed power and water generation system for the individual home. Fuel cells which might be technically and economically suitable for this application are still in the early development stages. Much work on catalysts and/or electrode reactions still must be done. The Gemini program demonstrated that the engineering can be done.

Automated techniques based on a system of controlled water distribution in association with preferred treatment measures can utilize NASA-developed computer, remote sensing and monitoring device capabilities. Thus, where waste can be adequately treated either for industry or the home, a closed cycling system is feasible, with a marked decrease in demand for new water.

WASTE DISPOSAL

Waste disposal and treatment of sewage has become a major city problem requiring immediate solution.* Today, as in the past, the solid wastes of cities are burned, stored, buried in the ground in

*See Appendix B.

the "city dump" or macerated in the sink and discharged into the local sewer system, and drowned in the ocean either before or after being treated at the sewage treatment plant

With burning, the air is polluted; with burying, valuable land is taken out of use and underground water may be polluted; discharging waste into the ocean or rivers pollutes recreational areas and fresh water supplies

The use of incinerators, a worthy development, is not a fool-proof solution, because they cannot burn all materials and because undesirable secondary effects arise, including intense temperatures from some packaging materials which disrupt incinerator operations, and because the volume of solid waste is constantly increasing and incinerator installations rapidly become too small.

An ever-increasing population, with each individual producing about 5 pounds of waste per day, bodes ill for the future of our cities even now faced with the problem of finding more effective solutions for the disposal of waste. A recent study of the waste management problem in California revealed that within 25 years the mounting problems of waste disposal will increase to the multibillion dollar level. Sewage wastes, the study report shows, are expected to increase two-and-one half times that of 1965 and municipal solid wastes nearly fourfold.

One technological link to this problem would be through NASA's work related to on-board waste disposal for spacecraft. This work, based on a recycling procedure which utilizes human waste and which produces potable water with a surprisingly small amount of solid residual, also considers the other facets of the problem such as reducing by-product solid wastes from packages. The applicability of these approaches for the reduction of volume of waste products in densely populated areas should be explored. The technological challenge would not be a difficult one. The difficult task would be associated with getting people to change habits of long standing. NASA's experience in training astronauts should accelerate psychological acceptance of the proposed solutions.

Another solid waste problem amenable to technological solution is the disposal of scrap. Junked cars provided about 5 million tons of scrap in 1964 and the railroads more than 3 million tons. About one-third of the 30 million ton annual crop of unprepared scrap comes from manufacturing plants as the left-overs of the products they fabricate. Other sources are demolition projects, ship-breakers, farms, detinning and tin shredding operations, and the scrap from public utilities and government agencies. Scrap is now a valuable by-product for factories and the scrap disposal facilities of local processors are important to them and the cities where they are located. Many urban planners and urban renewal experts are acknowledging the need for scrap processing services in cities.

The scrap industry has specialized equipment for handling large quantities and varieties of scrap. [illegible] includes balers, presses, hydraulic guillotine shears, automated shredders, hammer mills, fragmentizers, and rock crushers. NASA's technolgies can make substantial contributions to the design improvements in this existing equipment and to the development of new systems, methods and equipment for scrap disposal in urban communities. The technology areas of machine element design and processes and structural mechanics are especially applicable to this problem.

NASA's techniques of system analysis can also be applied to the [illegible]lems of waste disposal and pollution. One such systems approach is described in Appendix B of this report wherein water, air, and land pollution are examined as related problems in the urban physical environment. Increasing population, industrial growth, and a rapidly expanding technology are also contributing to critical problems of gaseous wastes and pollution of land, water and the atmosphere. Even lakes, such as Lake Erie, and the immense oceans are beginning to react to the wastes that are increasingly poured into them.

Until recently, the disposal of waste was treated as a set of separate problems. Sewage waste was one, trash and garbage a second, and atmospheric wastes a third. But as these problems grew in size and complexity it became apparent that solid waste disposal is closely linked to that of fluid waste, and both, to a degree, can affect atmospheric wastes. An integrated approach to waste management by means of systems analysis would consist of combining the problems of fluid and solid wastes with those of air, land, and water pollution as discussed in Appendix B.

AIR POLLUTION

The growth of industrialized society has created an atmospheric environment which is hazardous to life and health and destructive to property. Air pollution costs the nation billions of dollars each year and, though visible to most urban residents, it has been, until recently, one of the most ignored major problems of this century, even though fifty years ago, Dr. Charles Steinmetz predicted the seriousness of the air pollution problem which confronts us today. (See Figure 3, Section 8.) With another 25 million people moving into urban areas by 1970, air pollution will be a frequent occurence and it may become a problem of calamitous proportions. It is essential, therefore, that our current knowledge be taken out of the research laboratory and feasible technology applied without delay to the major sources of air pollution.

It has been estimated that each day American auto vehicles pump into the atmosphere about 250,000 tons of hydrocarbons, and 10,000 tons of nitrogen oxides, major ingredients of noxious smog. Industrial pollution is another major source of atmospheric contamination. Recent studies by the Indiana and Illinois boards of health revealed that 10,000 tons of solid matter and over 7000 tons of gaseous matter were being discharged into the atmosphere daily over the Chicago metropolitan area. Today in Chicago, which has been monitoring air pollution since 1928, the average monthly dustfall of particulate matter comes to 43 tons per square mile as compared to 15 to 20 tons common to many suburbs.

An often-used cost estimate of property damage due to air pollution is $65 per capita per year, which represents a national cost of over $11 billion annually. This figure refers only to property deterioration and maintenance.

Another important adverse effect of air pollution relates to local weather phenomena. Pollutants in the atmosphere can decrease ultraviolet light penetration, reduce illumination, and increase the frequency and density of fog and cloudiness, thereby creating traffic hazards on the highway as well as around airports. On the other hand, weather has an important influence on the distribution of air pollution. Thermal inversions, in which warm air overlays cool, often trap pollutants in toxic concentrations, causing illness and death of urban residents. The hazards to urban public health resulting from air pollution are discussed in Section 6 of this report.

Only recently has an understanding been evolving of the chemico-physical mechanisms involved in air pollution. Approximately 90 percent of our urban population lives in areas with air pollution problems. Few cities are immune. Estimates show that all 212 communities (Standard Metropolitan Areas) with a population greater than 50,000 have air pollution problems; some 40 percent of the smaller communities (2500-5000) also have like problems. In total, about 6000 U.S. communities are affected in varying degrees by air pollution. The current estimates of economic damage to the nation by air pollution, ranging from 4 to 11 billion dollars annually, cover all kinds of damage from livestock to corrosion to reduction of property values.

Air pollution does not originate from a single source but rather from a multitude of sources, all man-made. The internal combustion engines of cars and trucks, the energy sources of many industries, heat sources for homes and offices all consume fuel and discharge incompletely consumed fuel residues into the atmosphere, creating the air pollution. The fuel consumed determines the character of the irritants. With the presence of certain local conditions of climate, the polluted conditions may remain static or increase in severity.

Polluted air is detrimental to people, plants, and materials. It poses a serious economic problem by requiring clean-room technology in various industrial activities and forcing corrosion control. Fog, for example, is found to be twice as prevalent in polluted urban atmospheres in contrast with its occurrence in clean air, thus contributing to delays or hazards in air transportation.

A continuation of these conditions without solution may ultimately affect the climate, geology, and economic balance of the entire earth by the end of the century. Not only can we visualize changes in meteorology, atmospheric chemistry and photochemistry and their influences on plant life including food products, but also the effects of breathing polluted air on the increased susceptibility of city dwellers to lung cancer, emphysema, bronchitis, and asthma, as well as the more acute non-specific upper respiratory diseases and pneumonia. Further, many of the older inhabitants who suffer with cardio-respiratory insufficiency find their breathing difficult, and with heavier concentrations of pollutants, sometimes experience a fatal inability to breathe at all. Evidence is accumulating which links air pollution to increased mortality from cardio-respiratory causes and increased susceptibility to respiratory disease.

An extensive effort was initiated by Congress in 1963 (The U.S. Clean Air Act) authorizing HEW to spend 95 million dollars through 1967 in research and development to control air pollution. One of the major contributions which can follow from NASA technology is the application of a systems-oriented approach to air pollution control with the development of a definitive set of air-quality criteria. Obviously there are numerous technical and social difficulties to be overcome in attaining these goals and in translating them into effective community control measures.*

Industrial contributors to air pollution can be controlled through ordinances, as the smelters were. Taxes can also be used as a weapon. Although, a good deal of air pollution arises from internal combustion powered vehicles, the entire American economy is vitally enmeshed with the use of these vehicles both for a major portion of our national transportation network and with the production of these vehicles and associated auxiliary equipment such as tires, batteries, and gasoline. Therefore, the pollution problem associated with the internal combustion engine cannot be resolved as easily as the pollution problem associated with obnoxious materials coming out of factory stacks.

The air pollution component contributed by the internal combustion engine can be removed to a large extent by electrifying urban transportation as much as possible. NASA's technological developments and capabilities in the field of batteries, fuel cells and other space power systems could be of great value in assisting in the development of suitable urban electric individual transporters.† Great improvements in fuel cells and in zinc-air batteries would lend much impetus to the development of more sophisticated electric vehicles. It is also conceivable that some of NASA's work in the development of moon travel vehicles could also be applicable to electric urban vehicles.

A rich source of raw hydrocarbons is the gasoline service station. Each and every time an auto or truck is refueled, copious quantities

*See Appendix B.
†See Appendix D.

of hydrocarbons are released into the atmosphere. NASA's work in fueling O_2 rockets or boosters should offer some contributions to the development of leak-proof gasoline service hoses. Similarly, NASA experience with rocket engines might be the source of knowledge for more effective and less expensive afterburners which can eliminate the undesirable hydrocarbons exhausted by car engines.

One application immediately transferable from NASA-supported work can be found in the utilization of various gaseous sensors such as gas chromatography. One of the vital considerations relative to air pollution is the protection of humans from excessive concentrations of "smog" and NASA developments with sensors and detections agents should prove very valuable in early detection of unusual concentrations of contaminants and in permitting the issuance of timely warnings of dangerous conditions.

NASA improvements and developments in the field of artificial atmospheres can be effectively utilized for creating clean atmospheric environments within buildings. Extension of this concept from space ships and space living quarters indicates that it should be possible to provide atmospheres for entire cities.*

There does not appear to be any realistic solution, at present, to the elimination of air pollution from cities as a result of any single NASA-developed technology. However, there are indications that combinations of NASA capabilities could lead to an alleviation of the problem. For example, approaching this problem as a complex systems problem, requiring the complete cooperation of the civilian segment of the population, would permit great strides to be made.

People could be encouraged to heat and work with electricity, to travel in electric vehicles and to electrify their industries. This would require much sophisticated information dissemination and public education to overcome vested interests and habits. It would require much good engineering work to design fossil-fuel generating plants for remote locations with extra high voltage transmission lines bringing large blocks of power into urban areas. Much creative work would be required to make the transition to an all-electric urban environment as economically attractive as possible. NASA has the systems engineering and management capabilities and the public information and education experience to structure the problem,

*See Appendix D.

determine solutions, and prepare and implement a plan leading to the solution of the problem.

It is becoming imperative that research in all major aspects of air pollution be expanded and accelerated. Areas where NASA research and technologies can make substantial contributions to overall research in air pollution include: BIOLOGY—Determining the mechanism of absorption of gases and particulates by vegetation; CHEMISTRY—evaluating new industrial processes for future sources of contamination, development of methods for recovering large-volume chemical effluents, and effecting carbon monoxide removal from the atmosphere; ENGINEERING—controlling motor vehicle exhaust gases and smoke-reducing precipitators for industrial chimneys and stacks; MEDICINE—study of the chronic effects of pollutants on organisms and determining the relationship between contamination and respiratory diseases; METEOROLOGY—relating emission concentrations to weather phenomena; PHYSICS—discovering the synergistic effects of vapor-particle systems; determining principles of deposition, retention, and transfer of gaseous and particulate contaminants; and applying fundamental particle dynamics to inertial separation, filtration, and electrostatic properties of particulates.

New industrial processes must be evaluated to determine their potential contamination hazard, especially in view of today's rapid technological advances. NASA's techniques for accurate testing of equipment over long periods of time should contribute to this need, as well as NASA-developed gas sensing and monitoring devices.

Basic knowledge is needed on the principles of deposition, retention, and transfer of gaseous and particulate contaminants. The results of NASA's research in the atmospheric sciences and artificial environments for human survival show promise of contributing to this knowledge.

More must be learned about the determination of fundamental particle dynamics as applied to inertial separation, filtration, and electrostatic properties of particles. NASA's research and development activities in artificial environments and human factors should be searched for applicable research which can expand our knowledge in these areas.

Considerable work remains to be done in developing methods for recovering large-volume chemical effluents and intermediate concentrations of odorous gases. With further research on the mechanism of carbon monoxide removal from the atmosphere, an effective device can be developed for the control of motor vehicle exhaust gases. NASA's chemical and chemical engineering research results may provide unique contributions to this required research.

Results of atmospheric sciences programs conducted by NASA to obtain detailed knowledge of atmospheric properties and the ionosphere and its variation can contribute to the improvement of weather prediction methods in and around urban areas. Another important application area for the results of such programs, combined with early warning communications, is the forewarning of natural physical phenomena associated with floods, cyclones, tornedoes, hurricanes, and extended periods of drought. Study programs to implement the transfer of NASA atmospheric sciences technologies can be conducted through the Weather Bureau, Office of Civil Defense, and local urban area disaster offices using R&D capabilities and facilities of local aerospace industries.

HOUSING, FACILITIES AND SERVICES

The mass flight of people, retailing, business, industry, and other urban functions into the countryside has created the phenomenon of the spreading, sprawling metropolis. In some highly urbanized areas, such as on the East Coast, the result has been the growing together of metropolitan influence areas into an amorphous and disorderly pattern, which has given birth to the new term "megapolis."

Dissatisfaction with the new spread-out pattern is beginning to set in. Sprawl cannot be continued indefinitely. Communications become overtaxed, public improvements cannot keep pace with the tremendous costs that sprawl involves, and, most important of all, we are running out of one national resource that is irreplaceable, that can neither be manufactured nor imported, namely, land. The flight to the countryside has effectively destroyed much of the landscape, and many feel now that surburbia is a place which offers neither the advantages of the city nor those of the country.

Victor Gruen has stated that during the last few years, some counterforces against suburban living have arisen and a trend back to the city has become apparent. This has spurred new interest in the fate of the central city as well as an increasing awareness of its problems and the desire to do something about them. This trend is of great importance, since the most troublesome aspects of the urban crisis express themselves in the central cores of the metropolitan areas.

With very few exceptions, city cores are stagnating, and statistics registering the number of visitors entering the city cores as workers, shoppers, or participants in urban activities show a steady and increasingly downward trend. People who can afford to do so eat and sleep outside the urban center and beyond the imaginary line that separates city from suburbs. They use the auto as a method of avoiding dirt, noise and taxes.

In many regions of the nation the flight of the taxpayers to suburbia has bankrupted the big city, making it difficult if not impossible, to provide the public facilities and services that city dwellers need. In many large cities of the nation residents have to endure bad housing, inadequate municipal services, obsolete neighborhoods, inadequate schools, a lack of recreational and cultural facilities, and a dismal environment.

Approaches to the problem of the central city have not always been thoughtfully evaluated as the magnitude of the problem requires. Too frequently, although inadvertently, actions have been taken to aid one part of the nation or one segment of the population which have resulted in irreparable damage to the central cities. For example, suburban sprawl and urban decay have not come about solely as a result of a free choice in a free enterprise market. The choice was influenced by federal housing subsidies, which, purporting to be neutral, have in fact subsidized low-density, middle-income living in the suburbs and have thereby financed the flight of the middle-income population (almost a wholly Caucasian group) from the central city. The Federal road building program has also played a large role in this process. It has made it easy for the suburban-dwelling middle class breadwinners to commute to their jobs in the city; it has made it convenient for industry to move out of the city, and has displaced people to make room for highways in the city, often contributing to the creation of slums.

Outside the cities, the mistakes committed in the metropolitan areas are being repeated. Along the highways commercial and residental properties stretch for miles in disorderly sprawl. There is little sense of community in the suburbs, but rather the negation of what the city is supposed to be. Ugly strips of gas stations, billboards, used-car lots and beer parlors are producing new slums faster than the central city can eradicate the old. As one philosopher, Lewis Mumford, has put it, "American people are becoming the victims of urban jam and suburban jelly."

The health of the central city and its ability to attract new residents and new businesses and industry depends on adequate public facilities and services and the economic, social, and cultural strength of its central business district. The city's ability to meet its obligations toward safety, security, housing, health, and education of its people is directly dependent on the tax revenue which it must obtain to a significant degree from the densely built-up central core. The central city and its environs still remain as the only parts of the metropolitan area that can properly support the cultural facilities and services dependent upon a metropolitan, areawide clientele. It will take many of the attributes connected with the concept of free enterprise—daring, imagination, creativity, the willingness to take risk—coupled with a working partnership of federal and local governments and business to implement feasible solutions to the problems posed by urban de

Grouped among the problems to which NASA technologies can contribute solutions are those in the areas of public housing, municipal services and facilities. Explosive urban growth has created problems and frictions in the expansion of physical facilities. urban services, and housing. The provision of public urban services will assume crisis proportions in many urban communities during the 1970s. Luther Gulick has noted that the provision of urban services requires the investment of about $1100 per capita. With an anticipated increase of 30 million persons in urban areas, this means an additional investment of $33 billion for services.

If the cities are to encourage builders to build the millions of housing units which are required in growing urban areas at a price the people can afford to pay, new techniques and new materials must be developed. NASA technologies can contribute substantially to the development of such techniques and materials.

Problem areas to which NASA research and technologies can be applied to alleviate the problems of urban decay, housing development, and the continued provision of urban services and facilities include:

- Data Processing Assistance to Trial Courts
- An "Information Utility" for the Centralization of Community Records
- An Information Center for Law Enforcement
- Police Identification and Intelligence System
- Hospital Information System to Store and Retrieve Patient Data
- Urban Data Management Systems
- Metropolitan Data Bank for Urban Research
- Urban Data Management Systems
- Computer Time-Sharing Systems for Public Administrators
- Computer-Planned Residential and Business Zoning Systems
- Improved Materials for Construction of Stadia and Auditoriums
- Underground Installation of Utilities
- Human Factors Applications to Design of Cultural Facilities
- Improved and Less Expensive Construction Materials and Methods for Housing and Urban Facilities.

SECTION 4

TECHNOLOGICAL SOLUTIONS TO PROBLEMS OF THE URBAN SOCIAL ENVIRONMENT

PERSPECTIVE

Throughout the course of U.S. history there has been a continuous trend toward population concentration in urban communities. When the first census was taken in 1790 there were only 24 urban areas, containing only 5 percent of the nation's population. The 1960 census showed that about 120 million persons, 68 percent of the population, lived in urban areas. By 1970, about 70 percent of the population will live in urban communities. This means that as many people will be in cities in 1970 as there were in the entire United States in 1950—about 150 million.

Explosive population growth in itself increases the tempo of social change, with increased frictions, strains, and requirements for personal and social adjustments and, when considered with other measures of urban growth, expanding population becomes a critical indicator of impending crisis in the urban social environment. Juvenile delinquency and adult crime, school drop-outs and unemployment, the spread of slums and the cost of welfare, are all related to the increase in urban populations. The social and economic costs of these problem areas to the urban community as a whole are enormous.

The problems of the urban social environment posed by the expanding population of cities constitute the most severe of the challenges for technological solution. Urban services such as education, sanitation, public health, recreation, and fire and police protection are certain to require expansion and improvement to keep pace with the changing demands and needs. Failure to respond to these needs and demands will have severe effects upon the social patterns and processes of urban life.

In contrast to their utilization in space and defense programs, science and technology are applied in a more indirect fashion to problems of the urban social environment. Although technological solutions can be applied to these problems, most of their benefits can only be realized through their implementation in federal, state, and municipal government programs, and through the resources and talent provided by private interests and humanitarian organizations. It should be recognized that an untapped reservoir of technology of great proportions may exist for determining applicable solutions to urban social problems, but that additional research is required into the multiplicity of factors serving as aids or barriers to its effective utilization. The efforts of the NASA space program can serve as a catalyst, however, to motivate and guide local governments in determining technological solutions to urban social problems, similar to the efforts of industry to utilize technological spinoffs to develop commercial products.[*]

The following problems of the urban social environment chosen for discussion in this report are representative of the more critical problems currently faced by the nation's cities. They are, in large measure, the problems of American society itself, but for purposes of discussion are limited to the aspects concerning urban communities:

- Juvenile Delinquency
- Race Relations and Deprivation
- Slums and Urban Renewal
- Unemployment and Welfare
- Education and School Systems

JUVENILE DELINQUENCY

Juvenile delinquency is one of the most shameful problems of the United States. In a nation with the world's highest standard of living, with one of the world's finest pieces of real estate, with every type of recreational activity available, with the world's finest educational systems, and with well-rounded local and national athletic programs, the incidence rate among teenagers of crimes of violence, of senseless attacks on other citizens and of lesser crimes is increasing. Fifty percent of the people arrested for serious crimes in 1964 were under 18 according to recent FBI statistics.

---

*E. E. Furash, Jr., "Businessmen Review the Space Effort," <u>Harvard Business Review</u>, September-October, 1963.

Many theories attempting to explain this behavior have been offered and many more can be expected. Actually, it is doubtful that any one theory is correct. The behavior of teenagers is related to their environment. It is a function of a variety of variables:

1. The extent that the school and their teachers challenge teenagers

2. The success with which a degree of responsibility has been instilled within them

3. The amount of their energy that is consumed by physical activity

4. The degree to which their interests are held by books, movies, hobbies and other similar interests

5. The influence exerted on them by bright, but warped contemporaries

6. The extent to which they are influenced by misdirected homage paid to gangsters, hoodlums, ruffians and the like through the various entertainment media.

Even if the delinquency rates remain the same, the volume of juvenile delinquency is expected to increase by 44 percent before 1970, due to an increase in the size of the age group alone.

The solutions to the juvenile delinquency problem are complex and point to many needs. These include: effective ways to assure the instillation of accepted moral values into teenagers; teachers who can recognize students who are not being challenged and who will strive to challenge them; opportunities and activities which will convince teenagers that it will be possible for them to attain their aspirations or, at least, that it would be worth their while to place themselves on the proper path to attempt to achieve these; and sports and other physical activities for all children and not for just the few who make the football, basketball, and baseball teams.

Realistic simulation equipment to be used both to train teenagers for developing employment skills as well as play skills, and to develop deeper interests and to stimulate them more are also needed. Activity programs covering many different functions and creating motivation and interest in the activities can dispel a great deal of the negative behavior and lead to more acceptable outcomes. The use of simulation devices themselves will not resolve the juvenile [illegible] problem but they appear to represent [illegible] to take a significant step in the right direction.

NASA can contribute greatly to the simulation needs of this program. Simulation will fail, however, unless it is made adequately realistic. NASA's work in simulating space and the manner in which man operates in space has been outstanding. The technologies involved in this capability can be applied to the development of devices to interest, challenge, and occupy youngsters. NASA's ability to develop devices for simulation can be used at a variety of levels of reality, thus providing equipments which are useful for physical and educational activities at schools, in parks, playgrounds, youth centers, etc.

The devices that could be developed are almost endless in variety. A sailing simulator could be developed for inland, lakeless areas, and it could be indoors or out. Skiing can be simulated with plastic snow. Golf can be simulated, and at least three simulators are now on the market.

Occupations also can be simulated. Auto repair, welding and other similar skills are now learned by doing; but our teaching methods seldom provide for simulating professional (medical, legal, engineering) activity at the lower educational levels where teenagers are being expected to develop an interest in life-time careers.

Improved kits are being designed for more effective instruction in astronomy, mathematics, and the several physical and natural sciences. Similar kits should be forthcoming during the next several years not only in the sciences, but in the social sciences and the humanities. With these kits will come improved instructional techniques and materials, leading in many cases to self-instructional techniques for use by delinquents in detention homes.

NASA technologies can contribute to other developments such as:

1. System planning concepts and techniques, with associated equipment developments for recreational systems.

2. Improved educational materials, represented by kits, video tapes, films, technical manuals, and programmed materials for rehabilitation of delinquent children.

3. Simulation of actual environments, conditions and situations to represent environments in order to improve student interest and understanding.

4. More advanced equipments and materials geared more directly to self-instructional techniques for retarded children.

RACE RELATIONS AND DEPRIVATION

The problems of race relations and minority-group deprivation, of segregation and integration, are complex problems of the urban social environment and admit of no easy solution. These problems are always, in part, the result of the desires of people of like kind—that is of like culture, religion, language, origin, or race—wanting to live together, as well as the result of pressures from the outside. Enclaves of immigrants are still visible throughout the nation's cities. In fact, American society has been characterized as a part-integrated and a part-plural social order.

Some immigrants and minority groups have fled the segregated areas in which they first lived to become residentially integrated, but others by choice have continued to live in still visible and measurable enclaves. The complex character of the problems involved is emphasized, perhaps, by the consideration that while some minority groups, such as the Negro, are at present trying to flee segregation, other groups on the American scene are striving to prevent integration. It is probably true that in urban communities of the United States evidences of both integrated and segregated living will persist for many generations, partly due to the persistent pattern of immigrants from minority groups gathering together for mutual advantage. The test of whether such living patterns are compatible with our nation's democratic order and the urban social environment may lie not in the disappearance of segregated living but rather in the ability of a people to live either in integrated or segregated patterns, in accordance with their preference.

The effort of minority groups to escape segregation will be increasingly apparent in future years through increased pressure for "open occupancy" and through the increased penetration of outlying suburban areas. Open occupancy, without adequate provisions to assure that tenants and landlords maintain high physical and occupancy standards, could lead to an accelerated deterioration of the open occupancy area. This could hasten the flight of residents from central cities to suburbs and could inadvertently increase the segregation of the minority groups by leaving them the sole possessors of a blighted central city. NASA's technologies can make substantial contribution to the maintenance of the physical plant through transfer of the results of its programs in sanitation of space vehicles and through development of street and building cleaning equipment for cities based upon the principles of its lunar excursion and anthromorphous machines.

The movement of the white populations to suburban areas and the concentration of Negro populations in the central city have intensified the residential segregation of the races in recent years. This pattern of urban geography and residence has bred antagonism within the city which gives every indication of heightening the differences in social status unless there is a change in the segregational trends of housing. Further, since 1945 the Negro population has been increasing at a substantially faster rate than the whites in this country, and in about 10 years, if these rates continue, it will exceed the white population in many of the larger cities of the nation.

If minority groups remain barred from suburban communities and highly integrated in central cities, the character of urban America will be profoundly and adversely altered in its economic, political, and social aspects. Planned "new cities" are seen as one solution to this problem.

A new city would serve as a framework within which solutions to these urban social problems could be tested. For example, it could serve as a means for alleviating discriminatory housing practices in suburban America. It would offer a way of accelerating the rehabilitation and redevelopment of a city's blighted areas. It would offer a framework within which new taxing concepts would be tried, i. e., raise taxes as property is neglected, lower them as improvements are made, and fight land speculation by taxing undeveloped land.

The new city concept can also serve as an opportunity to break the vicious circle of poverty and lack of opportunity in which hundreds of thousands of disadvantaged persons in most of our mature metropolitan areas find themselves locked. It may well be that once this vicious circle in the old urban area is broken and selected individuals find themselves in a new and yet unknown environment, the heretofore hopeless vision of the future will dissipate and a group of productive individuals will emerge, willing to take their places in society. This new city must be more responsive to the real urban problems than developer-planned new towns appear to be.

All the technological developments of recent years can be incorporated into a new city. This would permit bridging the gap that has developed between cities and technology. Concepts to be incorporated could include:

1. Information Utility
2. Community Medical Systems
3. A Modern Police System
4. A Complete Waste Management and Control System.

The new city concept would initially require substantial injections of public (probably Federal) and foundation funds in order to make it viable and responsive however, when concrete results become apparent, the private and local government sectors can be expected to take over.

Planning this new city could be a monumental and challenging systems task that could eventually compete with NASA for the services of the top talents within the United States. NASA's systems management and engineering capabilities would be indispensable in a project of this nature and magnitude.

Among the many serviceable developments produced by NASA, either directly or through stimulation of industry and university laboratory, are many new materials which can be adapted for construction purposes. These materials include metals, plastics, and other synthetics, as well as bonded combinations of metals and synthetics. Their utility in aerospace vehicles indicates their ability to withstand severe rigors and to provide needed insulation against the ravages of weather extremes and to retain their appearance with age. These new materials can serve as a new source of building material which could mean new building techniques, new economies, and new building codes. New codes would require a coordinated and comprehensive educational program to convince the building crafts unions and city personnel that they are desirable and beneficial. NASA has demonstrated competence in disseminating this type of public information and could assist in planning the program that would formulate and evaluate the building codes.

Many of the new synthetics could also be used for repair of old structures within reasonable cost limitations, thus providing a new facade to old buildings and perhaps inducing both owners and residents to clean up the building interiors. The new materials are longer-lasting and more attractive, and they could be used to demonstrate longer maintenance-free behavior than the materials currently used.

Some of the older designs and less efficient equipments used for heating might soon be displaced by recent NASA developments, such as banks of solar cells with improved battery systems for energy storage. These developments will be able to function without discharging raw hydrocarbon into the atmosphere or producing soot to blacken buildings, streets, and furnishings.

Appendix D discusses other technological approaches to implementing the new city concept which could contribute to the solution of the social problems of race and deprivation.

SLUMS AND URBAN RENEWAL

In broad definitive terms urban renewal involves the clearance or rehabilitation of slum or blighted areas, or deteriorating or deteriorated areas. Through it such areas are replanned so that they can be used in the best interests of the central city by demolition of structures that cannot or should not be retained, and the provision of building sites for modern business areas and industrial facilities. Urban renewal also has a social dimension in the urban environment since it also covers rehousing of families that are displaced by site operations.

Urban renewal provides for the installation of streets, sewers, water mains, schools, playgrounds, sidewalks, and the many other services and facilities that contribute to a useful and productive social environment. It is based on the belief that slums and blight are self-perpetuating and contagious. Urban renewal, as practiced, has not been eminently successful, partly because most urban renewal planning projects were too expensive to be afforded by the people and small commercial businesses displaced by urban renewal projects.

Slums generally result from a random combination of factors such as inadequate and aging housing, neglect on the part of the residents, neglect on the part of city officials, and neglect on the part of property owners. Slums in cities are growing faster than they can be removed. Even in New York City, which has had the largest slum clearance and rebuilding program of any city in the United States, the rate of deterioration of housing units has been as great as the rate at which new housing has been constructed. New luxury apartment buildings constructed since the end of World War II have not prevented the exodus of the middle-income white families to the suburbs. It was thought that after upper-income families moved into these expensive apartments, people in the next lower income level would move into the apartments vacated. Instead, the vacated apartments were converted for occupancy by lower-income people. This conversion consisted of breaking the residential units into smaller units, thus making it possible to rent to more families, yielding the landlord more income. Since each unit rented for less money, the landlords were not inclined to maintain the property as carefully, and the units gradually deteriorated in appearance. This prompted more middle-income families to move to the suburbs. This population shift raised the economic burden of the city because more people had to be served by schools, hospitals, and transportation, but the people were less able to pay for these services. Landlords made more money on their property due to the increased rentals, but the taxes they paid remained unchanged.

The movement of whites to suburban areas and the concentration of Negroes and other minority groups in the central city will be intensified during the next fifteen years if present trends continue.

The total of new housing units constructed is vastly insufficient, especially insofar as inexpensive housing is concerned. Recent statistics of the National Association of Homebuilders show the following:

1. In order to accommodate the yearly added number of new householders alone, 1,200,000 units are needed

2. To replace housing units destroyed by demolition in the process of highway or other construction, 300,000 new housing units are needed yearly

3. In order to replace that portion of the 52,000,000 existing housing units which falls into disrepair or is outmoded (on the assumption that the average lifetime of these units is fifty years), 1 million new units a year are needed

4. In order to overcome the presently existing short supply of housing which manifests itself in overcrowding, 500,000 units a year are required.

Thus in order to keep abreast of demand, it is necessary to construct 3,000,000 housing units per year during the next decade. This is exactly double the figure which the housing industry provided in 1959.

The general shortage is complicated by the unevenness of the supply in various price brackets. Oversupply of high-priced housing units in certain communities contrasts sharply with the serious under-supply of medium and low-priced housing. It can safely be assumed that nearly the entire gap between the total demand for 3,000,000 units a year and the actual supply of 1,300,000 is attributable to shortages in the low-cost and medium-cost field.

As long as the housing demand of urban residents is not adequately met and in proportion to the needs of various economic groups, efforts to clear or prevent slums will be unsuccessful. Thus the problem areas of slums, urban renewal, and housing for urban residents present challenging opportunities on a vast scale for the application of technological solutions. Opportunities for application of NASA-developed technologies to the solution of these problems include:

1. NASA studies of urban growth such as the one sponsored under grant contract NASA NsG-508 concerned with urban growth as it relates to the Florida counties adjacent to Cape Kennedy

2. Methodologies and analytical techniques related to long-range planning such as developed under Contract NAS7-100 which can be used to assist planners in more effective planning of urban renewal and housing programs

3. Development of improved and less costly methods of building construction, especially in the areas requiring large investments for labor and machinery

4. Development of improved, economical, and long-lasting materials for low and medium-cost housing units, including economical methods of manufacturing such materials

5. Development of methods and materials which can be implemented to increase the life of housing units and to keep them from getting into acute states of disrepair

6. Development of multi-purpose construction machinery and apparatus for the building of residential housing units

7. Assisting in the formulation of adequate and effective training schools to teach modern methods of the construction arts and crafts.

UNEMPLOYMENT AND WELFARE

Migration to the cities has already imposed heavy burdens on the welfare activities of the cities concerned. With many of these migrants poorly educated and trained, opportunities for employment at a wage adequate for a decent life are becoming extremely rare. Welfare payments often are more substantial than many of the migrants have ever experienced in income. This tends to encourage them to remain on welfare rolls. In some cities a generation of children is evolving for which the welfare agency is the normal and accepted source of income.

Many disadvantages accrue to minority groups in addition to poor housing. These include high rates of unemployment, low levels of education and training, the necessity to compete with the more highly educated and better trained people for jobs, and the bias frequently found in many communities. Members of minority groups are often relegated to the menial jobs where skill requirements are low and the opportunity to improve job status is often lacking. Other disadvantages involve transportation to and from employment. As the whites and industries move out into the suburbs and countryside, Negroes, as well as other minorities in the city center, lacking an automobile and without adequate public transportation, do not have the mobility required to compete for and hold jobs.

The migration to the cities of rural Negroes, Southern whites, and Puerto Ricans has already imposed heavy tax burdens on the city. In 1959, for example, New York City spent $50,000,000 for remedial programs for its Puerto Rican newcomers. This was more than the city spent on all its parks, libraries, zoos, and museums during that year.

The picture one obtains in projecting these facts can be described as a group of low-density regional settlements in which industry and the white population are spread out over the countryside, with a concentrated Negro occupancy at the center of the city. The city's tax base will be diminished by the flight of industry and its affluent citizens; its expenses will increase to care for its immigrants. A large number of the center-city residents will commute to jobs in the suburbs while many of the suburban whites will continue to travel to jobs in the central business district. They will demand good roads but, by keeping themselves off the tax rolls of the central city, will not be responsible for paying for the facilities they demand.

The inability of the automobile and the expressways to handle the traffic, the changing character of the city occupied jointly by a financial and business community and segregated minority group populations, the problems associated with financing public services for a migrant population in the face of disappearing industry and lost taxes are all reasons for not allowing present trends to continue.

Another facet of the welfare and unemployment problem concerns the increase in the aged population unable to subsist on meager incomes in urban communities. Problems that affect human beings of all ages are found to occur more often or with greater intensity among older individuals. In the economic area these problems concern employment opportunity, income maintenance, cost of housing, and medical care. The emotional and physical well-being of older people is often threatened by occurrence of chronic diseases and the mounting requirements of medical care. Modern medical science can provide help to the elderly, but the individual older person's opportunities in the area of health and medical care are inseparable from his economic problems. The recently instituted "medicare program" for the aged will alleviate this latter condition by serving two major groups of older people: those receiving public welfare assistance, and those with some, but limited, financial resources of their own.

To combat the problems of depletion of welfare funds and to remedy partially the problem of unemployment of minority groups and the aged in urban communities, constructive programs of revitalizing cities must be implemented. The nation's cities will recover their vitality as they are continually restructured in the image and conditions of our times. A new climate and new opportunities for investment and development are needed and can be created through the recognition that "self-help" programs can also be carried out in the private sector of the nation's economy. In many areas of many cities the investment potential is so great and so apparent that private enterprise will do the job without assistance, although at present such cases are the exception rather than the rule.

The challenges and opportunities for private investment can be found in providing services in life preservation and extension, in life enrichment and in convenience and leisure. Another force in continuous operation that will provide new investment and business opportunities to absorb the unemployed is innovation. To channel this force successfully, however, the problems which require innovation must be identified. The private sector of urban life can call upon research organizations and universities for assistance, and the innovators, entrepreneurs, and risk-taking financial institutions can develop programs to determine technologies which can be applied to the solution of the problems identified.

NASA's centers for the study and development of means to transfer its technologies to commercial and industrial applications (such as established at Indiana University and Pittsburgh University) will play an important role in assisting private and business investors to generate requisite innovations. These innovations will create whole new industries, businesses, and new social and economic forces which could change the national economy and drastically reduce the need for welfare and unemployment programs.

Businesses and industries may be encouraged to invest in training institutes of their own in the style of youth and vocational training organizations operated by the Federal government to meet their own specific demands. A key element in the process of technology transfer is the effective flow of technical information. The fullest utilization of the technological by-products of space programs will flow from an effective information system. NASA's publications dissemination program should prove of value in this regard if it is extended to include universities, vocational, and trade schools.

Many opportunities for new products and services will accrue from the transfer of NASA's technologies, through its publications and technical briefs, to the interested private sectors of the urban communities. The potential for the resulting innovations to create jobs which will contribute to the alleviation of the problems of welfare and unemployment will then be limited only by the zeal, imagination, and technical capabilities of the innovators and entrepreneurs. J.S. Parker* has stated that "the transfer of technology, rather than products, will be by far the most important for some time to

*J.S. Parker, General Electric Company, "Space Technology's Potential For Industry," Fourth National Conference on the Peaceful Uses of Space, Boston, May, 1964.

come the areas of new methods, new design approaches, and new production techniques offer promising transfers to industry and innovators."

EDUCATION AND SCHOOL SYSTEMS

The most recent statistics released by the U.S. Office of Education show that there are 54.2 million students comprising nearly 28 percent of the U.S. population. Elementary enrollments account for 35.9 million, 12.9 million are in secondary schools, and 5.4 million are in universities, colleges and professional schools. Not since the Depression of the early thirties have educational developments of the nation's schools been so greatly affected by social and economic developments. This is particularly true of city schools, which are affected by the financial support and the racial, economic and population shift forces.

The next few years will severely test the progress of new developments in school systems and the extent of their impact on educational practice. It has become apparent that cities did not keep up with school growth needs and gradually fell into an educational deficit. Today schools are working to overcome this deficit to keep up with rapid changes facing all schools and to operate their schools in a tighter budgetary climate.

Some problems of city school systems of special concern today are: (1) The increase in the numbers of pupils; (2) decreases in financial support; (3) school dropouts and young adult unemployment; (4) labor organizations of school employees; (5) rapid changes in school curriculum, and (6) adjustments to new methods, systems, and materials for teaching. None of the foregoing are really new problems, but because of a variety of conditions they each press for immediate attention and their magnitude in terms of the numbers of pupils affected makes them especially crucial.

Problems associated with handling increased enrollment and providing adequate and effective facilities will accelerate the need for changes in methods and systems of instruction. The opportunity for the application of NASA-developed technologies will be greatest in these areas. NASA technologies will find a place in the development or improvement of instructional television, language teaching laboratories, teaching machines, programmed instruction devices, visual aids to education, acoustical training aids, newer approaches to teaching mathematics and the sciences, new texts, new testing methods and systems, automated libraries, computers as instructional tools, school simulation vehicles, design of continuous process schools, computer-based instruction in the humanities, computer applications to medical instruction, audio-lingual systems and equipment for language teaching and correction of speech impediments, information and data systems for maintaining and retrieving school and pupil records, centralized computer facilities for university research in the sciences, time-sharing computer systems for interconnection between other computers throughout the country, and video tape libraries of lectures, concerts, and school activities for viewing by students as means of study and enjoyment.

In many large urban communities there has been a noticeable decrease in the quality of school instruction in recent years. This has been especially true in the area of the central city, partly because of the changing pattern of school population and partly because of the shifting of better teachers to the suburban communities. The middle class white families, disturbed by the increasing disorder and misbehavior created in overcrowded schools and classrooms, have fled to the outskirts. Teachers, also of middle-class origin, have done the same. Further, the heightening of racial groupings and the influx of poverty stricken people from the rural parts of the country have contributed to the decay of the central city and a consequent lowering of the quality of education as numbers of children in schools increased, while available funds could not keep up with the growth of student population.

In educating children during their earlier years of schooling, there has been a feeding of the same standard curriculum to all, notwithstanding individual differences, interests, motivations, or capabilities. And, more often than not, educational methods and techniques have failed to recognize the existence of the individual, with his different tastes, motivation and interests. As a result there are (1) juvenile delinquents, (2) underachievers, and (3) dropouts.

In the economic world, the individual receives recognition: his needs, tastes, and desires are appealed to on that basis and he responds as an individual in his purchases. Certainly he can be classified in one of several categories in his habits, likes and dislikes, etc., but students aren't so classified and so treated. Similar consideration should be given to education, particularly during the lower grades in order to make education more appealing and to meet individual needs and capabilities. The perpetuation of nineteenth century thinking in educational methods is totally unwarranted today.

Space activity developed during the past 7-8 years has produced a profound impact on education and the extension of knowledge. The exposure of our children, through radio and television, to ideas, processes, and world-wide on-the-spot events directly resultant from space activities have stimulated widespread interest on the part of all children of all ages in education, new technology and science. The scientific and technological developments fostered by the space program have become part and parcel of the educational content at all levels of schooling. Every child now has a feeling for space and has a better background for developing a realistic understanding of the universe as a system, the place of planets and especially the earth within this system.

Space activities have enhanced the application of closed circuit and open circuit television as an educational technique by means of the extraordinary content made available. Video tapes, as well as other records of on-the-spot events, are valuable supplements to the books available within libraries which are fast becoming automated.

Communication satellites are now used as way stations in the transmission of knowledge and events from one continent to another. When the communication satellite system is expanded, it will be possible to transmit cultural information directly into the schoolroom without undergoing the warmed-over processing required previously when programs where transposed via language or other visual media.

The availability of this knowledge directly will provide a better understanding of the values and behaviors of other cultures, encouraging the learning of specific attitudes, ideas and behaviors, while at the same time discouraging other attitudes, which represented stereotypes, frequently of doubt, ignorance, tradition, and other dubious origins.

Space activities have given increased value and acceptance to the teaching (and learning) of various subjects which previously were considered somewhat exotic and of limited interest. Where science and technology lost their attractions to youth, there is a reawakening at all levels, attracting new interest in technology. Further, new fields of science and technology have widened, attracting more interested persons ready for careers in these fields An additional item of value has been the demand and institution of higher standards, especially at the secondary school level, with expanding opportunities for gifted children insofar as intellectual development is concerned.

At the college and university levels, the advent of space developments has led to an increased need for highly trained scientists and technologists of all kinds. As a result, NASA has been issuing scholarships, grants, fellowships and research contracts, many of which are directed to the training of students in a variety of professional disciplines. One additional factor has been the tremendous stimulus given by NASA to interdisciplinary education, principally required by the critical demand for planning in the space sciences and space travel programs. Graduate programs are just beginning at various locations in interdisciplinary sciences. Equipments and teaching devices are in demand for classroom and laboratory in order to meet new educational requirements. In fact, many NASA personnel are teaching on a part-time basis to assist in developing new graduates and in designing the new equipment and devices needed.

Methods and techniques developed in connection with space activities have introduced NASA-type system concepts to education which are leading to improved scheduling and related administrative activities soon to be more widely adopted in a variety of educational systems and institutions. With increased sophistication and the greater availability of equipments and trained personnel in the near future, these applications will be universally accepted and used.

Although programmed materials were initiated prior to the breakthrough in space developments, the impact upon programmed materials due to space activities was extreme. This resulted in a tremendous boost in the development of programmed materials, which today are beginning to prove more effective than many traditional materials for teaching and learning purposes. NASA can contribute in this area by helping to encourage the use of these advanced teaching methods and by publicizing the use of these within its own areas of interest.

Ingenuity applied to the design and development of synthetic training devices essential for familiarization training of astronauts and maintenance technicians is being applied to the development of training devices and kits for introduction in the various levels of education.

Space programs have shown the futility of lacking specific skills, whether these be in terms of professional and technical skills, or in terms of the several vocational trades. With many sophisticated equipment systems and the associated growth of automation, unskilled and semi-skilled workers find it necessary to upgrade their skills and knowledge in order to maintain employability. Courses of study for expansion of knowledge and developing, improving, and upgrading skills are being initiated throughout the nation to meet the demands of many workers. Technical skills and professional requirements, so highly demanded space programs, are fostering educational and training programs at the secondary school and university extension levels.

Scientists and engineers have had to add both new knowledge and understanding of new methods to their capabilities in order to function in the space program. Professional and technical skills have had to be modified in order that their utility could be transferable to space activities. Special courses have been started and will be continued with instruction by knowledgeable individuals under NASA contracts or in NASA employ, in order to add to the capability of scientists and engineers. This program will be needed for a number of years, especially as new knowledge of space is being gathered, for new technical developments in man's conquest of space.

Adult education courses dealing with the new problems of undeveloped countries and familiarization with foreign cultures are receiving impetus and new interest throughout the country. The use of communication satellites for intercontinental telecasts has broadened the interests of people in international activities. Thus cultural interests have broadened with a special heightening of concern for the needs, assets, and way of life of other cultures and communities.

In fact, for many, these adult education courses may also prove a means for stimulating commercial interests and ties in the expansion of international trade. Economic development can be expanded when businessmen have a better understanding of the culture of the nation with which they propose to do business. The information being conveyed to them—first by intercontinental telecasts, then by adult educational courses—is fully instructional on the needs of other nations and the means for dealing with them.

The technical and professional requirements demanded by NASA space programs, especially at the skilled trade levels, plus the requirements for increasing numbers of highly skilled maintenance technicians of all types created by the adoption of automated techniques and equipments, has not only had adverse effect through the displacement of workers with lesser skills, but also has created an advantage by generating demands for many workers with higher levels of skills. There are extreme shortages in the number of highly skilled craftsmen, and there is need for training in these skills. There are also increasing demands for trained service workers and the expansion of service needs.

These demands have led to renewed interest in the trade or vocational schools in order to develop persons with the needed skills for business and industry. Up to now, the pressure has been in education, emphasizing the importance and values of college and university educations. This view, however, led to neglect of a large portion of the population, many of whom could not qualify for higher education and for whom the schools were proving inadequate. Therefore, with government support, new funds and life are being pumped into the trade schools, craftsmen are being developed, and the technological economy will again be able to move on. This development will be needed for the next five or more years to build up a suitable capability and the several craftsman levels.

In order that the skilled craftsmen be properly trained and developed and service workers be able to develop their needed skills, it will also be essential that trainees be able to perform the various basic reading, writing, and computing skills in order to attain employability. Programs of support have been initiated via the Department of Labor (MDTA) and the Office of Economic Opportunity to provide the opportunity for people to complete their basic education. These programs, of course, also have the salutary effect of obviating the several local and Federal welfare programs, at least in principle, and hopefully in practice. Those who become employable as a result of the combination of education and training to which they are exposed, will be able to leave the welfare rolls.

Any municipality (or institution) contemplating the need to progress is dependent upon the modernization, not only of its plant and environs, but also of its people. Technology has put a great increase of requirements upon the educational demands of municipal employees. Municipalities have a history of stodginess and tradition, as well as a reluctance to increase tax rates and modernize their procedures unless forced into these practices. However, modernization can be attained only as municipal employees are educated to new developments, new procedures, and new concepts to improve their performance in their jobs.

NASA can help to advance these various programs by hiring graduates of the various training programs and advertising their action. They can also disseminate to the various educational activities knowledge of teaching methods and instructional techniques used by the agency in its employee improvement programs.

SECTION 5

TECHNOLOGICAL SOLUTIONS TO PROBLEMS OF THE URBAN ECONOMIC ENVIRONMENT

PERSPECTIVE

The most troublesome aspects of urban crises express themselves in the central cores of cities. With very few exceptions these cores are stagnating, and statistics registering the number of visitors entering the city cores as workers, shoppers, or participants in urban activities show a steady and increasingly downward trend. Such conditions threaten the vitality and function of urban communities. As President Johnson recently stated: "To save the vitality of our cities, we must make continued progress in eliminating slums, in rehabilitating historic neighborhoods, in providing for the humane relocation of people displaced by urban renewal, in restoring the economic base of our communities, and in revitalizing our central areas."

People have long banded together because they found that any task, whether it be to obtain protection from wild beasts and human enemies or the making and exchanging of goods, could be better accomplished by a common effort.. They formed cities because man is a gregarious animal looking for sociability and ease of human communication. As technology and industry developed and as agriculture needed less land and manpower, cities started to increase in number and population.

The mass flight of business, industry, and other urban functions into the countryside has created the phenomenon of spreading, sprawling metropolis, which many scholars and city planners have attributed to a variety of causes ranging from land use patterns and taxation to inadequate facilities and city administration. It is an established fact, however, that its effects are far-reaching in the physical and social environments of cities and become especially critical in the urban economic environment.

Victor Gruen has predicted that over the next ten years local private enterprise will take the initiative in the economic revitalization of cities; that the task will be carried on in partnership with the government; and that it will be stimulated by technological advances and implemented by the business and industrial organizations in communities through the establishment of new businesses risking investments in innovations. For this prediction to be realized, the effectiveness of government agencies concerned with city planning must be improved. Land use and tax policies must be re-evaluated to revitalize the economic climate of urban communities. Procedures must be established to attract new business and industry. Finally, economies and efficiencies must be introduced at all levels of administration.

Critical problem areas in the urban economic environment which have been identified as amenable to technological solutions for purposes of this study are as follows:

- City Administration
- Operation of Municipal Facilities
- Retention and Attraction of Business and Industry
- Land Use Patterns and Policy
- Urban Planning

CITY ADMINISTRATION

The operations of municipalities and municipal government have increased in complexity in all directions. The many transactions which require official recording demand accuracy, and the information searches and legal processes must be accelerated to avoid unnecessary delays. Further, the patterns of city growth, with steady increases in the urban populations, place greater burdens on the city governments in the demands and costs of administrative functions.

There are some overlapping relationships, but each specific urban problem contributes its unique difficulties and attracts its unique special interest groups. Municipal administrators face their greatest challenge in requirements for programs for action in this complicated area of relationships. The critical question for consideration thus becomes: Is the administrative apparatus of municipalities adequate for the application of modern sciences and technical skill to the critical problems of the modern city? It would seem logical to assume that administrative mechanisms designed for the nineteenth century will never be adequate for the purpose of enabling cities to solve their twentieth century problems with twentieth century means. The complexity of administrative relationships is the heart of the problem of implementing many corrective action programs. The methodologies and techniques identified with the management sciences, the information sciences, and economic analysis which have been used in NASA's large-scale programs hold a good potential for modernizing the administrative apparatus of the city.

The basic information essential to the administrative functions of a city is an ever-expanding mountain of records. Although much of the basic information is relatively invariant over long periods of time, a history develops as each transaction occurs, and various minor additions or subtractions are made from time to time. Nonetheless, the actual transactions and processing of these actions are recurring affairs with their frequency increasing each year.

For example, land recordings, tax assessment actions, school records, health and sanitation records, personnel and payroll records, inspection records, police records and operations, and other municipal functions produce daily, weekly and other regularly recurring frequent actions. Instances have already proven the utility of computerized systems which permit organizing the various records into suitable data banks to facilitate the needed handling, processing, storing, and retrieving of information. The data bank concept needs associated with a large computer require NASA's tremendous information handling, classification, storage and retrieval know-how for incorporating several record systems into one computer. NASA's work in the field of data storage density and high speed retrieval is of particular interest here. This capability has been gaining widespread application at other levels of government functioning and should be utilized more at the municipal government level. The technology has been demonstrated and now requires only modifications and software to permit its being applied to the data bank problem.

Communication systems today include the telephone, telegraph, radio, television and public address systems with a capability for two-way communications. In general, these various communication modes have been operated as independent systems and rarely have been organized into network fashion to serve a municipality. Effective communications provide one of the major keys to successful administration. These communication systems involve, in addition to the messages communicated by people, equipment with the ability to trace automatically by means of remote sensors, i.e., locating leaks in municipal sewer systems, and to generate signals conveying information relative to the size and location of the trouble. Such signals may be generated by fires, by unexpected breaks in water or gas mains, or by other emergencies that can be sensed and transmitted to a central display console where the type, location or criticality of the event can be displayed. NASA's remote sensing work could lead directly to capabilities of this nature.

In some cities, mobile two-way radios are now utilized by patrolmen on beats; this gives them a response capability similar to that of police car patrol. Fire engines and ambulances can also have radio communication installations and sometimes do, but these are exceptions rather than the rule. The police officer who leaves his patrol car is out of contact with headquarters; the fireman who goes into the burning building is out of contact with the chief and his fellows. The leaky water or gas main is not detected until a subway is flooded or a home explodes.

School systems, more concerned with records and the transmission of information between people and from stored records to people, are behind in the application of current communications capabilities. Closed-circuit TV is used for teaching, yet closed-circuit TV to scan and transmit records on demand of school teachers or administrators does not exist, nor is there a system that permits students to interact with TV lecturers. The technology required is generally available partially as a result of NASA developments. Feasibility demonstrations must be conducted.

Another area of concern to city administrators is that involving the municipal courts and their concern with city ordinances, regulations, and enabling legislation. Law and legal decisions are generally based on precedent or on enabling legislation, yet history has frequently shown the existence of conflicting laws and ordinances which have often been overlooked. The law, precedence, legal conflict, and legislation have scarcely benefitted from modern techniques and developments. There is strong dependence upon the old-fashioned procedure of library search by the individual. This is a definite hindrance to the workings of justice because it is a slow and costly operation. Computer application to the classification, storage, and retrieval of the laws, legal actions, and previous cases offers another sensible solution to the modernization of a municipal government activity by the application of NASA technology. Computerization can at least relieve, if not eliminate, the long delays and waiting lists for civil and criminal actions. Much of the time devoted to library search and retrieval of pertinent precedents by attorneys and their law clerks can be reallocated to other facets of the legal process, allowing funds to be used more effectively in exploiting legal procedures under the law.

Cities need the fiscal capability to invest in the new systems and new equipments. Operations have expanded throughout municipal functions and costs have risen accordingly. As a result, taxes have also risen. The monies for capital investment must be sought elsewhere—from Federal or state government sources and internal revenue producing sources. Until such funds become available, the improvement picture will be delayed and the opportunities for more efficient city administration either lost or postponed. NASA can contribute to this problem area by financing studies to develop procedures that will permit the application of NASA-developed techniques, such as CAST, to this problem area in a general way so that the ultimate cost to cities is reduced by the development cost.

OPERATION OF MUNICIPAL FACILITIES

The non-revenue producing facilities in an urban community usually consist of:

1. Sewage disposal plants
2. Parks and other free recreational facilities
3. City equipment maintenance facilities
4. City street departments
5. Welfare and social service departments
6. Police departments and jails
7. Fire departments.

NASA technologies can contribute to the attractiveness and efficiency of these facilities. For example, sewage disposal plants now in existence are largely based on both antiquated sewage generation requirements and sewage treatment technology. New sewage treatment processes, tailored to today's wastes and utilizing modern technology, should be developed.

Water supply, sewage treatment, air pollution, garbage and refuse disposal are problems in every city and demand better solutions. Since they are interrelated, they are amenable to solution through a systems approach. At present, there is no integrated approach to handling the water cycle, solid waste disposal or air pollution, and garbage and trash collection trucks continue to ply the city streets.

Since adequate water to supply the requirements of some large cities (such as New York) is becoming more critical, planned re-use of wastewater should be studied as a method to eliminate or forestall emergencies related to water shortages. Approximately 40% of total residential water consumption is utilized in the bathroom; if this water can be treated and re-used at minimum expense, great savings could be realized. In the development of future communities, the available water, primary and secondary systems, wastewater treatment, wastewater reclamation plants, and water re-use, irrigation, and fire protection requirements need adequate systems planning to obtain a better water cycle system.

Therefore, the approach to handling wastewater should be flexible enough to economically cope with any situation: individual home treatment, sub-division treatment, and city treatment.

Garbage can be eliminated by discharging food waste into the sewer after grinding it up in a food waste disposer. It is entirely plausible that a macerator could accept all solids except bottles and cans, shred them, and dispose of them in the waste water if conventional gravity type sewer lines were replaced by pumped pressure lines. A sewage disposal plant could be designed to separate these solids and then process them separately.

An interesting trend developing in the area of municipal facilities is the sale by one community to another of services ranging from police protection to dog catching. In addition to the financial gains involved, these arrangements enable small communities to take advantage of the more extensive service facilities of their bigger neighbors. A recent survey by the International City Managers'

Association of 1007 United States cities showed they had 1168 contracts to purchase services from other governmental units. In most cases services are provided by fairly large cities to smaller municipalities and, sometimes, to entire counties.

The city of Riverside, California, for example, runs the county library system for Riverside County. Los Angeles County sells 50 different services to 76 cities, several of which buy over 4 services each. The county is the largest purveyor of government services in the nation, and last July it had 1553 contracts in force as compared to 1278 in 1961.

Officials of many small communities regard intergovernmental contracting as an opportunity to offer their citizens the features of a larger city while staving off the threat of annexation. As this public facilities contracting continues, new management problems will emerge which will require the use of computers and information systems to resolve. NASA technologies in the computer, information and communication sciences can make a meaningful contribution to the solution of management problems in this area.

Almost all American cities are currently operating revenue-producing facilities. For many, these businesses consist of services that private operators cannot operate at a profit or services that residents expect a city to provide for a fee. These facilities consist of operations such as:

1. Airports
2. Transportation Systems
   a) Rail rapid transit
   b) Bus systems
3. Concessions at Parks, Beaches, etc.
4. Stadia
5. Museums, Concert Halls and other facilities for performing arts
6. Municipal Utilities
   a) Water
   b) Power and light.

The problems encountered in the operation of these facilities and services for the most part are amenable to solutions by NASA technologies in systems engineering and management techniques.

RETENTION AND ATTRACTION OF BUSINESS AND INDUSTRY

A serious problem facing many American cities is the retention and attraction of business and industry. Cities today are beset with the problems of urban sprawl. In some instances the central city has been nearly abandoned and the municipal boundaries obliterated as people, jobs, and industry move into the outlying areas beyond. If this means that the city itself is growing, then there will be no problem, but the city's tax rolls are shrinking, and its supply of reasonably priced industrial land has disappeared. The city government is vitally concerned with those occurrences where its tax base is affected as business and people leave its environs. This pattern of behavior leads to a vicious cycle: as business and residents flee to the outlying sectors, depleting the tax rolls of the central city, tax rates for those who remain must be increased to meet the requirements of municipal government. An increase in taxation stimulates a new wave of migration which launches a second cycle.

The central city cannot live without adequate sources of revenue. Thus, it must attract affluent businesses and industries and residents within its borders to maintain a reasonable tax base for revenue. The city must be in a position to create a climate that will not only retain business and industrial establishments within its borders but will be able to attract new industry, provide a basis for growth and look forward to a developing prosperity.

The city's basic problem can only be solved through long-range planning, utilizing the methods and techniques of systems analysis and operations research which are used in NASA's space programs. The potential expansion and directions of growth of the city's economic base through exploitation of special assets and attributes, such as new uses for natural resources, ports development, and central city facilities present new problems requiring the weighing of alternative solutions in allocating the city's assets.

Industry looks for many specific attributes in a community when considering location of a site. These include:

1. Adequacy of services and physical facilities

2. Sound and fair governmental management and fiscal policy

3. A healthy community climate including cultural attractions, a cooperative force and an understanding populace.

The techniques of management control and planning and the improvements in system analysis and operations research used by NASA provide an excellent methodology for municipal planning. A comprehensive long-term approach is indispensable for an orderly and methodical plan for a city's economic development. Such planning should utilize the best talents available in the community from business, industry, education, and the various civic agencies.

With the collective efforts of a municipality concentrated on its future economic growth, it is then more likely that the city's resources, both physical and human, and its various services and amenities can be developed as attractive assets along with ideally-located industrial and business facilities, attractive residential communities, suitable public transportation capabilities, and reasonable tax rates.

Work that NASA has already done as well as work now underway for NASA can be valuable to cities seeking to attract new industry or to retain their existing industry. The hundreds of new systems and equipments that have been developed by NASA in the national space program represent a large source of new opportunities for industry. Cities officials could operate a program to distribute NASA technical literature (such as NASA "Technical Briefs") to interested businessmen to help them to find new processes and products for their businesses. A local agency reporting to the mayor or city manager could be formed to review these documents for new product opportunities that local entrepreneurs could use to start new businesses.

LAND USE PATTERNS AND POLICY

Crucial among the problems affecting the urban economic environment is the layout of the spatial pattern for growth. It is in the designation of land uses within the areas subject to its control that local government makes its most far-reaching determinations of the shape and density of the emerging city, of the pattern of traffic that will result, the businesses and industries that will be attracted, and the services that must be provided.

A city can be visualized as an aggregation of contiguous property sites, each devoted to a particular purpose, and each generating a more or less regular flow of trips carrying goods and persons to and from that site. The establishment of a pattern of land uses for the growing parts of cities thus establishes the main outlines of the transportation network required to serve this flow of people and things. This approach to land use results in the transport network being derived from a preconceived land use pattern established on the basis of partial criteria such as the apparent necessity for certain kinds of industry to occupy particular sites or the peculiar suitability of a topographical feature for some other kind of installation. Many city planners believe that the community should use as its primary criterion the implications of land patterns on public outlays for roads and transportation services which the land use pattern will entail. This criterion offers a potentially objective measure of the public interest and one that involves consideration of the urban area as a whole.

NASA's capabilities in system analysis, cost effectiveness, and systems effectiveness, coupled with industry's capabilities in resource allocation techniques and economic analysis, can contribute to the approach and methods by which land use-transportation studies are conducted. Techniques of mission analysis and long-range planning of alternative solutions for decision-making can also make contributions to the required research. Finally, NASA's technology in the computer and information sciences can be applied to the problem in structuring data bases and criteria considerations for policies concerning land use pattern and urban zoning.

URBAN PLANNING

Urban planning, to be effective, must have a goal. It must have before it an image of what it wants to achieve, even if the fulfillment of that image may seem far removed, or never completely attainable. The "city of tomorrow" is essentially the image used in urban planning. The city of tomorrow in the planners' sense of the term is a place where millions can live and work and rest, each in his own fashion; a place where each has a choice between solitude or sociability; a place which allows us to fulfill our needs in childhood, youth, and maturity, old age, in illness, in health, in varying moods, in all the seasons, at any time of day or night. It is most of all a place of variety and diversity offering exciting areas full of vitality and glamour, challenge and inspiration.

In the social realm, the city of tomorrow offers peace and relaxation in our homes, in parks, and in natural surroundings. It offers opportunity for the exercise of the body and the mind. It offers a free choice of the surroundings in which one wishes to live, independent of color, race, creed, nationality or economic fortunes, a choice which can be made on the basis of personal likes, of one's age and occupation, and the number and age of one's children.

In the realm of technology, the city of tomorrow is a place in which all urban functions run smoothly and noiselessly, out of sight and hearing; in which not only wires and cables, water and sewage lines, railroads and rapid transit, but all forms of vehicular traffic are removed from consciousness. In the city of tomorrow it should be easy and convenient to get from home to work or to school or to places of cultural and spiritual enrichment without the sacrifice of the prized possession of free time; one will similarly be able to reach places of unspoiled countryside and recreational facilities conveniently and swiftly.

It becomes obvious from the consideration of these needs, requirements, and desires for the city of tomorrow that the task of urban planning takes on a monumental responsibility. Many urban planners are turning to the computer and information sciences to discover means to cope with the variety and number of criteria that must be considered in tasks of urban planning. Economic pressure from business and industry is being brought to bear on the urban planner to improve the economic climate of the central city. Private citizens are also becoming aware of the interrelationship between urban planning and city taxes, voicing dissatisfactions with the manner in which urban planning is now conducted.

NASA's contribution to the technological solution of the problems involved in urban planning are essentially the same as for the problems of land use discussed in the previous section. In addition, NASA can contribute greatly in the area of applying the techniques of mathematical modeling to the phases of urban planning requiring rigorous quantitative treatment to determine alternative solutions to urban problems. Such techniques are briefly discussed in Section 8 of this report.

SECTION 6

TECHNOLOGICAL SOLUTIONS TO PROBLEMS OF PUBLIC HEALTH IN URBAN COMMUNITIES

PERSPECTIVE

Once more public attention is focused upon the health problems of American cities. Large concentrations of people always present special difficulties; but in periods of rapid growth and change, urban health problems multiply and become critical. The urban environment of today presents infinitely more risks to life and health than in the past, due to increased water and air pollution and new pollutants whose effects are still relatively unknown. The sources of pollution are far more numerous and include manufacturing and commerical establishments; homes, hospitals and other public buildings; and some 70 million mobile sources—chiefly automotive vehicles.

The man-made environments—in the form of chemical and radioactive wastes—underlie the high costs of municipal waste treatment and public water systems. The most effective systems today cannot remove entirely the many new chemicals in use. These substances interfere with treatment systems and show up downstream in another city's water supply. Little is known about the effects which even minute amounts of these substances in public water supplies may have over a long period on the health of an urban population.

In atmospheric pollution, the natural environment usually presents difficulties impossible to overcome, as in Los Angeles with its periodic smog weather. But again, the technical problems of air pollution arise primarily, as in water pollution, from man-made wastes. At the present time advanced technology is not being used in these fields to the extent that would ensure greater protection of human life and better conservation of these basic natural resources.

Noise and vibration comprise another new risk to urban health. Little is known about this risk to the general population and only a little more about noise and vibration as a health hazard in certain occupations.

In such an environment of mechanical and chemical efficiency, accidents take on new dimensions in number, variety, and severity. Explosions, conflagrations, accidental poisonings, mishaps in handling powered equipment, not new in themselves, assume new proportions in urban communities. Accidents involving automotive vehicles within the city limits, however, outrank other single types in number and severity.

The development of community services and facilities for the prevention of illness and care of the sick is a major health problem in metropolitan areas throughout the country. Prominent among the specific factors in this health problem are: the high prevalence of chronic disease and severe injuries; the increasing number of aged persons in the population; and the growing complexity and costs of personal health services and facilities. In metropolitan areas, the development of hospital and medical facilities is often frustrated by drastic population shifts. Urban redevelopment and the construction of highways leave many city hospitals high and dry. Hospital planning in urban areas thus assumes new dimensions in both scope and depth. It is becoming imperative that some means be found to ensure orderly development and rehabilitation of needed facilities, without mutually destructive competition for the community's financial resources.

Newly developed and improved technologies developed by NASA can contribute to the solutions of urban health problems in many and varied areas. The discussions which follow are concerned with the following urban health problems amenable to technological solution.

- Environmental Health Hazards
- Accidents and Public Safety
- Illnesses and Infectious Diseases
- Hospitals and Medical Facilities
- Urban Public Health Departments

ENVIRONMENTAL HEALTH HAZARDS

The unplanned and uncoordinated industrial expansion during the nineteenth and early twentieth centuries followed by periods of great population growth resulted in the widespread pollution of our streams and rivers and more recently in the pollution of the air we must breathe. Water pollution and air pollution are not new problems. In October, 1948, in Denora, Pennsylvania, 14 people died in two days from a heavy SO_2 concentration in the air. Actually, 40 percent of the 14,000 residents became ill. For years, until legislation forced smelters to recover the SO_2, the areas for miles around the smelters were completely devoid of plant life. Once these recovery processes were forced upon the ore producers, they found that they could not economically afford not to recover these gases.

Processes must be developed either to recover industrial wastes now emptied into our rivers or to reuse or otherwise make these wastes innocuous. These steps must be required by law. In 1900, municipal wastes reaching streams was equivalent to the raw untreated sewage from 24 million people. By 1959 this had grown to the equivalent of 75 million people, and by 1980, it will grow to the equivalent of 150 million people.

One of the most complex problems associated with the recovery of polluted water is the psychological block that people have concerning reprocessed sewage. Therefore development efforts must be concentrated on the task of developing processes to treat effluent streams and rivers in order to avoid the problem of having to reprocess and distribute polluted river water. Present day installed sewage treatment plants for the most part are obsolete, since they were designed to handle the loads and wastes of 40 years ago. Little or no development work has been conducted in this area. Therefore, a major water pollution need is the development of waste treatment processes to remove more of the contaminates than is now possible and, if possible, to do this more economically and at a low enough initial capital cost to make the processes readily affordable by all urban communities.

NASA can contribute to this problem area through the application of several of the technology areas it has developed or advanced. Discussions pertinent to the application of NASA-developed technologies in the areas of air, water, and land pollution and to solid and liquid waste disposal are presented in Section 3 of this report. From an ecological viewpoint these problems represent crises in the urban physical environment as well as public health problems. It is recognized, however, that the impetus for their technological solution will come from public health considerations of their criticality.

Various modes of transportation, especially those associated with the mass transport of people within or between urban communities, are a major source of noise and vibration which can have a deleterious effect on the health of exposed citizens. Many industries, both heavy and light, use machinery whose noise and vibration levels are high. In some cases, these levels are increased through reflectance, thus creating an added hazard to the health of individuals exposed to the noise. In general, we cannot attribute serious health problems to noise and vibration, but we do know that noise affects the efficiency of people and these hazards may have an insidious effect on their mental health.

NASA, through noise suppression techniques developed in relation to engine testing, could contribute to techniques and materials for better attenuation of noise and vibration in the urban environment. Vibration design and testing criteria from measurements and analysis of complex vibrations of space vehicles can be applied to development, design and testing of high-speed urban transportation systems to upgrade the comfort and reliability of such systems.

ACCIDENTS AND PUBLIC SAFETY

To list the gamut of accidents to which civilized man is susceptible would not serve the purpose of this study. The category of automobile accidents was selected as an entity for discussion because of the enormous annual toll. NASA, through its in-house and sponsored contracts, has emphasized operator and passenger safety in aircraft and spacecraft. The automobile industry has gradually adopted minor safety measures, but these have been minimal and have not been the result of a systems approach to the problem. A systems engineering approach to the automobile from the viewpoint of rider safety might result in radical design changes. These changes undoubtedly would provide significant improvements in the degree of safety afforded auto passengers. NASA-supported work in aircraft cockpit design and in space capsule design should provide a wealth of design and development information that could be of immediate value to such a systems engineering study.

Equipments already developed by NASA for aircraft and space vehicles, such as instruments, sensors, seats and cushioning, could be used immediately. This problem area requires a systems engineering approach coupled with public information and education programs to obtain the public's support.

The large amount of time lost from work in the United States on account of illness and injury due to accidents presents a challenging problem to preventive medicine and the safety movement. Data collected for the period July 1959 to June 1961 indicates that the loss of work time averaged 322.9 million days a year for the usually employed population aged 17 and over. Table 1 shows that illness was responsible for about three-fourths of the work-loss days. Somewhat over half of the work-loss days due to injury—38.4 million days out of 73.5 million—were caused by injuries arising out of and in the course of employment.

Accidents involving a motor vehicle were responsible for 14 percent of the days lost because of injuries sustained "while at work." With regard to work-loss days from all causes, nonoccupational motor vehicle accidents and accidents in and about the home resulted in 7 percent of all time lost. NASA's programs in human factors and engineering can be used as a source of technology for this problem area. Through the National Safety Council NASA can disseminate information concerning the systems, equipments, devices, and methods which can be used to reduce numbers of the loss-time accidents.

Generally, food poisoning is not a serious problem for cities whose health departments have established routine food preservation standards and inspection procedures. However, there is always the possibility of unexpected events, particularly as a result of human error. In such cases, problems arise and develop rapidly.

Much food poisoning is a direct result of failures in meeting preservation standards, in the malfunction of equipment, and in the introduction of unsanitary practices. Recently, there was an epidemic of intestinal virus in Riverside, California, due to contamination of the city's source of water. Some 18,000 persons were

TABLE 1—ESTIMATED AVERAGE ANNUAL WORK-LOSS DAYS FROM ILLNESS AND INJURY

Persons Usually Working,* Ages 17 and Over
U.S. National Health Survey, July 1959-June 1961

Condition Leading To Work Loss	Number of Days, in Thousands	Percent Distribution	Days per Currently Employed Person
All Causes	322,857	100.0	5.49
Illness	249,386	77.2	4.24
Injury	73,471	22.8	1.25
At work	38,424	11.9	.65
Motor vehicle	5,433	1.7	.09
Other	32,991	10.2	.56
Motor vehicle (not at work)	13,571	4.2	.23
Home	10,371	3.2	.18
Other and unspecified	11,104	3.5	.19

*Persons in the civilian noninstitutional population who were paid employees, self employed, or unpaid employees in a family business or farm and who were usually working during the year. The data relate only to persons living at the time of the household interview. Source: Unpublished data from National Health Survey Division, National Center For Health Statistics.

affected in an inordinately short time. The occurrence of an epidemic not only creates a great deal of anxiety but produces a severe strain on medical facilities, first, in determining the epidemiology and second, in alleviating the problem.

Improved equipment and new tools, such as specific sensors, as well as the development of improved procedures for retaining control over food-handling inspection, are needed in this area because rising costs in the area of municipal services both for new services and for services oriented to people has put a cost squeeze on some of the less glamorous city departments. NASA-developed technology in the field of remote sensing, telemetering data and remote viewing could be used to develop a more automatic and probably less expensive food processing protective service. For example, there are bio-sensors designed to automatically sample the biological content of atmospheres or of lunar and planetary surfaces and report their composition.

Temperature sensors, humidity sensors, radiation and other particle sensors can be placed in dishwashers, refrigeration boxes, rooms, or other closed spaces to make periodic measurements of the atmosphere and signal sub- or supra-standard conditions. It is feasible to operate a widespread monitoring program to protect the public by assuring the maintenance of sanitary practices in restaurants, laundries, hospitals, and reservoirs. Over the long run, it is also reasonable to expect to attain dollar economies with reliable equipment systems while maintaining better health standards.

Other NASA developments could contribute to health practices in food preservation and preparation, food dehydration, rehydration, freezing and techniques of reconstitution. These developments offer improved techniques for the food industry. When commercially available and producible at a reasonable cost to the average consumer, these approaches can provide food preservation techniques which are less susceptible to contamination yet offer a longer shelf-life.

ILLNESSES AND INFECTIOUS DISEASES

Although advances in medicine and public health measures have brought many communicable diseases under control, there still are dangers where controls do not operate and where infectious disease can assume epidemic proportions. The common cold, viral influenza, certain forms of meningitis, hepatitis, and other viruses are still sources of infectious disorders which can be highly disruptive in an urban community.

Cardiovascular-renal diseases and malignant neoplasm are major causes of death in the United States today. Morbidity rates show that caridovascular diseases affect the largest numbers of sufferers, followed by arthritis and rheumatism, asthma and hay fever, syphilis, tuberculosis, and cancer. Ailments which show the greatest incidence indicate that stresses and infections are the underlying factors.

The economics of ill health are difficult to compute with accuracy. However, estimates have placed these losses each year in the billions, much of this being attributable to time lost by those who are in the labor force. The benefits secured through advances in medicine and health measures are seen in the increase of our aged population. This indicates a need for anticipating increases in the prevalence of new diseases and new types of malignancies. As the older people survive the more commonly known infectious disorders, especially as control measures become more successful, they become more susceptible to deteriorating diseases and to other types of infectious disorders, many of which are killers or cripplers.

Illnesses account for a large proportion of the time lost from work. The common cold. pneumonia, influenza, and other acute respiratory conditions were responsible for more than 100 million work-loss days. Digestive ailments ranked second among the acute illnesses. The leading chronic conditions keeping people from work were cardiovascular diseases, orthopedic impairments, genito-urinary conditions, and arthritis and rheumatism. In both sexes the work-loss days per person tends to increase with advance in age, largely a consequence of the greater frequency of chronic disease at the older ages and of the longer time required by older people to recuperate from illness and injury.

Physical educators today believe the average American is being robbed of maximum physical well-being by an increasingly automated, motorized society. The President's Physical Fitness Council several years ago reported, for example, that 10 million of 40 million school children could not pass even a simple screening test of physical performance. Business executives are being encouraged to sponsor physical fitness programs for employees. Labor Department statistics and insurance surveys indicate that companies can reap benefits from such programs. Absenteeism and paid sick leave, which averages more than $35 a worker annually, is reduced when employees are in good physical shape. Morale of physically fit workers is unquestionably higher.

NASA technologies can contribute to the problems posed by the physical fitness of workers in urban communities by assisting in the development of effective and cheap exercising apparatus and by distributing the knowledge gained from the training of and physical fitness programs for astronauts.

NASA activities in space medicine and bioastronautics have evolved many technologies and the inter-relationship of many disciplines. New and improved approaches and equipments are being developed for space flight, covering such aspects as sterilization, filtration, culture growth, agent identification, air sampling, aerosol generation and dispersal of bacteria. One would assume that a cooperative program involving NASA, NIH and Fort Detrick could wage a successful attack on the more troublesome of man's illnesses and infectious diseases.

Some of the contemplated NASA activities which seek a greater understanding of the origin of life may, in time, provide some of the needed solutions. Investigations of the beginnings of life on other planets, possibly on the moon, and the development of biological organisms may be the means for a better approach to the problems of life and disease and death.

NASA investigations into the behavior and effects of biological organisms including humans under conditions of weightlessness, may soon tell us whether a zero gravity or subgravity environment may be a source of new understanding of biological development, a basis for new therapeutic measures for alleviation of selected infections or stress disorders, or a means for producing increased stresses and new infections.

Sensitive techniques for detection of microbes being developed by NASA for control of foreign contaminants can be studied for feasibility of application as bacteria detectors in (1) epidemic prevention and control throughout urban areas, (2) large municipal and commercial food-handling and distribution establishments, (3) urban ports and harbors which handle foreign cargoes, (4) urban hospitals and schools for early detection of contagious diseases. Feasibility studies for such applications of microbe detection can be conducted through federal, state, and municipal agencies concerned with problems of prevention and control of epidemics and food poisoning.

HOSPITALS AND MEDICAL FACILITIES

New demands for expanding medical care programs, partly evidenced by recent federal legislation, and new developments arising in diagnostic and therapeutic procedures create a strong need for conceiving of a community health program and its facilities from a system's viewpoint. First, it is necessary to improve overall medical care, and secondly, it is important to achieve, in time, a halt in the constantly rising costs of medical care. Although historically, medical care has been based upon a personal relationship between patient and physician, the demands for medical information have increased at a tremendous rate, as have the results of research and development relating to clinical medicine, improved diagnostic methods, new treatment techniques and drugs. Many new equipments have also become available, contributing directly to the prolongation of life and improvement of health. Further, many equipments now operational enable information to be collated, processed and communicated through automated procedures at very high rates of speed. In addition, our population is growing quite substantially, placing even higher demands upon medical resources for pertinent current and historical information and for immediate response.

A typical community generally includes within its medical system: (1) various facilities, such as hospitals, clinics, laboratories, nursing homes and ambulance services; (2) professional personnel resources, such as physicians, dentists, nurses, aids, auxiliary medical professional technical personnel covering a variety of services and capabilities; (3) administrative and nonprofessional service personnel. Recent studies* have shown the need for interrelating all the information among these several capabilities which can be implemented only by a communications system network containing adequate storage and retrieval facilities.

This overall system design is now feasible as a result of the system and computer developments resulting from the demands and stimuli of NASA space programs. A community medical program can be designed around a network using a computer or series of computers as a core facility and storage, tying together the various medical and hospital facilities and the several associated personnel resources.

For example, the computer storage will contain the life-time medical histories of the total population of the community and serve as a continuing reference to meet the information requirements of

---

*See Appendix C. "A Methodology for Hospital and Medical Facilities Planning."

all medical personnel and facilities of the community. A physician can communicate with the computer for diagnostic or treatment information regarding his patients, or conversely, he can add to their medical history following examination or treatment. Where consultants are called in for special examinations, direct access to patient records stored in the computer will provide the pertinent medical data and historical information on the individual patient.

For special problems such as cardiacs with pacemakers, epileptics, etc., radio telemetry devices can be automatically triggered to communicate with the computer, indicating the existence or expectation of an emergency. NASA-supported work on bio-sensors, miniaturized and microminiaturized radio and telemetry systems, and on the predictor displays developed for space navigation offer excellent sources for application to the fields of medical emergencies within a matter of a few years.

Sterilization and biological "clean room" techniques developed by NASA are applicable to contamination protection in urban hospitals and clinics particularly for protection against "staph" and similar hospital-breeding infections. Modifications of these techniques can also be studied for use in decontamination of enclosed places of public assembly, such as civic auditoriums, in times of flu and other epidemics, to minimize the dangers of disease spreading to large segments of urban population. NASA's research in the optical and electronic properties of matter, especially in the ultraviolet range of the EM spectrum, may also contribute to development of sterilization contamination protection systems and equipment for hospital use.

Within a hospital,* a more complex communication network is proposed, comparable to the command and control system effectively developed and used by NASA for controlling space flight. Medical care problems, research, administration and all types of record-keeping can be covered by utilizing the hospital's computer facility. Where the size of institution does not warrant an independent facility, time-sharing will be accomplished through remote transmission concepts. New developments will place emphasis upon intensive treatment units where patient monitoring around the clock will be essential. Thus, data processing devices, sensitive detection or sensing devices, useful displays and suitable warning systems

*See Appendix C.

will be necessary in the event of significant alterations in the patient's status. Again, NASA's work in these fields will prove very valuable in the applications of space-developed systems, devices, instruments and concepts. For example, monitoring devices in some cases will include measuring as well as sensing capability in order to process data for future research needs as well as immediate evaluation of a patient's condition. Time-sharing concepts will be needed at this level of communication and processing as well as the level described above.

Paging systems used by patients to call nurses and attendants can be improved. Today's systems can only indicate a need. A simple coding system or use of a multiple display device can reflect the patient's needs and reduce appreciably the number of demands placed upon the staff. The old-fashioned handwritten note in the "journal" is outmoded elsewhere, yet used daily in every hospital. Simple electronic systems can be adapted to replace the outmoded handwritten entry which is frequently questioned and difficult to retrieve. The use of simple alpha-numeric codes and display boxes alone would cut the burdens of the nurses and attendants substantially.

One major area of concern is that of patient monitoring in an intensive care unit. Today, most cases of serious illness require 24-hour nursing care because of the problem of monitoring. Professional nurses are frequently difficult to find to staff hospitals, to function as "specials" and to meet the patient care standards. Space flight activities have shown that individuals can be monitored from 100 miles away, and their physical, physiological, and psychological behavior observed and interpreted correctly from multiple display stations. This capability should go a long way in making it possible to monitor hospital patients.

Such systems are feasible in part today, and should be wholly feasible within the next few years for improving the care of hospitalized patients and the overall administration of the hospital. Human systems tend to be replete with human errors. Too often the routine that is repeated daily becomes a source of error because of the boredom it breeds. Certain hospital activities, especially those accomplished in the laboratory, become conducive to boredom.

Recent surveys in several Eastern cities showed that private laboratories were making serious and frequent errors in their tests on patients. This can be critical in the diagnostic evaluation and determination of a patient's progress. NASA technologies involving sensors, communication networks and controls, combined with a computer's characteristics should lead to automated laboratory analyses for most routine tests. Many tests could probably be automated immediately if development programs were authorized. Automation can provide decreasing unit costs while upgrading the quality of the test results.

URBAN PUBLIC HEALTH DEPARTMENTS

In the modern urban environment, the case for urban health is lost if the public health department is not qualified to be a leader in coping with old and new problems. Health departments should take the leadership in anticipating needs for basic health facilities and services. They should also provide the means to assist municipal planners in urban hospital planning and administrators to manage and operate urban hospitals.

Costs of hospital operations have jumped by an order of magnitude in the last 20 years. Communication systems remain primitive and many manual procedures still exist. One of the major problems in administering hospitals and medical facilities is high personnel turnover and the necessity to continually train new personnel at all levels and in diverse functions. Suitable hospital communication systems developed as a result of minor modifications to NASA-developed space equipment can be made available within a short time. This type of development should help to alleviate the shortage of hospital personnel.

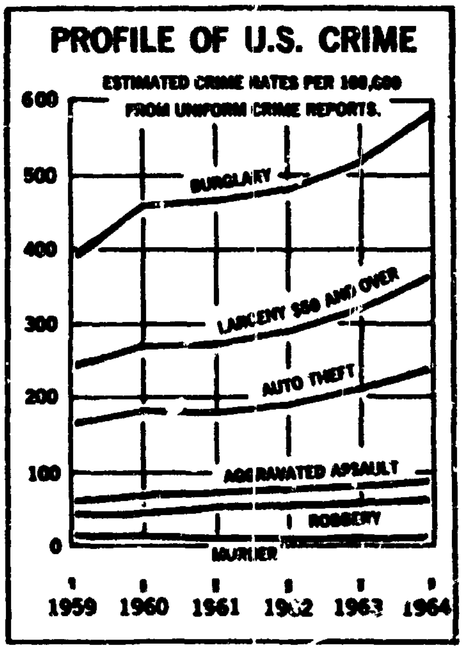
Hospital and medical facilities planning should be an important part of the assistance rendered by urban health departments. NASA long-range planning and management methodologies should make a substantial contribution to the solution of hospital planning problems. One such methodology, developed by an aerospace contractor, is presented in Appendix C of this report.

SECTION 7

TECHNOLOGICAL SOLUTIONS TO PROBLEMS OF SECURITY IN URBAN COMMUNITIES

PERSPECTIVE

Because crime in the streets of the city is becoming increasingly commonplace and violent, law enforcement is faced with the greatest problem in combating crime in its history. As shown in Figure 2, the crime rate for every category of crime is increasing. Parks which were once the pride of cities have become places to avoid, particularly at night. Teenage gangs rule sections of the large cities and crime-syndicate gangsters rule in other sections.



(Source: NEWSWEEK, August 16, 1965)

Figure 2. Increasing crime and its relation to population.

The average citizen faces odds greater than 1 in 10 that he will be mugged, robbed or otherwise victimized by criminals within the next 10 years. Crime is increasing five times as rapidly as population, thereby increasing each individual's chances of being victimized. The cost of crime is staggering: President Johnson recently estimated it at "tens of billions annually."

At the same time, the increased crime rate has improved the criminals' chances of going unpunished—there are fewer than two policemen per 1000 population. Police officers have twice as many crimes to solve per man as in 1950. Consequently, they are making fewer arrests per 100 offenses reported. Smaller percentages of those arrested are held for prosecution. And smaller percentages of those tried are being convicted.

A battery of statistics presented in the FBI's current report on crime in the United States shows that by its very prevalence alone, as well as by its spread, crime has posed a plethora of acute problems—social, economic, and political—in the nation's cities. These statistics have also affirmed the truism of law enforcement: the bigger the city, the harder it is to deter crime. The search for "causes" of crime has become an effort to isolate the social, economic and psychic conditions under which crime seems to occur most frequently. Technological solutions to the prevention, control and deterrence of crime are a comparatively recent development in the long evolution of police methods and law enforcement.

Although the major security problem in urban communities is crime, there are other threats to individual, community, and commercial security posed by natural disasters such as fires, floods, hurricanes, tornados, and earthquakes which require investigation for technological solutions. Preventing, controlling and combating of riots perpetrated by hostile groups against other groups and sections of communities represent another area requiring analysis and study. Public concern for immediate feasible solutions is increasingly emphasized in the popular press and is nowhere more apparent than in the actions of President Johnson in establishing commissions to combat crime and to study means to decrease the toll of human life and loss of property by natural disasters.

Out of the vivid headlines, the climbing statistics and the citizens' alarms, comes an urgent need to identify and implement effective and immediate means for controlling and alleviating the problems associated with crime, riots and other threats to security in the city. Although technology is not the sole answer to these problems, every problem does have some technological solution and NASA's wide technological base represents an excellent starting place in which to seek answers.

The critical problems of security in urban communities selected for analysis and evaluation of technological solutions in the study and which will be discussed in the following sections are:

- Individual Security
- Community Security
- Commercial Security
- Riots and Organized Crime
- Police and Fire Protection.

INDIVIDUAL SECURITY

The protection of the individual is one of the most difficult security problems existing in urban communities today, since attacks on individuals are occurring with increasing frequency. Over the years, ingenious devices have been developed to protect the individual, however, many of these are now obsolete or ineffective. For example, the American consumer spends over 100 million dollars a year for protection against intruders, purchasing door locks, window fasteners and similar pieces of ineffective hardware which do not deter or hinder burglers and prowlers. It is economically unfeasible to hire enough police officers to constantly patrol all areas of the city. Therefore, a surveillance system is needed that permits one man to constantly oversee, by remote means, a considerably larger area than he could watch in person. Lightweight, small, remote surveillance and warning systems can provide effective protection for the individual, particulary if the use of such devices is widespread and if the locations of remote surveillance equipment or persons equipped with warning devices are not immediately discernible.

Small protective, non-lethal but incapacitating, devices could be developed which would permit authorized individuals to protect themselves when attacked or threatened. Devices of this nature might consist of gas bombs, hypodermic releases on umbrellas and night sticks, or even weapon-launched hypos. The use of these devices must be controlled, however, because they could become powerful weapons in the hands of a criminal.

TV surveillance systems to monitor unsafe urban areas can be developed, employing low light intensity TV cameras. NASA's work with image orthicon tubes is applicable here. The signal can be fed to a monitoring station in constant voice contact with the police cars of the community. A positive and known capability to have a police car on the scene within 30 seconds should discourage criminals from operating within surveyed areas. These systems could be used in remote areas, deserted downtown areas and even in rail rapid transit cars as well as on station platforms. The existence of such a system and the areas covered must be made known to the public in order to avoid the resistance which may be incurred reminiscent of Orwell's "big brother is watching" concept in "1984."

Inexpensive, directional communication devices can be developed to pinpoint an individual's exact location in an urban locale. These devices, operating at extremely high frequencies, could be developed as a result of NASA's work with short wave length, high frequency communication equipment. These devices could be issued to individuals desiring to or needing to use parks at night and to individuals such as bus and taxi drivers whose duties cause them to visit desolate areas unescorted during dangerous nighttime periods. These equipments could easily be designed to permit an individual to secretly switch on the device, causing an emergency signal to be received at a monitoring station. These devices could also be installed in self-service elevators and in hallways and lobbies in apartment houses and could be designed to be activated by an individual leaning against an innocuous wall panel switch or standing on or near a foot switch.

COMMUNITY SECURITY

The community itself is a vulnerable entity. Although many of the problems of a city are related to the protection of the individual, local businesses and industries, there are other major problems associated with the protection of the community from the ravages of hazards such as fire, flood, and earthquakes and from large-scale epidemics of illness and disease.

Time is a crucial consideration in fighting fires. The greater the elapsed time between the start of a fire and the beginning of efforts to fight it, the smaller the chance of saving the structure(s) involved. An urgent need exists for sensors to sense and trigger signals at an earlier stage of fire ignition, and NASA's technologies in sensing and signalling instrumentation offer opportunities for feasible solutions to this problem.

Since many fires start as a result of overloaded or defective wiring, simple solid-state devices could be devised for insertion in fuse boxes that could trigger an alarm in case an unsafe wiring condition develops. IR devices could also be used as detectors for searching out dangerous hot spots that might spontaneously ignite. NASA-developed technologies in solid-state physics and electronics can make contributions to encourage the development of these devices and similar equipment for fire detection and warning.

Highly sensitive and stable fluxgate magnetometers developed for satellite and submarine detection may prove to be useful in other remote sensing applications such as: (1) location of breaks and shorts in underground utility cable in urban areas, (2) inspection of buildings and homesites for oil and gas leaks to prevent fires, and (3) remote burglar alarm systems for commercial establishments which can be connected directly to central display boards in urban police stations.

Industrial fires are a great threat to a community, not only because of the monetary loss which is frequently high (421 large industrial fires in 1963 caused $319 million damage) but also because of the large numbers of people idled and the resulting loss of purchasing power which affects the national economy. NASA technologies can contribute to solutions of this problem by transfer of its developments in remote sensing and signaling. NASA-developed IR technology could be used as the basis for the development of fire sensing, hot spot sensing, and trouble spot sensing equipment.

Miniaturized circuit development studies resulting from NASA's need for small equipment could lead to the development of small lightweight circuitry suitable for use in monitoring home electrical circuits. NASA's remote sensing and telemetering experience should be of great value in establishing more effective fire warning systems with a capability to pinpoint the fire and to bring greater fire fighting equipment to bear on the fire in less time.

NASA's developments work in satellites and the atmospheric sciences can make valuable contributions to the solution of many problems posed by hazards of excessive temperatures, wind, and rain. Knowledge gained from these developments can be used to make reliable long-range weather forecasts. For example, untold hardships could be avoided if cities could prepare in advance for the weather disasters that regularly occur. Pinpointed forecasting can also benefit urban businesses sensitive to inclement weather

NASA's technical developments in sophisticated computers can play a vital role in weather prediction programs by making possible long-term studies of thousands of conditions that might affect the weather. Three to six-month reliable weather forecasts, which can eventually be made possible by linking time-sharing computers in a local area with those of other stations and the U.S. Weather Bureau, could contribute to accurately-planned programs by cities to minimize the loss of life and property due to high winds, excessive temperatures, and rain storms. Police, fire departments, and civil defense agencies could also be alerted in advance of impending hazardous weather conditions by means of early-warning systems connected to the prediction computers.

The prediction of earthquakes should be attacked with the same degree of enthusiasm, technical competence, and creativity applied to space projects. The problem of earthquakes could conceivably be approached on an energy basis. That is, the earth's surface can be considered to be in meta stable state and the area of highest energy level could be expected to rearrange to lower energy level states. Measurements from satellites and NASA's sensor development work might be of value in attempting to measure the energy of the earth's surface. Perhaps IR measurements of the earth's crust could be compared with past frequency of occurrence of earthquakes.

COMMERCIAL SECURITY

The problem of protecting the commercial and industrial facilities of a city from lawless elements is a difficult one. The larger industries and commercial establishments spend a great deal of money for protection, installing complex systems. The sale of security systems and the services associated with them represent a growing industry within the United States. This industry offers motion devices, nearness sensors, circuit interruption systems, safe-lock filing cabinets, safes, and, most recently, central control consoles. These central control consoles serve as process control and equipment monitoring equipment in addition to serving as the heart of a security system.

The smaller, less affluent commercial establishments and industries within a city are problem areas, tending to be the target of many small criminals because the owners or operators cannot afford either adequate protection equipment or private protection services and because, frequently, they remain open long hours and are located in remote areas.

As presently constituted and equipped, a city's police force cannot be expected to furnish 100 percent effective, round-the-clock protection to every individual, industry, and commercial establishment within the city. All services offered by cities are dependent on available funds; at the present time the costs of providing these services are increasing at a rate that frightens many city officials and most taxpayers. Therefore, if better protection is to be offered to the commercial and business enterprises within cities, great technological improvements must be made in the equipments and the methods used for furnishing this protection to permit it to be accomplished more effectively and at a lower cost.

Sophisticated equipment is available to business and home owners willing or able to spend large amounts of money for the protection of their property, privacy and/or selves. Devices such as phtoelectric cells can be used to sound alarms and to turn on flood lights. Motion detectors, nearness detectors, trip wires and even radar can be used to set off alarms. These systems can be tied into central monitoring stations or can be used to sound alarms on the site. Usually, industries and commercial enterprises have their alarm systems connected to a protection service, while the individual home owner generally has his sensor tied into an alarm on his property. For the most part, these systems are expensive and often are susceptible to triggering by pranksters and stray animals. No system is in existence that permits tying sensors into police headquarters.

There is a need for less expensive, more dependable and more widely acceptable products to function in this area. NASA's work with technologies such as IR, UV and other remote sensing devices, microelectronics, extremely short wave length radiations, higher frequencies, and lasers should lead to sensors with better discriminatory behavior, greater reliability, smaller size and, hopefully, lower cost. The availability of many more frequencies for communications purposes should make it feasible to have each and every home tied into a central monitoring station without the expense of running wires. Systems that sound an alarm at some remote location are more effective than those that ring a bell at the point of entry. Experience has shown that burglars tend to shun those establishments protected with remote signalling devices because they have no way of knowing whether or not they have triggered the warning device.

RIOTS AND ORGANIZED CRIME

The American public is not fully aware of the vulnerability of the city to those who would exploit it. The complete success of the "Hell's Angels" motorcyclists in disrupting and demoralizing a town is a matter of record, as is the success of small Communist groups to incite and conduct riots. The recent tragic riot in Los Angeles was a vivid demonstration of how a small minority of a minority group could panic a great city and tie up an entire militia of a great state. The extent of the influence of organized crime in many large American cities has still be be determined. History has shown repeatedly how a few organized individuals can influence a whole community and seize control during an emergency or period of confusion.

Currently existing techniques, equipment and procedures for protecting cities during situations such as riots are woefully inadequate. Most cities have little or no intelligence gathering, storing or analysis capability. Where this capability exists, it is generally inferior to that of the organizations it is attempting to protect itself from. The intelligence gathering and analysis capabilities developed by federal intelligence agencies such as CIA, ISA, DIA, and the Air Force's Foreign Technology Division can be used as models to establish similar capabilities in police departments of urban communities.

NASA-developed information systems capabilities can also be applied to this task. For example, NASA-developed information storage and retrieval systems such as CAST can be employed for the classification and storage of community protection information, while NASA-developed technologies related to the remote monitoring of space flights and the telemetering of information can be used for monitoring suspect operations and individuals. Some of these suggested actions may involve invasion of privacy, and the information gathered by these techniques would undoubtedly be inadmissible as evidence, just as information gathered by wire tapping is inadmissible. However, these techniques could lead to the accumulation of information that would permit both setting traps to apprehend riotors and criminals on the scene and to deter riots and crime. They may also lead to the downfall of the large criminal empires that now exist. NASA-developed technologies can be applied, for example, to develop remote monitoring equipment that could be used to take pictures, to record sounds and to transport pictures and sounds from remote locations.

The ability of members of an organization to communicate is a measure of the effectiveness of the organization. Current techniques do not permit the rapid exchange of information between two police or fire protection officers in different sections of a city. Systems that would permit instant intercommunication among all members would be of inestimable value to a police force and fire department. NASA developments in fields such as microelectronics, greater electronic equipment reliability, smaller and lighter electronic equipment, short wave length, laser and high frequency communications, and batteries make such systems feasible and make possible programs for the development of equipments capable of performing the needed functions of rapid and effective communications.

Organized crime uses every piece of modern equipment available and, in order to fight this enemy, there must be even more advanced equipment serving on the side of law and order. Although some people have the vision to bridge the gap between a technology developed for a space application and its use in a non-space application, this gap actually will be bridged much more rapidly if specific programs to demonstrate this bridging are structured and implemented. Every delay in attempting to utilize available techniques represents an advantage to organized crime and to groups who perpetrate riots as forceful means to gain their advantages.

POLICE AND FIRE PROTECTION

Analysis of the task of furnishing effective police and fire protection to the residents of urban communities can be approached in two ways. Solutions to segments of the problem can be sought, structured, and developed, or a systems approach can be taken toward the entire problem. It is obvious that results can be obtained most rapidly by first seeking solutions to problems rather than systems.

Much can be done to improve the effectiveness of today's police officers if the proper problems are attacked. Probably the greatest need is to improve the efficiency of police officers in order to permit them to increase the number of arrests that they can make per 100 offenses reported.

One of a policeman's most reliable tools is his car. A properly designed police car could make a significant contribution to the increased effectiveness of a policeman. Those who have worked NASA and DOD contracts for the development of equipment would probably conclude that a parametric design including cost effectiveness studies would be the path to follow in developing the optimum police car. Such an approach is described in Appendix A.

Another valuable tool for a policeman is information. The more information he has instantly available to him, the more effective he can be. This would require the development of police intelligence systems that could store all types of information that police departments need, such as stolen automobile data, wanted criminal statistics and MO data and that would permit the rapid withdrawal of this information at any time by any police officer.

Both of these approaches to improving a police officer's efficiency are dependent on technologies and techniques not usually applied to the solution of non-NASA, non-DOD problems. For example, the combined use of parametric analysis and cost effectiveness studies is seldom found outside the shops of NASA and DOD contractors. Police intelligence systems of the type suggested here would require a higher degree of data storage and retrieval sophistication than is normally found outside of space contractors' operations. Perhaps one answer is to have a small computer in every police car. NASA's work on projects such as increased information storage on tape, microelectronic circuitry and small, lightweight computers is all directly applicable.

NASA's research programs with visible and ultraviolet light can eventually contribute to citizens-band type communications equipment required for effective police protection and firefighting. They can also contribute to the development of ultraviolet sensors which can be used for remote monitoring and alarm warning systems.

Another unique development amenable to the transfer of NASA technologies is the linking of alarm systems with telephone dialing systems so that burglar trip devices can be used to set diverters which can silently dial the police automatically and identify the residence being burglarized by means of a coded buzz in the police station. Such devices can contribute to the protection of private homes during periods when the owners are on vacations.

In the long run, however, the best approach to the problems of police and fire protection is the systems approach, and undoubtedly the Federal government will eventually have to accept the responsibility for initiating the development of complete and effective police and fire protection systems for urban America. This type of a system is complex and requires competent systems engineering and systems management, two areas in which NASA can make contributions. General Electric TEMPO's systems approach to the development and solution of problems of a municipal police system is discussed in Appendix A of this report.

Protection of the city from fire is currently a relatively straightforward, standardized procedure; however, little use has been made of technology to anticipate fires and to search for potential fire areas. Every urban community has permanent firemen and firefighting equipment such as pumpers, ladder trucks, scout cars, fire alarm boxes on the streets and fire stations. Although the systems analysis approach discussed in Appendix A concerns itself with an urban police system, the same type of analytical techniques can be applied to an urban fire department.

Individual problems of a fire department which can also be analyzed for technological solutions include: more effective alarm systems in buildings and private houses; parametric design and cost effectiveness of firefighting equipments; more effective means, methods, and materials for firefighting; improved communications systems for firefighting; and more efficient transportation means for firefighting.

Areas to which NASA can contribute technological solutions are: the identification and definition of urban area characteristics significant to firefighting techniques, evaluation of equipment and operational control procedures most effective in firefighting, and analysis of urban regions most susceptible to ignition and fire damage by examination of topography, local combustible materials, and access routes.

NASA methodologies and analytical techniques can also contribute to the study of preferred communication requirements for firefighting, operational control, and the resulting electronic equipment requirements. Such requirements should be related to the apparent fire hazards and threats in an urban community and an evaluation of effectiveness of present equipment should be made.

Civil defense trans-attack and post-attack communications systems should also be studied for such things as the identification and quantitative definition of potential damage environment to various metropolitan areas from nuclear and conventional weapons. NASA analytical techniques of systems analysis and systems engineering can contribute to this study.

SECTION 8

URBAN TECHNOLOGY AND THE FUTURE OF CITIES

URBAN RESEARCH TRENDS AND NEEDS

The ecology of cities has evolved as a special field of study within the past half century, although men began to live in cities over 5,500 years ago. The range of ecological studies concerning cities embraces both the observation of whole cities in all their elaboration and the personal needs, choices and preferences of the individual city dweller. A review of the literature generated by these studies reveals the size and complexity of the problems faced by modern cities and the critical need for a framework for a general theory of urbanism.

Several such theories have been proposed, the latest and most complete being the concepts of "ekistics" proposed by C. A. Doxiadis of Athens to describe the science of human settlements. None of these theories, however, have fitted ecological studies into a general framework which enable investigation of the most meaningful elements in the city and which show the relationship between each facet of city life and structure. The future course of urban research, development and planning is dependent upon enlarging ecological studies to include new methodologies for structuring urban processes. As Carl Stover* has stated, "Methods developed and employed in the effort to understand other complex phenomena should be useful in the effort to understand the total urban system. For example, the concepts and techniques of system analysis provide a powerful tool."

The ecological approach is to consider the city as a complex living organism whose many functions, activities and processes are interrelated in a dynamic environment. This approach is similar to the

*Carl Stover, 'Technology For Cities", Speech delivered at 49th annual conference of ICMA, October, 1963.

method of "environmental analysis" currently used in the management sciences for long-range planning studies. Environmental analysis assumes that complex problems create and are a consequence of a complex environment; to analyze and solve such problems it is necessary to understand the effects that present and prospective social, political, economic, and technological factors in the environment are likely to have upon proposed solutions to the problems. Once solutions have been postulated, the impact that they will have on future environments must be considered, involving a reiterative analytical process.

Both ecological research and environmental analysis permit the use of advanced mathematical techniques and large-scale computer facilities to draw up plans of action to cope with the dynamic and interrelated nature of city problems. Present mathematical models of urban phenomena, however, have become so simple that it is difficult to relate them to the real world. But accepting their limitations in this regard, the models have provided a new dimension to the field of urban research and have shown the way towards a theoretical exploration of many facets of urban development which in the past have received only anecdotal treatment. They have brought to bear the powerful techniques of mathematics to the analysis of urban processes and, thus, pointed the way towards a coherent theory of urbanism.

Urban research in many areas is now centering upon the possibility of a "general urban model" which could be used to describe urban processes as they exist and which might be used to direct attention towards the latent forces which are tending to result in undesirable patterns. But the problem of a general urban model presents certain conceptual difficulties. In particular, historical and cultural factors narrow the scope of such a model. It is difficult to see how cultural attitudes towards cities in different parts of the world can be incorporated in a general theoretical structure, and the problem of an adequate description of the urban process as a whole remains unsolved.

In the matter of techniques and general approach, there are two main views to the general urban model. One holds that an aggregate approach, using broad groups of data, such as the census or the overall patterns of employment or travel, is the most useful beginning to urban theory. The other takes the position that the individual decision-maker is the fundamental unit of urban activity, and that a truly coherent theory of urbanism can arise only from a detailed account of the rules governing the individual's choices and decisions concerning his urban existence. The separation of these two views raises problems of aggregation and disaggregation in translating theory into the real world, and much work must be done before an adequate connecting treatment can be found.

An operational difficulty which arises in connection with a general urban model is the actual means whereby it might be constructed. It might be possible to build an overall model using several submodels so constructed that their outputs become inputs of successively larger model units. On the other hand, it may be that the researcher will have to bring together several different kinds of urban models and attempt to fit them to each other. These problems of form, content, approach, and technique pose questions concerning the future development of model building in urban research.

OUTLOOK FOR AEROSPACE TECHNOLOGY TRANSFER

In March 1962, Lyndon Johnson referred to funds for space programs as "investments which will yield dividends to our lives, our business, our professions, many times greater than the initial costs."*
Although this enthusiasm has now begun to wane, a more balanced and realistic understanding of the process of technology transfer is becoming evident. Potential for technology transfer is achievable but not inevitable, nor is its realization automatic.

The accepted definition of transfer of technology is the acquisition, development, and utilization of technological information in a context different from that in which it originated. The result of this process is innovation, the novel application of technology to a perceived need. Innovation, whether it is realized as new systems, equipment, methods, or processes, must gain social acceptance to be successful; thus, a lack of this acceptance can become an inhibiting factor in the process of technology transfer.

Aerospace technology involved in the transfer process varies along a broad continuum marked at one end by basic scientific knowledge and at the other end by highly specific and complex inventions. The

---

*Cited in Vernon Van Dyke, "Pride and Power—The Rationale of the Space Program", University of Illinois Press, 1964.

mid-range of general technology consists of novel developments representing advances in components of a manufacturing process, new techniques and general engineering skills. When technology transfer occurs, it takes place by means of imitation or analogy. The process of imitation is called the diffusion of innovation and has been extensively studied by social scientists during the past 50 years. Transfer by analogy poses distinctly different problems, is less well understood, and occurs when someone perceives a similarity between characteristics of a discovery or invention and aspects of a need or opportunity in a situation.

Results of the research presented in this report concerning the potential for the application of aerospace technologies to the solution of city problems show that: (1) estimates of the magnitude of the potential for transfer are difficult to justify (2) the mid-range of general technology has the greatest potential for useful application followed by specific inventions and basic science. (3) both analogy and imitation will contribute to transfer of aerospace technology for resolution of the identified problems. The research results also show that more definitive broad classifications of technological contributions should be used in future research to facilitate functional emphasis of potential solutions. For example, a classification system could contain the following distinct, but not mutually exclusive, categories:

1. Stimulation of basic applied research
2. Development or improvement of methods, processes, and techniques
3. Improvement and cost reduction of existing systems and equipment
4. Development of new systems and equipment
5. Increased availability of materials, components, and equipment.

Research results of aerospace technology transfer have shown that there are other factors which inhibit or accelerate the process of applying this technology to non-space activities. These can be identified, but their effect and interaction are not well understood. One of these factors is the time lag between the development of technology for aerospace use and its transfer to other applications.

Waterman and Marts* identified over 30 broad technological areas in which transfer has taken place or can be expected to occur for commercial activities in business and industry. A total of 185 individual examples of transfer were identified in their study which provided evidence of this time lag and of the magnitude, nature and scope of aerospace contributions to the private sector.

Rosenbloom † has emphasized that, although the extent of successful transfer of aerospace technology is difficult to measure, the potential is great enough to justify continued research in the mechanisms which contribute to the utilization of new technology and the factors which influence technology transfer. This research, when combined with results of urban research, may provide the basis for an urban technology specifically concerned with determining feasible solutions to critical city problems.

IMPACT OF FUTURE URBAN TECHNOLOGY

Both science and technology have always presented a curious mixture of the predictable and the unpredictable. Therefore, by necessity, most attempts at prediction have been relegated to discussion of their future impact on society. Fifty years ago Dr. Charles Steinmetz published amazingly accurate predictions of future technology and its impact on American society. These predictions, reprinted in Figure 3, were concerned with some of the urban problems identified in the present study. The discussion which follows, although a less-ambitious attempt to prognosticate the future impact of urban technology, presents examples of technological developments that can accrue from the national space program projected to the limits of current knowledge and a time span of 15 years.

Throughout the remainder of the twentieth century, aerospace technology will keep feeding back a wealth of new developments that can be put to use in hundreds of unforeseen ways to solve the problems of urban communities. It has been stated that more scientists and engineers are at work today than the cumulative total over the

---

*R. H. Waterman, Jr. and L. G. Marts, "Space-Related Technology: Its Commercial Use", Denver Research Institute, Denver, Colorado, July 1964.

†R. S. Rosenbloom, "Technology Transfer -- Process and Policy," Special Report No. 62, National Planning Association, Washington, D. C., July 1965.

You Will Think This a Dream

Then, When You Think Again, You Will Begin to Wonder

By Charles P. Steinmetz, A.M., Ph.D.

Chief Consulting Engineer of the General Electric Company

ILLUSTRATIONS BY M. L. BLUMENTHAL

IT WILL REVOLUTIONIZE ALL OUR DOMESTIC LIFE

THE time is coming when the cost of electricity will be infinitely lower than now, and when that time comes it will revolutionize all our domestic life.

First of all, when electricity becomes universally used, it will be against the law to have a fire of any kind within the city limits. The Government will not allow fires because they are dangerous, dirty and insanitary: dangerous because of conflagrations, dirty because of handling the coal and ashes, and insanitary because of the smoke and gases in the air. No fires will mean no cellar furnaces, no kitchen ranges, no illumination by gas, no steam-power plants, no gas engines.

When we use nothing but electrical power for heating as well as for other purposes the supply will come through transmission lines from big central stations of many million horse power. These stations will be located wherever power is available, such as at waterfalls, coal mines and oil and gas wells. This will do away with the wasteful process of hauling coal from the mines to the relatively small power houses scattered all over the country.

It may be that at the coal mines, instead of taking out the coal and burning it in the way we do now, steam power will be generated in the mine itself by setting the coal in the vein on fire. No—this is not beyond the dream of possibility. It has already been seriously proposed by an eminent English scientist.

Startling will be the changes effected by such a supply of electricity. At present, when we wish to keep warm in cold weather, we use a furnace fire, steam heat, stoves, open fireplaces and other unsatisfactory and insanitary methods. At other times in the year, when the temperature is above normal, we are helpless and have to suffer.

As a matter of fact, when the weather is very cold our extremely crude method of heating does not give us a desirable and uniform temperature; and, besides, we are bothered by dirt and ashes and by gases and the nuisance of taking care of fires.

Nothing could be of more trouble than a furnace fire, because the heat energy from coal is very difficult to control. It takes much time and attention to keep the fires regulated.

be made for use in the home. We can have the best and finest productions in this way. Both the films and records will be greatly improved.

Automobiles in Cellars

FOR local transportation the majority of people are now dependent upon rapid transit systems or trolley cars. These require subways, elevated structures in the heart of the city, rails in most of our streets and almost an endless amount of noise. The automobile is very convenient. When fires are not allowed within city limits electric automobiles, bicycles and tricycles will be developed, and, on account of the low price, will be available to almost everyone.

These electric cars will be kept in our cellars or basements, where now we keep the furnace and the coal and ashes. We shall have a driveway going right under the house, and this will make a convenient place to store our cars in, from the big family or touring car to the small bicycle or tricycle. This will eliminate the need for garages. While the cars are in the basement they will have their batteries charged.

Evergreen Trees Will Grow in Our Cities

ALL these changes in our domestic life will revolutionize the appearance of our cities. In the first place, cities will become sanitary—no dirt, dust or smoke will be possible. The streets will be beautifully clean. There will be no reason for dust or dirt. Without fires, and with no animals for traction labor, there will be no dust and dirt.

The atmosphere will be perfectly clear. Today it is bad enough in the city when only anthracite coal is burned, but in places where soft coal is used the people cannot see the sky on account of the smoke and gases in the air.

With clean, pure air we shall be able to raise evergreen pine trees in the city, and it is healthful to have pine trees

Of course there will be many other hobbies that men will be following, and all kinds of articles will be produced as a result of this work. One man may enjoy making brass lamps by hand. After he has supplied his own home with lamps he may make some for his neighbors who, in return, will furnish him with vegetables from their gardens, with eggs or with some articles which have been made as a result of their hobbies.

In some respects this will return us to the days of barter and trade, and it will be a good thing, because the articles will be produced very cheaply.

Turning Our Hobbies Into Money

WE OFTEN lose sight of the fact that when a man has a hobby and produces something as the result of that hobby the labor does not cost anything. Hobby labor is the cheapest labor in the world. It is also pleasure and recreation.

You will frequently see a man who has developed a hobby for raising chickens. He takes a lot of pleasure and pride in looking after all the work himself. He finds that raising chickens on a small scale is profitable. This is true, but the profit lies in the fact that the labor is cheap; it does not cost him anything. But he doesn't figure on this, and, thinking that the business itself is profitable, he invests in a larger plant, employs his labor—for which he has to pay—and then loses his money.

The production of a great many things by people carrying out their hobbies will greatly affect our economic life.

Another effect in the cost of living will be that, as the result of clean, pure air and even temperature in our homes, materials will have a very much longer life. Curtains and carpets will not have to be cleaned so frequently. This means less wear and tear.

Furniture will last almost indefinitely because of the even temperature and no excess humidity or very dry air to warp and crack the woodwork. The cost of renewals will be very greatly reduced and we can afford to pay more for our household goods in the first place. The standard in our homes will be raised.

96

Heating and Cooling Our Houses at Will

WHEN heating is done electrically, if I want seventy degrees in my home I shall set the thermostat at seventy and the temperature will not rise above that point. This temperature will be maintained uniformly without regard to the temperature outside.

If it is very cold electric heaters will hold the temperature at seventy. If it should be ninety or one hundred degrees outside, the same electrical apparatus will cool the air inside. In this way we shall have a uniform temperature in our homes throughout the year.

Besides temperature, we have to suffer from humidity or from dryness of the air. This is especially true with the present day furnace. With electric equipment we shall be able to control this and have the humidity normal at all times. This electric equipment will have an absolutely automatic control of both temperature and humidity.

Ventilation doesn't exist in the average home today. At present we have to depend upon the windows and door ways, or we turn on an electric fan to blow the bad air out. When electricity is developed we shall have apparatus that will destroy the bad air, bring fresh air into the home, and, when the air outside is not sufficiently invigorating, automatically arrange a distribution of ozone. We shall constantly have good, fresh, pure air indoors.

When We Shall Cook on the Table

OF COURSE there will be no more coal or gas kitchen ranges. All cooking will be done by electricity. A great deal of our food will be cooked on the table, so that with the elimination of the coal stove the kitchen will be very small, compact and efficient.

Cooking by electricity will be very much more satisfactory and under perfect control. By adjusting the regulator the food will be perfectly cooked automatically.

For example, should the directions for baking a cake call for heat at a temperature of two hundred and eighty degrees for forty-five minutes, you would simply adjust your regulator to "280–45," and automatically the heat would rise to the temperature indicated and automatically turn off at the expiration of the time.

Hearing Concerts in Our Homes

THE telephone will be improved. If we want to hear a concert we shall not have to go out in the crowd and sit in an unventilated room. By means of the improved loud-speaking phones, we may listen to the concert in our homes. That will mean that unlimited numbers can listen to such concerts, even if they are living many miles away in small cities and villages.

With wireless telephones, if a great singer should be singing in an opera in some European capital, we should be able to listen to this opera in our own libraries in America. The new telephones will make it possible for millions of persons in moderate circumstances to hear the finest concerts in the world without crossing their thresholds.

With the motion picture and the talking machine perfectly synchronized, as they will be, it will not be necessary to go to the theater for our amusement. These machines will [illegible] where you live. There are no pine trees in cities now; all trees are deciduous. The reason for this is that trees and all plant life need air the same as human beings. With an evergreen tree the needles are the leaves or lungs. The dirt, gases and smoke that we now have in the air of our cities clog the breathing spaces in the needles, and in a few years the tree dies from suffocation. Evergreens have only one set of needles. The deciduous trees have a chance to live in cities because their leaves or lungs drop off each autumn and they get a fresh set each spring. That is their only salvation.

The industries in the city, of course, will be operated by electrical power, which means no dirt and smoke. The tendency will be to move all industries as near the source of supply of raw material as possible, the same as the power houses will be moved to the various sources of power.

The Cost of Living Will be Less

NATURALLY, the question arises: "How will all these changes affect the cost of living?" In the first place, today the farmers are almost entirely dependent upon manual labor. With electrical energy available and with the application of scientific methods and the production of quantities of nitrogen fertilizer from the air – the same as is now being done in Sweden and Germany – the cost of raising food supplies will be very materially decreased. This should result in a corresponding decrease in the cost to the consumer.

The use of electricity will so facilitate labor that the hours of labor will be shorter. The working day will not be more than six hours. This means that workers will have more time to carry out their hobbies. Vegetable gardens and raising chickens are the outdoor hobbies of many men. These occupations bring returns to the home, and, as the work under these conditions is pleasant, the cost of food will be reduced

ALL THESE CH[illegible]S WILL [illegible]IZE THE APPEARANCE OF OUR CITIES

Electricity Cost by Tax, Like Water

ELECTRICAL power will be used so generally that it is very likely its cost will be on the basis of a tax, like a water tax. For example, so much a page, as we are now charged so much a faucet. It will be very cheap and it will not pay to install meters and have them read and keep the accounts in the office of the electric companies, or in the Government building if the power is being generated by the municipality or the Government.

Today water is used universally and no one would think of making a charge to a friend or even a stranger for any amount of it. It will be the same with electricity. If you make a call in your electric vehicle the vehicle will be run into the friend's basement and the batteries will be charged while you are making your call. It won't make any difference whether you get your electric current from your friend's plug or from the plug in your own home—the tax will remain the same.

We Shall Have Easier but Better

WHILE making life very much more pleasant, easy and worth living, naturally the question will be raised: "Will not the human race degenerate because of the removal of so many means of resistance?" I think the contrary will be true. In the first place, human nature will always demand a change, and for recreation we shall go out into the wilderness and live like our ancestors. The same as many of us do now when we enjoy camp life; but even in camp now we have very many modern conveniences to make the life easier.

[illegible] does not reduce the physical ability and endurance of man to have him take the best possible care of himself. We have a splendid example of this today in the European war. Look at the physical power and endurance of the men who are spending and have spent so much time in the trenches. This sort of thing calls for more endurance than any of the labors put upon the soldiers in Napoleon's army; and many of these men are clerks, industrial workers, college professors and professional men who are unaccustomed to the rigors of out door life.

Another example we have is the contrast between the street urchin and the boy of well-to-do parents. When it comes to a test of endurance as in an athletic contest, the rich boy is almost always superior, because he has been well taken care of all his life.

The means for all these things are [illegible] now. No difficult scientific or engineering problems are presented. Of course, no one can predict exactly what is going to happen, because of new devices that may be invented. What I have said is based on what we have today.

(Page 12)

Figure 3. A 1915 prediction of the impact of future technology.

(Reprinted from Ladies Home Journal, September, 1915) previous 6000 years of recorded history, and that the entire body of our scientific knowledge doubles every decade. The mere effort to solve urban problems by means of technology will broaden and deepen man's understanding of the nature of individuals and groups and extend his control over the materials and forces of the physical world.

Virtually all of 1980's workers are already alive. The majority of them have already had all the formal education they will ever get, though many of them will be re-educated due to progress in automation and information systems. Though the houses built in 1980 will be very different from today's, the majority of Americans then will be living in houses that already exist. The newest 1980 schools will be designed around TV, around electronic printers, around microfilmed libraries that are automated, with instruments and methods of education still in the research stage. However, the majority of 1980 children will be learning in school buildings a generation old.

The new factory of 1980 will be computerized, automated, air-conditioned, landscaped, relocated, compressed and miniaturized, but the majority of workers will be employed in plants already built today, many of them operating machines and equipment now already in place. There is an almost absolute certainty that there will be more and more on-the-job type training, that in fact more and more education generally will occur within business and industry or be provided by other private enterprise.

The limits of America's cities will be stretched still further with the most dramatic changes in living, not the further invasion of the suburbs, but the profound differences in the central cities. The rebuilding of America's central cities will provide and set in motion enormous opportunities for business. By 1980, America will be the first nation in human history to spend a larger total on urban services, such as cultural and recreational provisions, than for the total spent for nondurables.

By 1980 the technological subtlety of synthetic polymers and transistors will be felt in a wide variety of consumer products. There will be home appliances using ultrasonics, refrigerators with no moving parts, and lighting systems without heating filaments or glowing gases. Solid-state refrigerating devices will result in the development of electronic refrigerators and special-purpose cooling units for portable use. Electroluminescence should lead to mural

TV screens of almost any desired size for both black-and-white and color.

Electronic safety devices will become a reality for automobiles by 1980. These will warn of cars approaching from behind or that a car ahead is being overtaken too fast. Automatic car guidance may also become practical by that time. The desalinization of sea water and brackish water will have become a standard practice for many cities by 1980. Thermoelectricity will become economical as a standby power source in large power plants and it will make possible obtaining power directly from a nuclear reactor. Fuel cells will be generating electric power for remote areas and will replace high-capacity storage batteries for standby power.

Suitable engineering materials will be developed to advance the use of atomic power. Irradiation as a processing method to preserve foods will have established a foothold by 1980. Foods will also be sterilized and pasteurized by gamma rays and electron irradiation.

A detailed understanding of the aging process will emerge from biological and cell research. Prediction of hurricanes, snow storms, and tornadoes will become possible from research in meteorology, cloud formations, and weather satellites. Air travel will take on a new look with 2000 mph VTOL airliners and may even lead to development of a small VTOL flying car. Rocket mail and rocket freight services will emerge as distinct possibilities.

The administration of justice will become more efficient in legal search by using computers which process data in trial courts and store and retrieve legal records. Law enforcement will be aided by the development of information processing systems for criminal records and statistics, for identification of criminals, and in retrieval and storage systems for licenses and official documents. In the urban area, information systems will be used for data management, for compiling census statistics in a central information utility, and for record keeping.

Urban hospitals will be revolutionized in administration and patient care by laboratory data systems, patient data storage systems, patient simulation and monitoring systems and many of the other advances discussed in Section 6. Computers and information systems will also find their way into education and training in many areas such as instructional tools school simulation vehicles, surveillance and detection systems for classrooms, audio-lingual training, programmed-learning methods, and automated teaching devices.

It should be pointed out, however, that many of these urban technologies may become feasible economically or materially only when introduced over a large area or in a wide range of activities. The dangers of technology will lay in man' failure to hold it to its proper place. Technology now offers a wider choice and more effective means for creating the city as it should be. Urban research and an understanding of technology transfer will help us to discover what that is and establish stands for governing man's technological pursuit of his urban future.

CONCEPTS FOR FUTURE CITIES

Concepts of the nature and shape of future cities center around the trend of cities toward the agglomeration of hitherto separate metropolitan centers into ever larger aggregations of men and buildings. Jean Gottman, in his study of the north eastern seaboard of the United States ("Megapolis, 1961") revealed this process in all its complexity. There is now a continuous urban area stretching from New Hampshire to northern Virginia and from the Atlantic shore to the Appalachian foothills. Gottman has suggested that this "megapolis" is only the beginning of a world-wide trend in urban development.

Melvin Webber has suggested that the occurrence of a large, continuous, built-up area is only the outward manifestation of a much wider and deeper social development —the evolution of the "non-place urban realm." He suggests that the great cities of the world are, in fact, simply nodes of a vast communication system, in which the distinction between urban and non-urban as physical areas disappears, and the concept of an urban realm, based on participation in a continuous communication and information system, takes its place. Thus he suggests that most of the advanced countries will in fact soon be almost complete urban realms, although not completely physically urbanized

Other and more radical concepts for future cities arise from the existing urban situation but are not a part of it. It has been suggested, for example, that mobility should be considered on a much wider scale, and that the new central areas of cities in the future be at airports. Already many airports are used for the transaction of business. Businessmen often do not step outside an airport during their stay in the city.

In Britain, H. Rou has suggested that cities should be strung out in long lines according to needs of water supply and disposal. Doxiadis envisages the ultimate evolution of cities as "ecumenopolis"—a continuous world city stretching from country to country along main communication routes.

Buckminster Fuller proposed a concept which involves placing a huge dome over existing cities to protect the inhabitants from hazards of the external physical environment. This concept has been extended to include the building of whole "new cities" under a dome, providing the advantages of modern urban technology (see Appendix D).

These visions and concepts of future cities play their part in forming our views of the urban process, . . deeper knowledge, gained by urban ecological research, of the processes of life and development in our cities today must provide a more immediate and satisfactory base for action.

APPENDIX A

APPLYING SYSTEMS ANALYSIS TO THE MUNICIPAL POLICE SYSTEM

A Concept Paper
by
T.F. Van Natta

27 July 1965

TEMPO
GENERAL ELECTRIC COMPANY
SANTA BARBARA, CALIFORNIA

APPLYING SYSTEMS ANALYSIS TO THE MUNICIPAL POLICE SYSTEM

By T.F. Van Natta

INTRODUCTION

An effective, controlled police system, operating within a democratically determined framework of laws, is perhaps the most important bulwark of a free society. An ineffective police system promotes crime which can only be countered by extra-legal defenses; an arbitrary or capricious system generates distrust and opposition; a harsh system generates revolution.

The framework of laws obviously is not the responsibility of the police, but of society. Similarly, the general nature and effectiveness of a police force are not a function and responsibility of the police alone, but are equally a function and responsibility of society. This sharing of responsibility demands coordination and understanding between the two systems, and particularly demands that the minor system adjust to the trends of growth and development of the major, encompassing system. No social system is static, but tends to grow and develop in many ways and directions, not all of which are beneficial. This can pose a serious problem to an efficient police system, for as a part of the larger system, the police system shares the total responsibility of molding and guiding the whole social system.

The present trends of sociological and technological development in the United States have brought new patterns of living, working, and movement with accompanying new patterns in vice and crime.

The above changes are forcing changes on the police systems. Modern psychology demands a "better" police officer. Rising pay scales, especially for better-quality policemen, seriously limit quantity. As in other areas of our society, costs must be kept low and efficiency high with more extensive use of our burgeoning technology.

The heaviest impact of these changes falls on the metropolitan police systems. The Federal government, through the Departments of Justice, (FBI, Immigration), Treasury (Secret Service, Customs, Coast Guard), and HEW (Public Health) has appropriated many nationwide, fairly clear-cut areas of the total police system. The states have similarly assumed the highway police function. This has left the municipalities and the counties responsible for "everything else," from lost children and strayed pets to the mass problems of riot and organized crime, and serious individual violence. It is here, too, in the metropolitan areas, that the greatest weight of responsibility for the delicate problems of prevention, rehabilitation, and juvenile handling falls.

The rural county and smaller municipal systems have not seen their police problems grow a great deal, but crime increases greatly with population, and our larger cities are becoming still larger and more populous. The metropolitan police system thus faces the most difficult challenge.

This difficult problem has not received the attention it merits. There has been greatly increased concern over the rise in crime; there have been frequent attacks on police deficiencies (with little praise for police effectiveness), and much of parts and facets of police systems and police work. There has never been, however, a serious, thorough analysis of the total municipal police system.

General Electric, TEMPO has discussed a police systems analysis with the Police Department of the City of Oakland, California, and both organizations feel that such an effort is badly needed, especially at a time when the President of the United States is generating a strong national effort to check and reverse the rising crime rate.

SYSTEMS ANALYSIS

The purpose of systems analysis is to insure consideration of all matters that pertain to or influence a particular problem. Any machine, group of people, operation, discipline, ideology or trend, or combination of these, can be treated as a system. Full understanding of a system depends not only on thorough analysis of its components, the internal factors, and intrinsic influences, but also on all external matters that may affect the system under consideration. These extrinsic influences, sometimes called the environment, are themselves systems and parts of larger systems. Frequently a desired change in the object system cannot be made by internal adjustment without an appropriate change in one or more of the external systems.

It is usual to divide a systems analysis, for convenience, into three main areas of consideration. One, and usually the first to be considered, is the mission of the object system: its boundaries of responsibility, its purpose, the ends it is designed to accomplish. Another, loosely called the environment, is the sum of external influences that affect the operation of the object system. Here discrimination must be exercised, for such a sum can easily become too great to handle. The third area is the object system itself and its subcategory systems, their interrelationship and cross influences, adequacies and inadequacies, and particularly the why and how of changes to correct the latter. The relationships and interfaces between the three areas must also be determined, and the full scope of corrective change methodology extended to this larger area. Again, discrimination must be exercised to keep the analysis within meaningful limits.

One very important analytical consideration is that very few problems can be resolved into a neat, two-dimensional system pattern. Technology is of such importance in our modern world that it merits nearly equal consideration with a functional analysis. Since the two rarely coincide, a three-dimensional pattern of functional influences, technological influences, and their integration is a better aid to understanding.

The objective of systems analysis is to find a means to improve, in some respect, the system under consideration. The analytical dissection is performed not as an end in itself, but as an effort to understand cause and effect and, from this, understanding to produce desired effects in the system.

THE METROPOLITAN POLICE SYSTEM

In accordance with the foregoing, the first step in the analysis of the Metropolitan Police System would be the development of a definition and statement of mission. This should be broad enough to cover the wide differences which may exist between the laws of the various states and the charters of the metropolitan areas.

Webster defines police as: "The department of government concerned primarily with the maintenance of public order, safety and health, enforcement of laws, and the prevention, detection and prosecution of public nuisances and crimes."

While this definition can be generally applied as a statement of mission, several exceptions must be noted. Health is generally no longer a police responsibility, having been delegated, almost everywhere, to separate government organizations. Prosecution, too, is not a specific police function, although in preparing evidence to support a charge a police officer must be well conversant with the problems and techniques of prosecution. On the other hand, other functions have been added, the foremost of which is public relations: a two-way communication which keeps the citizen informed of his police department and the police sensitive to local trends. Another is civil defense, which in many localities has become a stated police responsibility. There is also a much stronger emphasis on prevention, coupled with a better understanding of its full implications.

There are also areas of uncertainties. One of these is the matter of recommending changes in laws. Certainly, in a democracy, every citizen has not only a right but a duty to take an active interest in government. Also in our Federal government the principle has been firmly established that Congress should seek the advice of all appropriate technical experts, including government employees, on legislative and budgetary matters. Nevertheless, opinion appears to be divided over whether the police should be consulted on any legislative matters.

The approach to developing the environment is outlined in Chart 1 appended to this paper. Here the extrinsic influences have been divided into two 2-dimensional areas. One is labeled structural and includes the specific human organizations that affect, to a significant degree, the form and functioning of the police system. The other is labeled cultural and includes the significant sociological, economic, legal, [illegible], and technical influencing factors. Further study and consultation will undoubtedly bring changes. One significant deficiency already noted is the absence of any central depository to collect and store [illegible] in police practices, from management down to basic technology.

The approach to analysis of the internal factors is outlined in Chart 2. Here the two-dimensional areas are labeled functional and technical. The same comment applies to this chart as to Chart 1.

As the system components are developed, [illegible] integration will begin. Such tests will serve two purposes: they will indicate needed changes in the components and will lead to a more effective final integration.

COST EFFECTIVENESS

A serious limitation of [illegible] large police systems is a complete lack of any accepted objective standards for measuring the effectiveness of any major area of the system, much less its totality. Some metropolitan police systems are based on [illegible] more limited view of police responsibilities. Are such systems as effective as those based on modern views? Particularly, is a similarity in apparent costs a true measure?

One definite objective of this study should be to examine the whole cost-effectiveness question carefully. Quality elements must be identified and carefully defined, and their interdependency established. Similarly, costs must be examined and related realistically to the established quality factors.

These costs should be divided into two areas labeled internal and external. The internal label will cover those funds provided to the police department from governmental budgets and from any fees charged for special services or activities. This area of costs should not be too difficult to identify though the allocation of subcosts to subsystems may require some ingenuity.

The external label will cover an attempt to determine the effect on community costs (other than taxes and fees to meet internal costs) from good or bad police system effectiveness. This will undoubtedly be quite difficult, and may require extensive research and observation, however it is essential to an understanding of the true effectiveness of a police system. This cost analysis is especially important, as too often the determining factor in decisions about police systems is the cost. Unfortunately, this "cost" is usually only the apparent, out-of-pocket cost, rarely are all internal and external costs analyzed.

STUDY METHODOLOGY AND OBJECTIVES

A study of the type discussed should be conducted in close and continuous coordination with the interested metropolitan police department. In general, the study contractor should be responsible for systems analysis theories and techniques, formats and displays, management and command/control theory, and general modern technology.

The police department contracting for the study should provide factual materials, police concepts and theories, police technology, and police requirements. Work loads of the two participants should be approximately equal. Within the constraints of available time and funding, maximum consultation should be developed with appropriate educational institutions and with other effective metropolitan police departments.

The most important objective of the study should be to produce a tool to measure the effectiveness of a modern metropolitan police force in meeting today's problems. At present no such tool exists. There is not even any general agreement on what a metropolitan police force should do, let alone a scale for how well it does. Of equal importance is the determination of a related method of costing.

Specifically, the study should provide:

- an examination of the full area of responsibility of a metropolitan police force
- a statement of standards of performance covering all areas of police operations and administration
- an evaluation of direct and indirect cost elements of the police effort related to operations (or their lack) and administration
- an integration of the foregoing into a measuring device for determining net police effectiveness.

ESTIMATE OF DEVELOPMENT EFFORT

It is estimated that the type of systems analysis study discussed in the preceding sections of this paper would involve five man-months of effort by a planning and advanced studies organization such as TEMPO. The study program should be organized and staffed to make maximum use of the knowledge and talents of the municipal police experts working in conjunction with the team of systems analysts under contract to perform the study.

EXAMPLE OF A PROPOSED POLICE SYSTEM STUDY

One example of an opportunity to apply NASA technologies to the solution of a municipal police system problem has been developed in discussions between General Electric, TEMPO and the Police Department of Oakland, California. This particular police system problem is concerned with the police patrol car: what it should do and how this can best be accomplished. It is proposed that this problem be studied on the basis of mission requirements using the methodologies of system analysis, mission analysis, parametric analysis, and cost effectiveness.

The complete police patrol car system as presently envisaged involves several problem areas where NASA aerospace research and development programs may have produced or indicated viable solutions. These include:

- a means for keeping police dispatch or controller offices constantly aware of the location of each patrol car
- a means by which a policeman can leave the patrol car and still maintain communication with the control office
- a means by which the police officer on patrol can obtain quick, positive identification of individuals (photography or fingerprint)
- a silent protective alarm system which can be interrogated from the patrol car
- an internal arrangement of the patrol car which permits quick and easy operation of supporting communications, recording, safety and security equipment without driver distraction, and which also permits unhindered exit and entry.

APPENDIX A

STRUCTURAL SYSTEMS

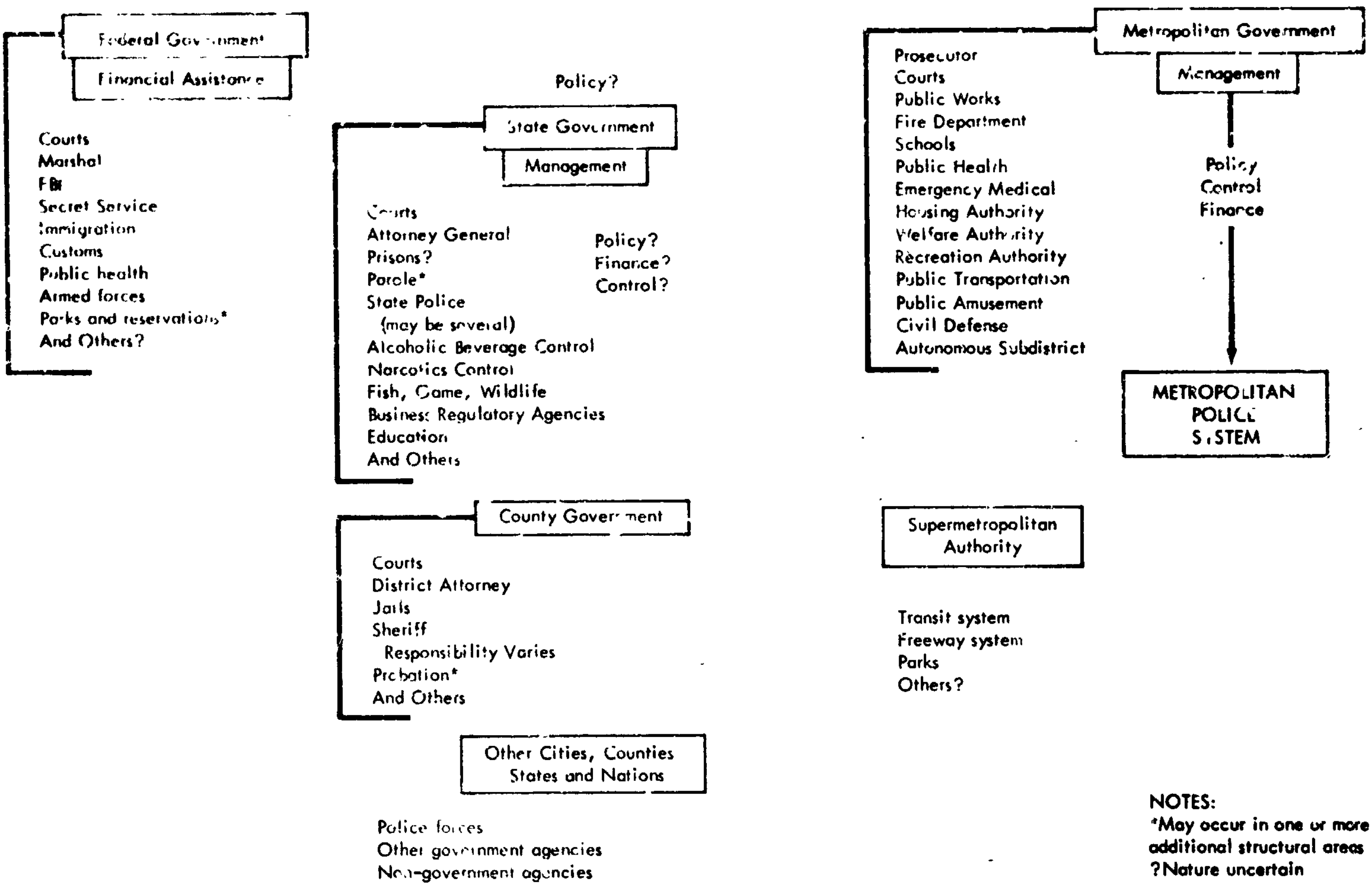


Chart 1. Metropolitan police system (external

CULTURAL SYSTEMS

Social

Patterns and Trends of Population
- Growth
- Composition
- Living
- Work
- Movement
- Education
- Recreation
- Segregation (Voluntary/Involuntary)

Non-government Power Structure
- Factions
- Patronage
- Influence
  - Individuals
  - Groups

Economic

Resources
- Municipal Income
- Fees for Police Services
  - Businesses
  - Individuals

Costs
- Wages and Fringes
- Material
- Services
- Education and training

Competition for Resources

Psychological

Present and Projected Attitudes to
- Law
- Authority (general)
- Police (specific)
- Juvenile
- Minorities

Amenability to Change

Legal and Judicial

Trends of
- Court decisions
- Definition of Crimes
- Aids and Restrictions to Police Operations
- Rights of Individual
- Limits of Police authority

Science and Technology

New Machine Aids
New Techniques

Adaptions of Machines
Communication Devices
Transportation Devices
Identification Methods and Devices
- People, Things

Information
- Data Storage, Retrieval, Analysis, Display

related systems).

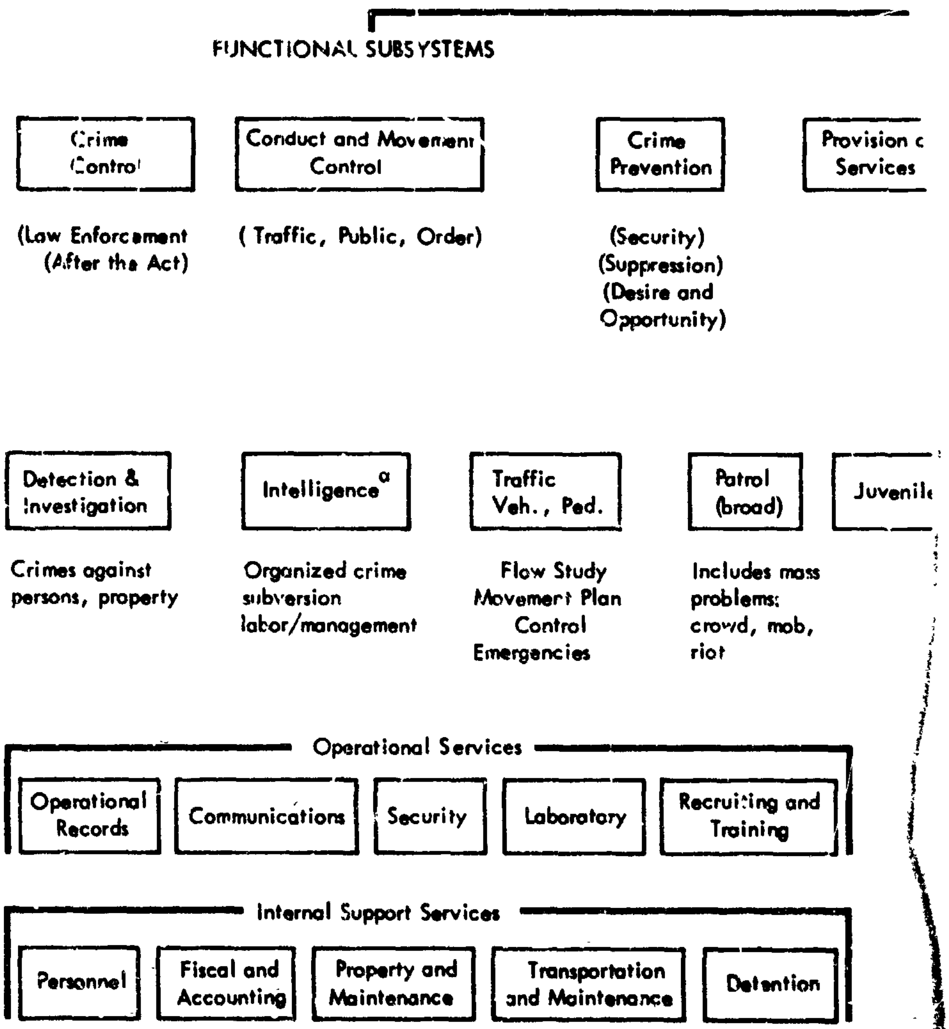
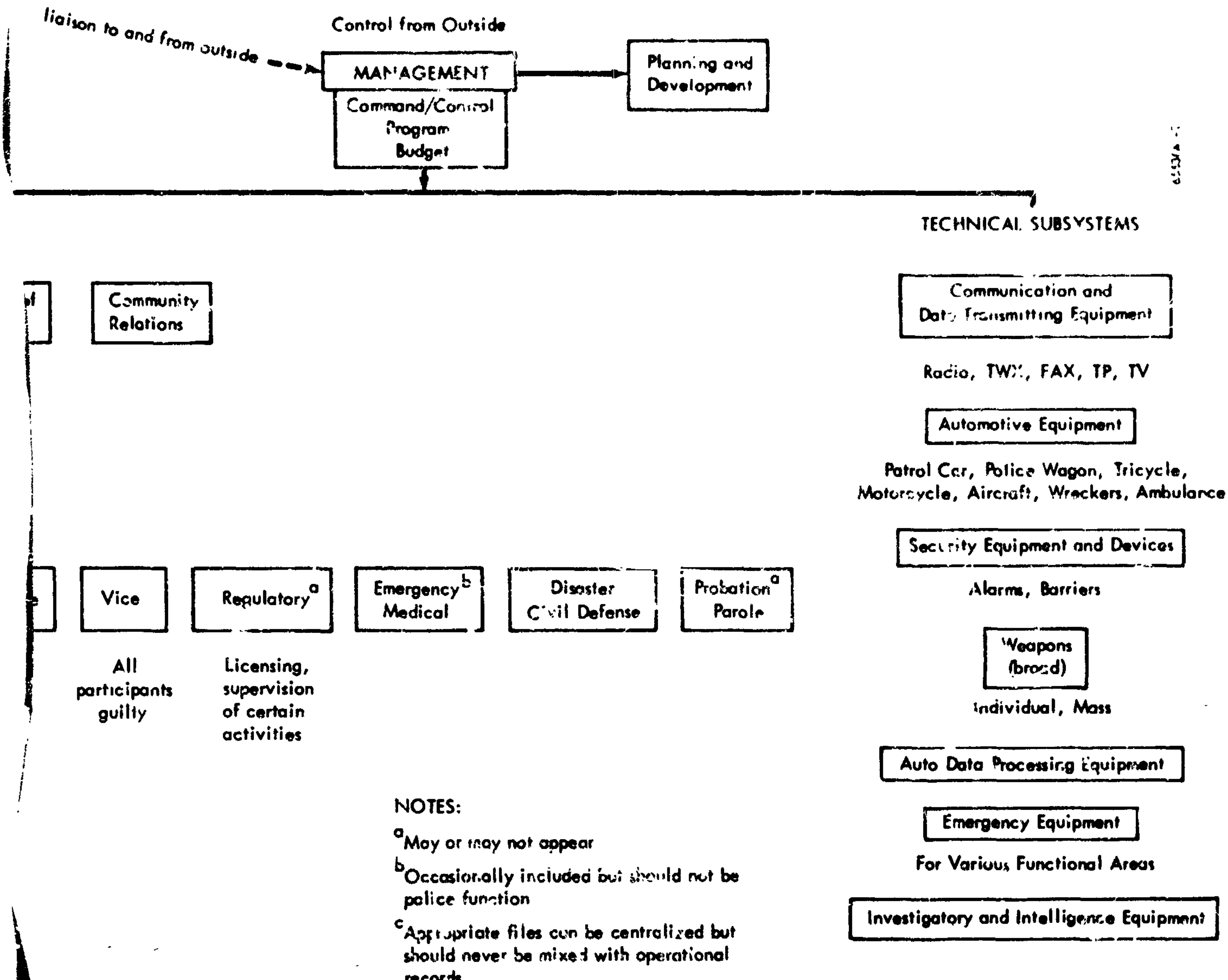

FUNCTIONAL SUBSYSTEMS
Crime Control
Conduct and Movement Control
Crime Prevention
Provision c Services
(Law Enforcement (After the Act)
(Traffic, Public, Order)
(Security) (Suppression) (Desire and Opportunity)
Detection & Investigation
Intelligence[a]
Traffic Veh., Ped.
Patrol (broad)
Juvenile
Crimes against persons, property
Organized crime subversion labor/management
Flow Study Movement Plan Control Emergencies
Includes mass problems: crowd, mob, riot
Operational Services
Operational Records
Communications
Security
Laboratory
Recruiting and Training
Internal Support Services
Personnel
Fiscal and Accounting
Property and Maintenance
Transportation and Maintenance
Detention

Chart 2.

APPENDIX A



Metropolitan police system (internal subsystems).

APPENDIX B

APPLYING SYSTEMS ANALYSIS TO WASTE MANAGEMENT

A Concept Paper
by
T.F. Van Notta

16 January 1965

TEMPO
General Electric Company
Santa Barbara, California

APPLYING SYSTEMS ANALYSIS TO WASTE MANAGEMENT

By T.F Van Natta

ABSTRACT

Increasing attention is being given to ways and means of applying modern technology to meet human needs on the national, state, and local community levels. One such need is the disposal of human, industrial, and agricultural wastes. This paper presents an integrated approach by General Electric, TEMPO which applies the methodologies and analytical techniques developed by the aerospace and defense industry to a study which will: (1) analyze the problem of waste management as a multidiscipline system; (2) apply systems analysis techniques to structure a recommended waste management system to best serve current and projected needs of the nation; and (3) outline a research and development plan to support the needs of the recommended waste management system. TEMPO's overall approach to the study is structured along disciplinary lines of technological, economic, legal, political, and social considerations. Requirements for an optimal waste management system are also presented.

INTRODUCTION

The problems of waste disposal and air, water, and land pollution in the United States are emerging as a serious challenge to present-day technology and to social, economic, and political systems. It has long been recognized that whenever and wherever civilized man gathered into large, close groups waste disposal and pollution become problems of serious concern. Various methods of waste disposal have been developed, but nearly all are mere variants of reducing the waste by diluting or converting it and then redistributing it in the air, in bodies of water, or over the surface of the earth, thus creating the additional problem of pollution. It is only in comparatively recent years that the inadequacy of such methods has been realized. The rivers located in the more populous areas have long been unable to dilute the quantities of human waste poured into them and have almost degenerated into sewers. The rate of population growth is also making it prohibitive to use rivers to dilute [illegible] sanitary sewage.

Wastes generated by an industrial society have greatly magnified the problem. Industrial wastes that have been disposed of into rivers vary all the way from practically clear rinses, to corrosives, caustics, flammables, and even explosives. Fortunately, the advancing technology of industry, which creates even more offensive. noxious and toxic wastes, also helps to inhibit the formation of dangerous or objectionable wastes, or to convert products to an acceptable form.

Fluid wastes, however, are not the sole problem. Solid wastes are being produced to such a degree in many states that disposal is becoming more difficult. Increasing population, industrial growth, and a rapidly expanding technology are also contributing to critical problems of gaseous wastes and pollution of land, water, and the atmosphere. Even the immense oceans are beginning to react to the wastes that are increasingly poured into them.

Until recently, the disposal of waste was treated as a set of separate problems. Sewage waste was one, trash and garbage a second, and atmospheric wastes a third. But as these problems grew in size and complexity it became apparent that solid waste disposal is closely linked to that of fluid waste, and both, to a degree, can affect atmospheric wastes. TEMPO's integrated approach to waste management consists of combining the problems of fluid and solid wastes with those of air, land, and water pollution.

It is becoming increasingly evident that complex problems cannot be solved by engendering only a technological solution. It is, of course, essential to use the technological capability at hand, but it is important to recognize that technology can provide only part of the solution to a problem requiring a multidisciplinary approach to its understanding, analysis, and optimum solution. What may appear to be a single, independent problem is nearly always related directly or indirectly to many other seemingly irrelevant ones. Frequently these interrelationships are not discovered until a technological solution to the original problem is put in operation and starts to cause new problems in other areas.

Even though the management and control of waste may never develop into a single organizational system, a study of the problems of waste management is best conducted on a systemic basis. This permits the causes, characteristics and feasible methods of disposal of wastes to be structured into a system, and to permit analysis of the many interfaces within the system and between the system and its physical, sociological, economic, and psychological environments. The technique of systems analysis permits subsequent use of this information to develop models of the elements of the overall system and to determine the alternatives required for effective management and control.

This paper presents a General Electric, TEMPO approach to the problems involved in the analysis, development, and structuring of a broad waste management system. Many of the methods and analytical techniques required for conducting such a study have been used by TEMPO in its programs for military and industrial clients. Within its wide spectrum of experience, TEMPO has developed a demonstrated capability to study the problems associated with waste management, recognizing that their solution is a serious need today and an imperative need of tomorrow.

OVERALL APPROACH TO THE PROBLEM

The overall approach to the problem of waste management as developed by General Electric, TEMPO is based upon interdisciplinary analyses of technological, economic, psychological, social, legal, and political considerations. These considerations are divided into investigative sub-areas until they can be logically examined as entities. This division prevents the analyses from becoming entangled in a net of interfaces before the sub-components have been adequately considered.

As the basic division and analysis is completed, the components are restructured along functional lines in order to produce a systems management model. It is during this restructuring that the many interfaces—internal and external—are identified and sorted. Alternatives are then grouped into related technical areas and, where applicable and possible, costs for each alternative are indicated. Figure 1 illustrates a portion of the analysis used in the overall approach to the waste management problem. The analysis base for the waste management system, as shown in Figure 1, is categorized into Classes, Transportation (before conversion), Conversion, Transportation (after conversion), and Disposal.

The first expansion of the analysis involves a breakdown of the management system base into logical and distinct sub-categories such as "types" and "costs" for the category of Transportation. It is in the second expansion that the analysis becomes rigorous enough to permit the identification of the major interfaces where the technological, economic, psychological, social, legal, and political

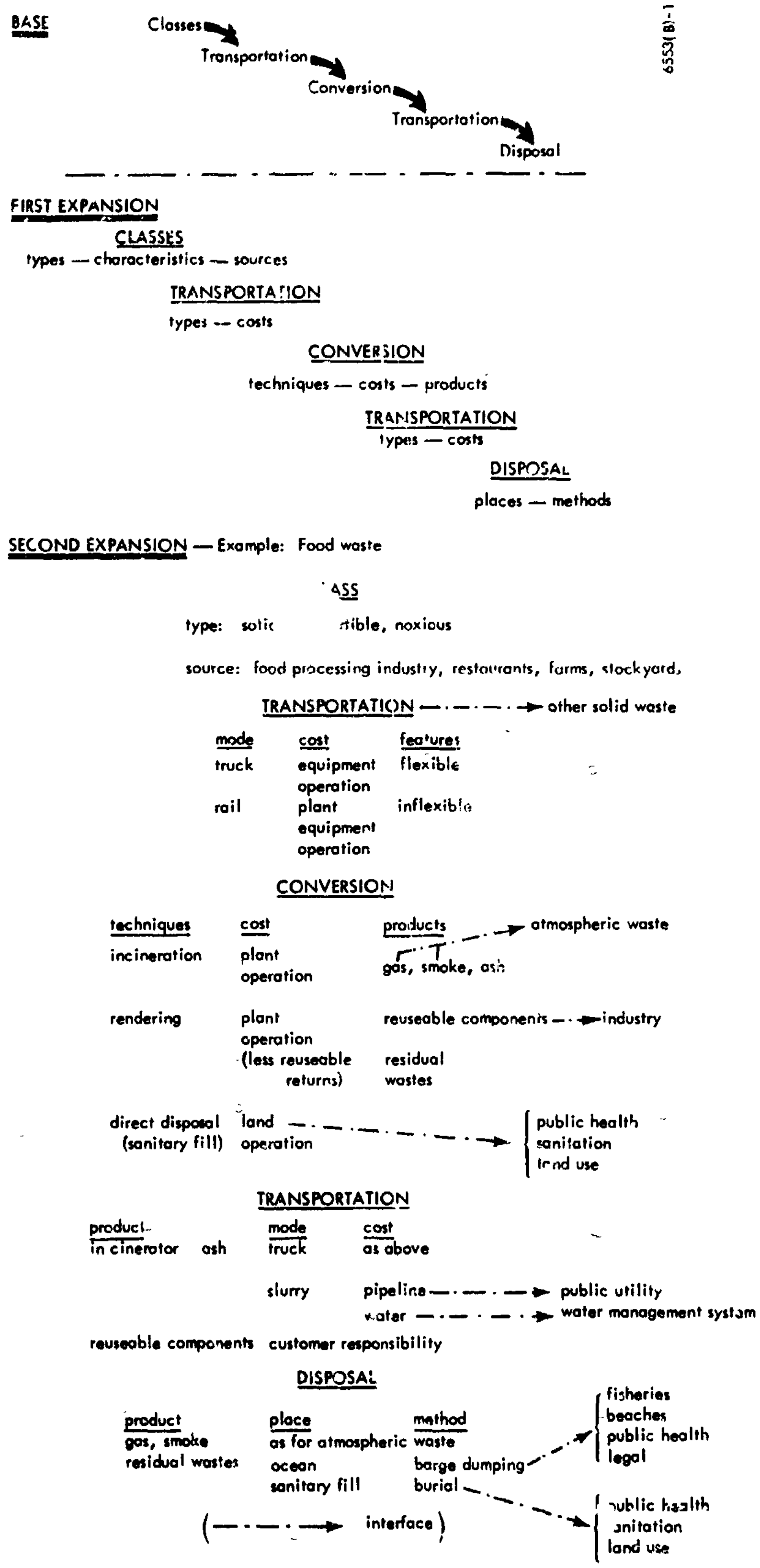


Figure 1. Analysis of the waste management problem.

considerations come to the fore as major factors in optimizing and synthesizing a set of alternatives. Thus, the second expansion will apply the analytical base to each type of waste, classified as solid, liquid, or atmospheric, and expand the analysis into investigations of the environmental factors contained in the interfaces. Figure 1 illustrates such an expansion for the example of food waste.

System engineering, being concerned essentially with the devising of operational processes that meet human needs, is used throughout the analytical expansions to bring order to the problem definition and to devise operations to match the functions that add up to a solution. The functions can be fulfilled technologically in many ways, but criteria will be set on the importance of each function so intelligent trade-offs can be made. The synthesizing process will lead to alternative methods of implementation and to trial solutions in attempts to make the waste management system output meet the overall requirement of the problem. At this point a wide variety of analytical techniques will be used to examine the alternative solutions in the context of the human environment in which the system must operate and an attempt will be made to predict the consequences of its operations.

TECHNOLOGICAL CONSIDERATIONS

Classification

The first of these environmental areas, the technological, is analyzed on a flow basis. It starts with a consideration of classes of waste and progresses through the phases of transportation, conversion, further transportation, and ultimate disposal. Figure 1 shows the complete process flow. Obviously, all steps will not apply to all wastes.

The first classification of waste is as Solids, Liquids, and Atmospheric. Solids in turn are classified as convertible or unconvertible, and further classified as toxic, noxious or objectionable. By definition, an objectionable, innocuous waste is one that requires no conversion or disposal of any kind. An innocuous waste is considered objectionable if it offends any of the human senses or obstructs any normal human activity. Liquid wastes are similarly divided into suspensions or solutions, and likewise are classified as toxic, noxious, or objectionable. Atmospheric wastes are divided into gases and smokes, with the same three area classifications.

These are the planned initial divisions. Further analytical divisions are then made if any of the foregoing sub-classes prove to be too complex. The final element of classification is an identification of sources for each listed sub-class of waste.

A principal purpose of the foregoing subdivision is to produce manageable packages for further technical consideration. There is no need for subdivision below the minimum subdivisions of the transportation and the conversion areas. For example, there is little purpose in sub-classifying the combustible material going into an incinerator, unless a noticeable difference in products of combustion (gas, smoke, ash) will occur.

Transportation

From consideration of the classes of waste, the study will advance to the problems of transportation, to which, in this initial first stage, will be added the problem of collection. All movement of waste from source to conversion, or directly to disposal, is included in this phase.

It is at this point that costs and alternatives begin to appear. The various means and methods of transportation are well enough known that cost determination should not be difficult.

Conversion

Conversion, the next step in the process, is undoubtedly the greatest and most complex problem. It includes all means and methods by which an objectionable, noxious or toxic waste can be changed into unobjectionable form or elements. A few of the wastes will not require conversion or are too difficult to convert. The need to convert certain mildly noxious and innocuous wastes will be much less where there is a readily available disposal area such as the ocean.

Conversion is where technology makes its greatest contribution, where the greatest research and development is needed, where the greatest advances must be made, and where benefits may be developed. It is also the area where the greatest number of interfaces exist, since some of the products of initial conversion can be objectionable or worse, and will require further conversion. Two simple examples are the gases and smokes from burning solids and the debris accumulated by liquid filters.

Future Conversion Techniques

The foregoing discussion has been aimed principally at what may be called "post-use conversion," where the generation of waste is accepted, and the problem of management begins only after this generation.

In the atmospheric waste field we have also considered the technique of "in-use conversion," whereby improved utilization of inputs avoids the production of objectionable wastes. This technique should be extended beyond the atmospheric waste field as much as possible.

A third area of technology, or what may be called "pre-use conversion," should also be studied. Success in this area would enable us to manufacture our expected eventual wastes so that they would be more adaptable to our conversion and disposal capabilities. An example of this is the development of naturally decomposable detergents; another is the study of better elimination of sulphur from petroleum products in order to anticipate and prevent the formation of sulphur dioxide in exhausts. Such techniques should be extended to our more common and more harmful wastes.

Another facet that must be considered in all industrial planning is technological obsolescence. Formerly, waste conversion plant limits were based partly on the limits of input (population and industrial growth) forecasting, but mostly on expected wearout rates; technological improvement was not fast enough to cause serious obsolescence prior to wearout.

At the present time, our great acceleration in technology has also accelerated obsolescence so that even our most stable technical and mechanical systems are finding that wearout is no longer an acceptable depreciation criterion. In a waste management system there will not only be this problem of direct technical obsolescence, but our increased understanding will so redirect the objectives of our system that new types of technological processes will be required. A system that is not structured to meet these technological changes can be expected to fail almost as quickly as one that is under-designed or under-financed.

Transportation of Converted Waste

The stage of transportation that follows conversion of wastes presents different and fewer problems than the first stage. The conversion products that must be transported to disposal locations are generally homogeneous and originate in much fewer and more accessible locations. These two factors permit a more accurately directed technology of collection and transportation- impossible in the handling of such mixtures as general urban waste. Further, careful planning can relate converter and transporter to disposal points. This last is important, for while the complexities are reduced, volumes may be so concentrated as to cause problems. An example is the sludge from sewage conversion plants. This can soon become a volume problem for though it is a useful soil conditioner and fertilizer, it cannot compete economically with the much stronger chemical fertilizers in commercial farming.

Disposal

The final disposal problem is a close second to conversion in complexity, scope, and unsolved critical elements. The word "elimination" is often used in connection with wastes, but it is inaccurate without the preposition "from," which requires a corresponding "to" to complete the action. Wastes eliminated from one particular element inevitably remain in one form or another. All that conversion of waste can do is change the waste into a form that reduces the problem of disposal; it can never eliminate it completely.

In general, converted wastes must be in such form that they can be released into the atmosphere, emptied into rivers or the ocean, spread on the surface of the earth, buried, or reused, without threat or harm to man and his works, and at acceptable costs. Ideally, conversion would transform all wastes into innocuous, unobjectionable, and useful products. Failing this, there will be a useless and possibly objectionable (or worse) residue to become a disposal problem.

Disposal alternatives of solids include reuse, spreading on the surface of the earth (scrap cars), burying in the earth (most household waste), and depositing in the ocean. Depositing in lakes and rivers is not included as this form of disposal of solids, though practiced in the past, is now (or soon will be) completely unacceptable.

All of these alternatives, except reuse, are unsatisfactory to a degree. Any use of land for waste disposal that will inhibit productive use of the land will soon become costly, as the populous eastern part of the United States is beginning to discover. The ocean can absorb a tremendous amount of waste providing it sinks; floating waste is highly uncertain. The current trend is to burial as the least objectionable solution.

Disposal alternatives for liquids include reuse, and emptying into rivers or the ocean. All three of these methods are acceptable assuming that the preceding conversion has been adequate. As has been shown, technology is well advanced in this area, and effective conversion can soon be practiced. There will remain a probable psychological barrier to full, direct reuse of reclaimed water; however, there are many practical, acceptable, and potentially valuable alternatives of reuse. This will grow as our demands for water increase.

With airborne wastes the disposal problem is negligible, as conversion products (again, assuming effective conversion) are limited to (hopefully) harmless gases and very small quantities of solids.

Conversion and Disposal Problems

There is still another disposal problem which concerns unconverted wastes. Where disposal means are available at low cost and conversion costs of particular wastes are high, any conversion becomes unacceptable. At present this concerns principally household and small-business solid waste. Burning, the only conversion means extensively practiced, is costly and frequently obnoxious. Other means of conversion with reuse in view have not yet proved practical. Direct disposal, unconverted, by burial in a sanitary fill is still the preferred practice. The defunct automobile is another example. Occasionally reuse as steel scrap is possible but too often it is uneconomical. In crowded areas the practice of piling them in a field is becoming unacceptable, yet there is no other means of disposal for this accumulating waste.

Radioactive wastes are currently unconverted—their disposal must be accomplished without poisoning the earth, the waters, or the air. The current practice of encasing these wastes in enough shielding material to hold them to expected decay, and depositing this shielded mass in an inaccessible spot (usually the ocean), is practical only with the present limited quantities of such wastes. Study to develop better solutions is becoming an urgent necessity.

The ocean appears to be a bottomless receptacle for all of man's refuse, but recent studies have identified increasing kinds and quantities of human waste in seawater. This effect is more pronounced near shore than in mid-ocean, and more pronounced in heavily-populated estuaries than along unpopulated exposed coasts. But pollution of the ocean is not a problem of the future, it is a current problem of serious proportions. The discharge of raw or incompletely treated sewage into the sea from communities and ships is creating a wholesale health hazard in several places along the California coast, particularly San Diego, Santa Monica, and San Francisco.

Although low-level radioactive wastes for many years have been deposited in shallow water, and more dangerous wastes in deep water, there is no certainty that these disposal areas are really safe. Oceanographers have not yet established the rate of overturn of ocean water from the deepest basins to the surface; twenty years ago it was thought to be on the order of thousands of years, but more recent investigations have found that the cycle may be on the order of a century or less.

Assuming that the radioactive waste containers will last their designed life, so that the waste, when finally released into the sea, is at a safe level of radioactivity, there is no assurance that the isotopes will not be concentrated in being taken up by the food chain. Marine biologists are only beginning to discover the various detailed food chain links in the sea, and to understand the ecological factors involved. As pollution of all kinds, including pesticides, detergents, industrial poisons, and radioactive wastes are discharged into the sea, we must foresee the effects on beaches, harbors, and marine foods in terms of health hazards and esthetics.

ECONOMIC CONSIDERATIONS

Economics provide a method of approach to synthesizing a diverse, seemingly irreducible, collection of technical, political, and social considerations. The output of an economic analysis is the definition of a course of action that will result in the maximum net social benefit.

Definition of an optimum waste management system can be obtained accordingly with considerable precision by means of economic analysis. Technical considerations are summarized by a production function, i.e., a statement of the ordered set of possible physical input-output relationships that will hold under different technological conditions. Political and fiscal considerations, such as the existence of numerous decision-making areas and levels, or legal limitations upon districts' maximum bonded indebtedness, can be introduced as constraints upon the derivation of the feasible solution set. Social factors, such as population growth in the next twenty-five years, and population location and density, can be introduced into an economic analysis as exogenous variables.

Some General Considerations

It is desirable to be quite clear how an economic analysis of possible waste management systems would proceed. For example, the term "system" should be given at least some conceptual definition. Further, there are certain specific types of traditional considerations within economics which are directly applicable to structuring a representation of such a waste management system. These pertinent economic considerations provide the means to analytically portray the relationships between the waste management system and such variables as water resource utilization, business location and expansion, regional economic growth, recreation facilities, and the population's employment of leisure time.

What is unique to an economic logic of waste management follows from three of its characteristics: Waste is a by-product produced in relatively fixed proportions as the result of private (household or firm) consumption.* Secondly, waste has a negative value in that it is a product which the producer (household or firm) pays a consumer (city, county, or special district sanitation entity) to accept. Third, and most important for the current study, the method of waste disposal (consumption by a government body) may significantly influence the value of other economic variables. This can arise either by the waste being converted into a useful product or when the method of waste disposal reduces the quality of other products which people wish to consume.

Some General Implications

The above discussion is intended to accomplish certain objectives. First, it suggests that an economical and optimum waste management system does not mean, nor require, the complete elimination of unwanted pollution of water, air, and land. While this may be a feasible objective, it also may be an uneconomic one. Thus, the social benefits of swimming in certain lakes or rivers may be outweighed by the cost of disposing of the pollutants by other means. It is an economic question of individuals' preferences. Thus the current study can only provide estimates of the likely costs of achieving certain air or water pollutant levels using different technical approaches and organizational structures.

*Air pollution does not fit this description very precisely. The producer may be required to produce another product with the gaseous material, as in industrial use of electrostatic precipitates. Alternatively, the producer may be required to modify his product, as in the impending use of automobile smog-control devices.

Second, the above discussion points out the important consideration of defining a political decision-making unit of such size and scope that its waste disposal cost is equal to the social disposal cost. Additionally, consideration of the possible economies of scale in waste disposal suggest that particular reclamation of economically useful products from the waste may imply structuring the political units so as to realize these economies.

Third, the above brief discussion carries another implication: the derivation of an optional waste management system can be done by a qualitative analytical method. The pertinent variables have been identified and their functional relationships at least loosely described. An economic analysis can then proceed by constructing a suitable mathematical representation of the inputs and outputs of alternative waste management systems. Insertion of prices, which of course would represent, as costs, the value of alternative opportunities and as a return, the preference of the public for a particular combination of outputs, would then give the optimum waste management system.

SOCIAL AND PSYCHOLOGICAL CONSIDERATIONS

There is always a degree of mental or physical revulsion attached to the idea of wastes. Before any new concepts or systems of waste conversion and disposal are inaugurated both public and private reactions must be anticipated and, where possible, forestalled or diverted. Objections may range from unwillingness to be bothered, through distaste for process or products, to religious objections and outright fear. The reuse of waste water is probably the most sensitive point.

Since most psychological and social objections are based on prejudice, ignorance, and fear, it will be essential to move cautiously, and to design careful educational and public information programs, where the need for the various elements of waste management are explained, benefits are convincingly described, and possible objections and fears allayed. The rather widespread fear of genetical harm from "atomic electricity" in the house and the religious opposition to desalinization of seawater are indications of the unexpected opposition that can develop. Luxury also limits tolerance. The United States, with the best fed people in the world, have undoubtedly the narrowest tolerance for food variety.

The public has accepted the need for reducing smoke pollution of the atmosphere (London smog), but there is still a noticeable psychological objection to measures for reducing gaseous pollution (Los Angeles smog). Although various educational and public information programs have been directed at this problem, there is still dissatisfaction over the expected economic impact and a lack of faith in the technical adequacy of the current solutions. This, in turn, has impeded necessary legislation and delayed corrective action.

Hence, any plan or program concerning waste management must include adequate consideration and support for attitude surveys, and educational and information programs that must continue throughout the overall program.

These latter programs must not only be factual and informative, but must also be especially oriented to develop support among the professional groups that traditionally engender public respect and help mold public opinion—especially religious leaders, physicians, scientists, and labor leaders.

LEGAL AND POLITICAL CONSIDERATIONS

Any waste management program developed can be expected to extend greatly the scope and extent of present organizations and operations, and new interfaces with other existing organizations and operations will be both created and discovered. This will inevitably generate a need for legislative revision and adjustment. Some old rules and regulations will be obstacles, some new powers and authority will be required, and developmental funding may be high. It is important also that any system or program be so organized as not to conflict unreasonably with the basic controls on individual liberty and reasonable freedom of action.

A preliminary analysis of socio-political aspects of the problem should be accomplished in parallel with the early systems engineering and technical feasibility investigations in order that, as the system becomes defined, the required political powers will evolve as an integral part of the system-selection process. This will allow the greatest interplay of support possible for the total system evolution, and will influence preliminary system evaluation toward the socio-political goals.

The socio-political phase of the study should emphasize critical considerations and as currently envisioned will:

1. Define the social objectives

2. Develop plans for political implementation for alternative system recommendations.

3. Study and report on preferred methods of allocating costs among system beneficiaries.

4. Develop guidelines for compliance/non-compliance determinations.

A careful study and analysis of the various governmental organizations that are directly or indirectly concerned with, interest in, or affected by the waste management problem is another essential. The governmental organizations that the people have developed in the various states and areas must be studied not only from a technical aspect, but also from the socio-psychological aspect. The technical aspect of the study can reveal the management processes as they exist, with their internal and external interfaces, their strengths, and their weaknesses. The socio-psychological aspect of the study can show how and why the present structure exists.

All democracies by their nature are technically inefficient compared to an authoritarian organization. But a study of history shows that large groups of people have accomplished unusual results only when a strong spirit of group unity exists. This group unity—where the individual feels himself to be a participant rahter than a subordinate—is found only where each member feels that his opinions can receive attention and exert influence on decisions.

Hence, no matter how technically perfect a waste management system may be, if it fails to conform to legal and political systems of the people who are to operate it, it will certainly fail. Thus, any waste management system must conform to the spirit of the people. It need not be an imitative extension of present organs of government, since these usually lag behind the popular trends, but any deviations from present structures must remain within the framework of probable popular acceptance.

SYSTEM INTEGRATION

After analysis, the various requisite elements must be sturctured into a system. This sytem must conform to accepted principles of organization, and it must also harmonize with specifics of the governmental structure. There are existing, established bureaus that have long covered certain aspects of waste management. There are also strong interfaces, such as water resources and recreational areas, and there is also a marked need to decentralize as much as possible the actual operation of system components as shown in Table 1.

Table 1. System integration of waste management system components.

Area	Functions	Levels	Methods
Control	Policies Objectives Standards Regulation Coordination Inspection Supervision Enforcement	Federal Regional State Local	Legislation Regulations Advice Incentives Penalties
Support	Financing Technical information Administration Liaison Public information Research and development	Same as above	Direct Indirect Periodic As required
Operations	Transportation Conversion Disposal Planning	Same as above	Government agency Government contract Private

OPTIMAL SYSTEM REQUIREMENTS

General Electric, TEMPO envisions an optimal waste management system to be:

1. Acceptable to a good majority of the people socially, esthetically, politically, psychologically, financially, and legally, or one that can be made acceptable within a reasonable time by education and public information.

2. Adaptable to the peculiar needs and problems of the various regions and localities, hence operationally decentralized as much as possible.

3. Effective. Provides adequately clean air and unpolluted water, does not mar the countryside; removes determinable threats to health.

4. Economical. Causes minimum waste of water, land and other resources. Provides best return on capital investment (public, industry and business, individual) with required individual capital investment within the reach of all.

5. Stable. Does not bear inequitably on a limited segment of the population or industry, nor permit unwarranted freedom at taxpayer expense. Changes and perturbations can be accommodated.

6. Harmonizes with the United States' neighbors.

These factors should be developed by the current study, and the final management alternatives indicated. In general, it is expected that:

1. The principal function of government should be regulatory rather than operational.

2. Government operations should be established only where environmental factors prevent or seriously hinder local agencies from functioning effectively.

3. Operations should be integrated only along maximum interface lines.

The recommendations to be submitted as a result of the study should introduce the system in an orderly, progressive fashion, particularly noting critical decision points. This will permit periodic re-evaluation at times when it is most needed, and not according to an arbitrary time schedule. This deliberate, orderly progress will also permit much better accomodation to the increasingly rapid rate of technological development. Finally, it should provide a better base for a public information schedule that will assure an informed electorate, well equipped to understand problem and objectives and to reach constructive conclusions.

ESTIMATE OF DEVELOPMENT EFFORT

It is estimated that the type of systems analysis study discussed in the preceding sections of this paper would involve six man-months of effort by a planning and advanced-studies organization such as General Electric, TEMPO. The study program should be organized and staffed to make maximum use of the knowledge and talents of the city authorities and technical experts concerned with the problems of municipal waste management working in conjunction with the team of systems analysts under contract to perform the study.

APPENDIX C

A METHODOLOGY FOR HOSPITAL AND MEDICAL FACILITIES PLANNING

A Concept Paper
by

Walter Hausz
and
E.L. Rivest

7 June 1965

TEMPO
General Electric Company
Santa Barbara, California

A METHODOLOGY FOR HOSPITAL AND MEDICAL FACILITIES PLANNING

By Hausz and Rivest

FOREWORD

The development of community services and facilities for the prevention of illness and care of the sick is a major health problem in metropolitan areas throughout the United States. A chief contributing factor is that the development of hospital and medical facilities in urban communities is often frustrated by drastic population shifts. Prominent among other factors contributing to the problem are: the high prevalence of chronic disease and severe injuries, the increasing number of aged persons in the population, and the growing complexity and costs of personal health services and facilities.

Urban redevelopment and the construction of highways leave many city hospitals high and dry, in a severely competitive position for obtaining a reasonable share of the available financial resources. Their former markets have dispersed and their new markets cannot provide adequate hospital income. Independent suburban hospitals spring up to fill the vacuum.

Hospital planning in metropolitan areas thus assumes new dimensions in both scope and depth. It is becoming increasingly evident that some means must be found to ensure the orderly development and rehabilitation of needed urban hospital and medical facilities without mutually destructive competition for the community's financial resources. This paper presents some thoughts on an integrated approach to the problem by seeking to apply the methodologies and analytical techniques (such as systems analysis) developed by the aerospace and defense industry. The paper does not attempt to fully analyze the problem or offer feasible solutions, but rather to structure a study comprising these tasks.

INTRODUCTION

Medical care is a significant and growing part of the national economy: 33 billion dollars in 1963 or 5.8 percent of the Gross National Product, and it is forecasted to grow to 58 billion dollars by 1970.

The increasing dollars represent, in part, a significant continuing improvement in the level of medical care provided: there are lives saved, organs and limbs saved, and patient-days saved by improvements in medicine and technology that escalate each year. But a substantial part of the dollar increase represents rising costs—of supplies, and particularly of services—tied to generally rising wages and expectations of standard of living. In industry, the answer to both rising wages and rising expectations of standard of living is capital investment to increase productivity. This may be realized as automation, as new technology, as creation of new and improved products, as improved personnel training, or as improved management and administrative practices and methods.

Providing sufficient and adequate medical care facilities for its population is an urgent responsibility of urban communities whose governing bodies have a basic problem of coping with the increase in costs without losing the benefits of improvements in the level of medical care. Thus, it is inevitable that cities will seek to find a logical approach to achieving this objective. This paper presents an approach which will endeavor to apply a planning methodology and optimization technique, generally known as the systems approach, to achieve the humanitarian objectives of increasing standards of patient care with the minimum expenditure of resources—money, required skills, and time.

This approach emphasizes the importance of the patient as the human being served by a hospital system and the responsibilities of the medical profession which must give prime emphasis to the quality and standards of patient care rather than to cost of that care. It also recognizes that mutual cooperation and understanding must be attained at all times so that the best combination of the objectives of all parties concerned may be achieved.

DEFINING THE PROBLEMS

The Urban Community Hospital Problem

There are approximately 5000 short-term general and special hospitals (totaling over 600,000 beds) in the nations urban communities. Costs in these hospitals average $32 per patient day, of which steadily rising wages and salaries now represent nearly 70 percent. The U. S. Public Health Service goal of 9.5 beds per

1000 population by 1970 will require the addition of 80,000 beds per year. These currently cost approximately $19,700 per bed for building and fixed equipment, and $3,300 for movable equipment.

Private and public expenditures for health and medical care in the United States have grown from $12 billion in 1950 to an estimated $31 billion in 1962. Per capita demand for health services is rising as a result of the increase in average life span as well as higher levels of disposable income. This is being influenced by prepaid medical care programs, which are stimulating greater health consciousness and creating a more favorable economic environment for hospital improvement.

Rising costs of medical care and shortage of trained personnel are forcing administrators to look for ways and means used in industries, such as the aerospace industry, to reduce costs. The problem in urban communities is that the rising level of minimum acceptable patient care and the rising price of all supplies and services—particularly labor costs—have made total costs climb yearly since World War II as shown in Figure 1.

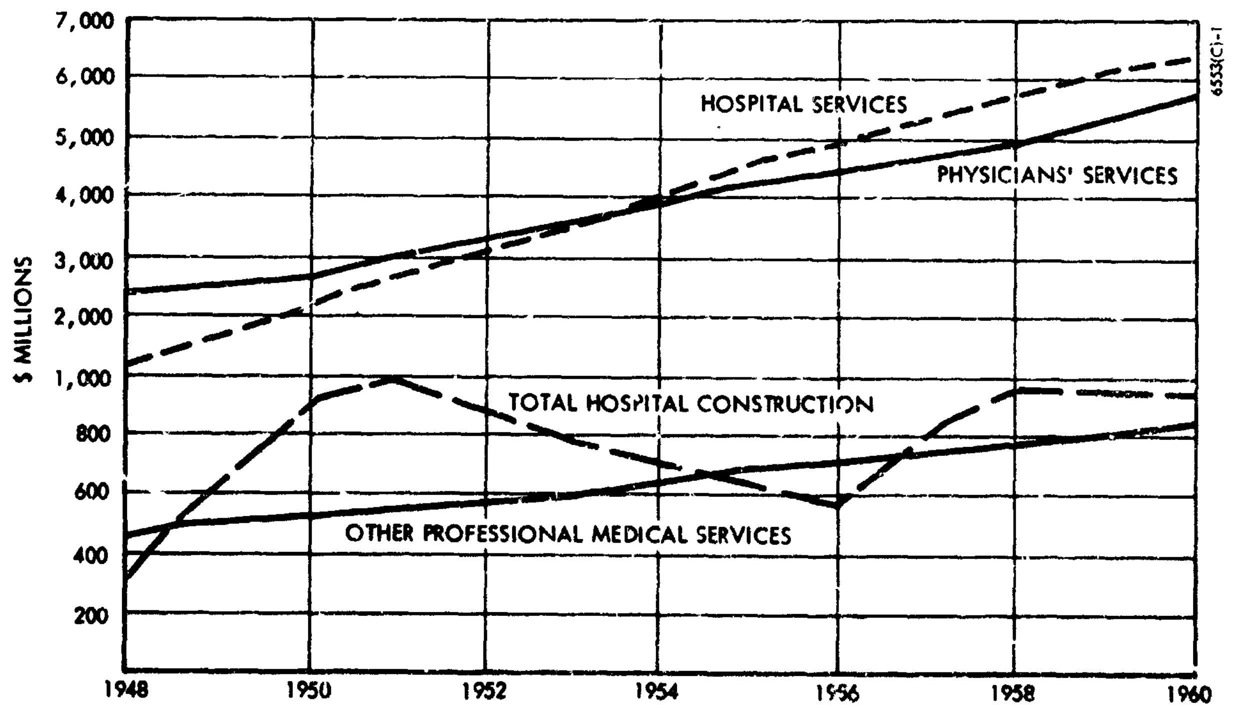


Figure 1. Hospital and medical costs 1948-1960.

Obsolescence of urban hospitals, many of which are World War II cantonments, requires a long-range replacement program as well as additions which represent improvement and growth needed in present hospitals. The investment costs plus the operations and maintenance costs combined will represent a substantial budget item for urban areas. The objective must be to maintain an "acceptable level" of patient care and reduce or hold down operating costs. Acceptable care must consider the standards of comfort and expectation of the patient and the scope and quality required by the professionals in responsible charge of the facility. This is not a fixed level of care, but rises continually as technological and medical advances make it possible to consider as common and ordinary practice in 1970 what was impossible in 1965.

The Hospital Improvement Program Problem

Many of the current practices in hospitals are traditional rather than derived from careful analyses of needs, interrelation with other practices, alternatives, and contributions to cost. Many new technologies and new medical advances have arisen in the past twenty years, and have been adopted in part in hospitals, but have been superimposed on the traditional structure rather than integrated into a concept of thinking of the whole hospital as a system. A course of action to pursue is an Improvement Program founded on logical principles. That is, to consider the hospital or medical care facility as a system with many interacting parts which must work together in optimal fashion to produce the dual results of acceptable patient care and minimum operating cost. This can be an important illustration of applying the systems approach—systems analysis, systems design, systems evaluation and testing—which has been used and tested for many years in weapons and aerospace systems procurement with excellent results.

The objective of a first-level echelon of planning should be the analysis, design, construction, operation, and evaluation of prototype hospitals which incorporate the output of the systems approach. If found to produce savings without sacrifice of level of care, the design and procedure features can be utilized for the continuing replacement program for urban hospitals for modernization of present medical facilities, and for use where applicable in private and military hospitals.

The Feasibility and Planning Problem

The planning of the improvement program in itself represents a problem. The systems approach has never been fully applied to the development of a prototype hospital as a system. What will it cost? What benefits or savings will it produce? How long will it take? How should it be managed? In justification of the improvement program for funding, in structuring the work by fiscal years, in dividing the work into relevant manageable packages for procurement, a Technical Development Plan (TDP) should be developed that will have a confidence level sufficiently high to contribute to affirmative decisions under management review.

Assistance may be required in generating such a TDP, and the requested feasibility and planning study would be in support of one part of the improvement program, the systems analysis phase. The complete improvement program, using the systems approach from start to finish, should have a number of identifiable phases: (a) systems analysis; (b) systems design; (c) system fabrication; (d) systems test and evaluation; and (e) systems operation. For a weapon system an estimate of the cost and schedule of all of these phases, including operating costs for five years, would be required early in the planning process.

The Problem of Scope

A system may be defined as an entity which accomplishes an operational process; that is something referred to as the input is operated on in some way to produce something designated the output. This operating entity is called the system. When the problem is to convert the given input to the desired output within constraints (such as minimum cost) the system may be considered as the means to solve the problem.

A systems approach could go upward and downward in echelons in a "stars to atoms" manner. The time and resources required to solve a problem with too large a scope are not generally justified by the marginal benefits obtained from the last additions to scope. The improvement program is too limited in scope if it considers only (or principally) the use of medical electronics, or the use of medical and administrative information systems. It must include at least a complete single hospital as an integrated system.

Some critical questions should be considered. Should the program be broad in scope and consider a group of hospitals in an urban region, or the assemblage of all urban hospitals in the United States as the system to be improved? The guiding principles in determining the scope of a program are to make it as broad as is manageable with the resources available and with the constraints imposed by responsibilities, access to information, and the possibilities of meaningful decision. Also where the contribution to costs generated by the inter-hospital interactions can be determined, the marginal utility of scope increase can be determined by whether these costs (or achievable improvements in them) are large or small.

As a preliminary conclusion, the regional assemblage of hospitals should at least be considered in a planning study and in an improvement program. There may be cost reductions over present practices without impairment of care by pooled purchasing, pooled information facilities, pooled inventory of rarely used drugs and equipment, increased use of specialized types of hospitals, or cost-effectiveness studies of patient and staff transfer policies to weigh transferral costs against the better care at lower cost available at the facility best equipped for a particular ailment.

OBJECTIVES OF A HOSPITAL PLANNING PROGRAM

A formal expression of the objectives of a hospital planning program, stated in proper detail, will enable one to tell when an adequate solution has been reached; they will enable quantitative criteria of effectiveness to be formulated that can be weighted and used to compare a proposed solution with others to rank them in order of preference Objectives of the larger problems or supersystems of which the task being performed is a subsystem must be considered, and the system derived must be compatible with them. However, they may be outside the scope of the task being performed; they may be an input.

Inputs

As previously indicated two objectives of a hospital planning study are to determine the best care of which medicine and its allied disciplines are capable and to attain this goal for the least cost in manpower, facilities, and money. At the improvement program level a tentative conclusion is that the humanitarian objective of improvements in patient care are an input rather than a function of the operational system.

There are many individual and organized programs of research aimed at medical advances, improved clinical techniques, and better understanding of diagnostic and therapeutic principles. Some are sponsored by DOD, much more is sponsored privately, or by government agencies through special hospitals. The best outputs of this work become, through the communication of journals, the medical schools, the teaching hospitals, a part of the consensus on the rising level of acceptable patient care. The improvement program should be aimed at accepting and encouraging this work, adopting it, and extrapolating to what this level may be at the time of implementation and operation phases of the improvement program. But it should not be aimed at contributing strongly to the methods of improvement of patient care per se.

Other inputs to the system (improvement program) are the patients—the number, the mix of infirmities, and the time distribution. The improvement program does not purport to alter this. The number and geographical distribution of hospitals is similarly input, determined by the objectives. The source of funds is an input, as are many policy constraints, determined by the Federal Government/ Municipal Agencies framework.

Another input must be the programming concept or policy required to achieve the ultimate goal of increased competence and efficiency in the overall medical establishment within realistic cost constraints. Two notions are fundamental in addressing the programming task:

1. The designation of a "programming period"—the time span between a current point and some time horizon.

2. A balance between short-term and long-term benefits over this period whereby the best position at the end of the planning period is attained consistent with maintaining adequate (and increasing) competence and efficiency throughout the period and vice versa. An analogy exists with many civil and, particularly, military programming activities where desired capabilities for the long-term future can be gained only through relatively substantial R&D expenditures which, in turn, impose penalties on near-term capability if fiscal constraints exist.

The programming concept is applicable at various levels in the overall planning process. At one level, for example, it aids in the choice of R&D validation programs leading to prototype facility construction under fiscal and time constraints. At another level, to achieve optimal phasing of the novel subsystems (practices) within the prototypes into currently existing facilities.

This policy must be an input, in that it determines in part the level of funds for the whole improvement program. For various funding levels, the benefits over a long period attainable by the improvement program can be compared with the benefits from other expenditures of these funds—as current operating expenses for urban hospitals, as short-term investment, or as non-hospital expense items. An optimum trade-off could be achieved among these alternative uses of funds, given sufficient information on the alternatives and the value weighting assigned to the different kinds of benefits derived.

Costs

The economic objective of delivering the desired level of care at the lowest cost must be weighted strongly in any hospital improvement program. The criteria for measuring costs must be defined further in the planning study to be sure alternatives are fairly evaluated. Operating costs of an urban hospital can be expressed in terms of costs per patient-day for an assumed patient loading and mix of infirmities. While convenient, this does not tell the whole story. However, maintaining or reducing this measure would be a real significant goal.

Reduction in the inpatient days per patient for the same assumed mix reduces room, food, and labor costs per patient. While it may be achieved at an increase in diagnostic and therapeutic costs, fewer beds may suffice, reducing the facilities cost or the same facility can serve an expanded clientele. Usual cost accounting procedures must be used to allow for and to balance operating costs, maintenance costs, and investment costs.

Another cost factor to be considered is the value of days hospitalized and in convalescence to the patient and to the municipality. Days lost cost sick pay and deprive the community of the patient's skills. Improvements in care that shorten the sick-list period should be suitably credited as a cost-savings to the community as a whole.

Similarly, there are economic values assignable to the extent of recovery or rehabilitation that can be achieved. The short-term benefit to the patient and the community measured by the extent to which he is enabled to work again at his full skill level and the long-term financial liability of the government and community for fractional or complete disability, must be assessed.

Documented discussions with surgeons in the medical facilities literature brought out strongly that the "best patient care" cannot be selected without considering many factors in addition to economics. For example, a serious injury to a fingertip requires the surgeon to ascertain occupation, psychological factors, future career plans, as well as insurance and ability to pay. For a laborer whose livelihood may depend on a rapid return to work, amputation at the first joint may be the preferred treatment. For a concert pianist, every effort is worthwhile to carefully reconstruct the fingertip by grafts—considering both appearance, muscle structure, and sensory structure. At intermediate levels, appearance may be important to an executive or an actor, sensitivity to cold may be important to someone who lives in, or expects someday to move to a cold climate. While "best care" might imply that everyone gets the concert pianist treatment, it is not warranted by the patient's needs or his own economic choice, nor is it merited as an expenditure of scarce surgical skills. This illustrates some of the complexities of trade-offs of cost factors.

Some objectives of an urban-area hospital represent costs without current benefits to patient care, which must be assessed for their long-term benefits, and may, in the long run, represent a cost saving. Research, teaching, and training are in this category. They are necessary to improve patient care in the long run. They are also necessary in the short run to acquire and hold good professional talent, and to continue upgrading it. Since an improvement program would consider different kinds of hospitals, some criteria for providing due weight to these objectives should be established.

METHODOLOGY AND TECHNIQUES FOR PLANNING

Environmental Assessment

In any systems analysis program it is always necessary to make an assessment of the environment in which the system is to operate. The environment consists of the current and projected technological, medical, financial, governmental, and political environments over a certain time period. The constraints and opportunities which these represent must be identified as an input to the selection of specific tasks.

Determine Objectives

The objective of a hospital planning study is assumed to be a program plan which specifies and describes the detailed steps required for a systems analysis of a long-range improvement plan, together with cost and schedule factors. Some effort must be devoted to defining, in detail, the scope of the program plan. Should the program plan contain all the steps necessary to improve patient care in one "typical" hospital, in a typical hospital of a certain class, or should it include some or all the interactions between hospitals, such as the flow of information or patients? Should the program plan contain only systems analysis studies or should selected R&D programs needed for validation be included also? If the output of a systems analysis is presumed to be a preferred system selection ready to proceed into development and design, some of the more radical concepts may require sufficient R&D to determine feasibility before the system selection is made.

Selection of Steps to Meet Objectives

System analysis should be applied to determine the steps required to meet the previously established objectives. There are many combinations of steps possible in terms of number, size, scope, depth of analysis, etc. These steps can be syntheisized into a program plan. The resulting plan is compared with the objectives, and by an iterative process, arrives at an optimum set of steps that describes the overall plan and can be readily implemented. The individual steps can then be further defined as necessary in order to describe each step in sufficient detail for costing purposes.

The greater payoff of the systems analysis approach will be in its application to the hospital planning study. Planning tasks are amenable to the same techniques. Instead of steps in a process, the parts of the system will be functional blocks or subsystems. One of the tasks of a planning study should be cost-effectiveness and trade-off analyses of various alternatives to meet functional objectives.

Cost-Effectiveness and Trade-off Analyses

For an array of functional objectives there will be a choice (for each objective) between alternative practices (subsystems) to satisfy the objectives to a greater or lesser degree. A program of cost-effectiveness comparisons should be defined for these alternative subsystems to provide:

1. A means for reducing the number of alternatives to be considered
2. A more efficient input to the overall programming problem.

3. Short-term decision aids for the selection of promising R&D programs.

In general, the type of result of such exercises is a function of the input information as shown in Table 1.

Table 1. Input/result relationships.

Inputs		Result
Current practice	Novel practice	
Cost and effectiveness	Cost	Required effectiveness of novel system
Cost and effectiveness	Effectiveness	Allowable costs for R&D, implementation and operation

The concepts involved in such analyses are straightforward. An analogy can be found between these medical considerations and the multi-mission/general-purpose weapon problems which arise during the analysis of equipment for tactical warfare. In tactical warfare a series of functional objectives can be stated and, to some extent, the degree to which an objective can be satisfied by a given weapon can be evaluted. It is found, however, that the fulfillment of a single objective may require the use of several weapon types, but that each of these weapon types may have application in fulfilling other objectives. Under these circumstances the dilemma is to evaluate the relative worth of alternative weapon types, particularly if the array of objectives to which they are applied cannot be ordered according to their importance.

Translated into hospital system terminology, this dilemma is illustrated in the matrix shown in Figure 2 which arrays a number of practices (subsystems) against the list of functional objectives. The effectiveness of the subsystem toward achieving the specific objective is represented by a scale where 0 denotes no effectiveness and 5 denotes maximum effectiveness. To resolve this dilemma, it will be necessary to develop a rationale for weighting the relative importance of the functional objectives in a given situation.

One guide to the importance or "payoff" in considering alternatives to a present practice (subsystem) is the present cost as a fraction

6553-(C)2

Practice (Subsystems)

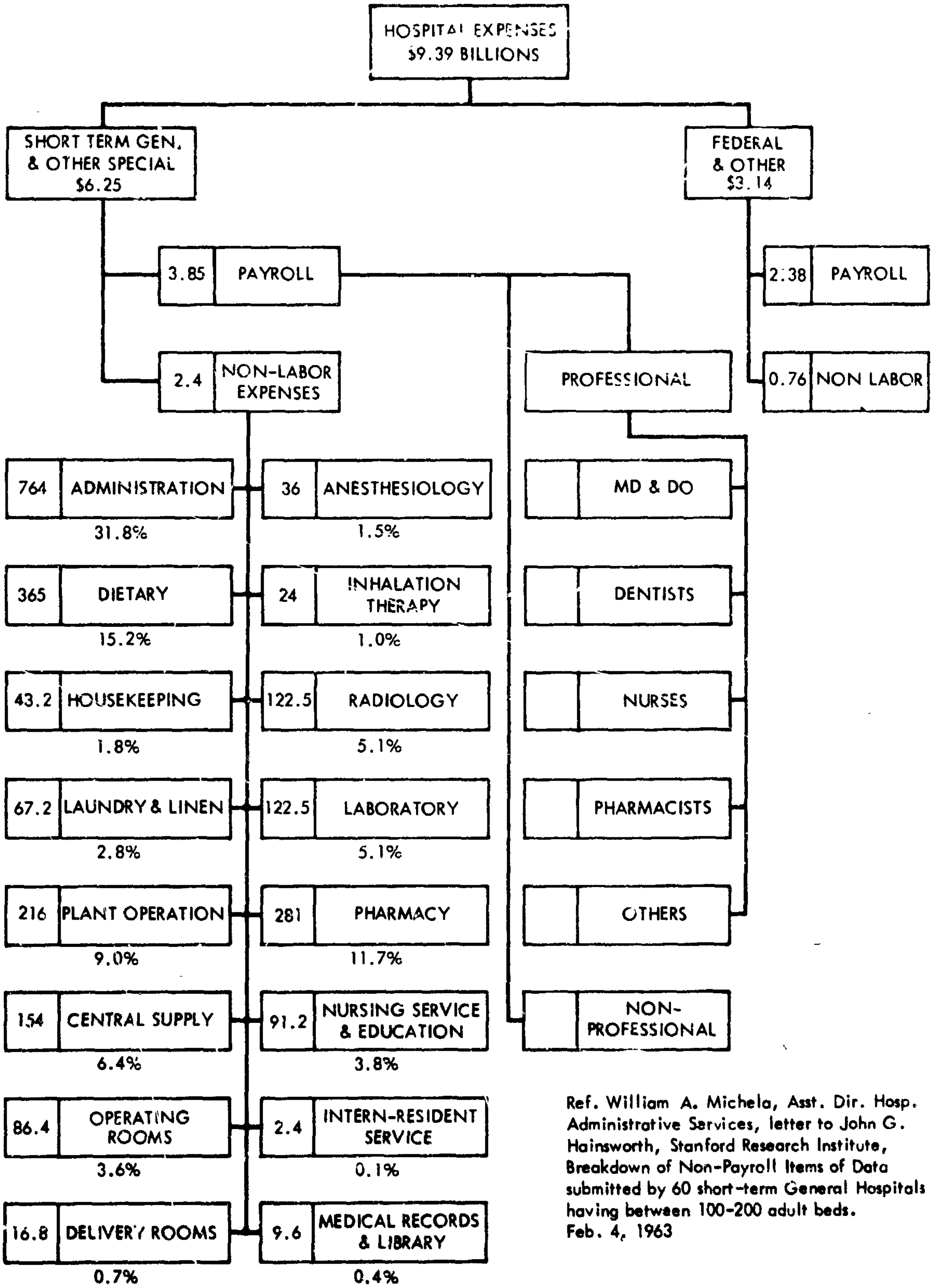
	A	B	C	D	E	F	–	–	–	–	–
1	0	0	0	1	0	3	0	5	–	–	
2	4	0	0	0	5	0	0	0	–	–	
3	0	0	0	0	2	0	0	5	–	–	
4	1	3	1	2	0	0	4	0	–	–	
5	0	0	2	0	0	5	–	–	–	–	
6	1	0	5	0	3	–	–				
1											
1											
1											

Functional Objective

Figure 2. Subsystem effectiveness matrix.

of the total operating cost. In a hospital planning study some level of cost analysis of present practices must be made in order to assess the magnitude of program implementation. An indication of the "cost centers" in a typical hospital are given in Figure 3 and Table 2. These show, for the indicated sources, the division into payroll and various non-payroll expenses, and the division of payroll into "department" categories. As these data are from different sources at different times they do not necessarily match. However, it is apparent that the greatest non-salary expenses are in administration and dietary, and the greatest salary expenses are in nursing and administration. More emphasis should be placed on analysis and improvements in these areas than on anesthesia or medical records for instance—important as the latter may be to patient care.

As different subsystem sets are considered, it will be necessary to break down these cost elements to the smallest identifiable work elements so that they may be aggregated for the candidate subsystems (i.e., nursing may be divided among a number of functional subsystems) and comparisons made with alternatives such as automation, new technology and differently organized procedures.



Ref. William A. Michela, Asst. Dir. Hosp. Administrative Services, letter to John G. Hainsworth, Stanford Research Institute, Breakdown of Non-Payroll Items of Data submitted by 60 short-term General Hospitals having between 100-200 adult beds. Feb. 4, 1963

Figure 3. Hospital expenses breakdown chart.

Table 2. Short-term hospital expenses, by department.

	Payroll Expenses as a Percent of All Expenses*		
	Salary and Non-Salary	Salary	Non-Salary
Administration	12.5%	7.5%	5.0%
Dietary	12.0	7.0	5.0
Housekeeping	5.5	4.8	0.7
Laundry (including linen service)	3.5	3.0	0.5
Plant Operation (including maintenance and repairs)	5.5	2.7	2.8
Central sterile supply	2.0	1.5	0.5
Other medical-surgical	2.5	2.0	0.5
Operating room	6.5	4.5	2.0
Delivery room	1.5	1.0	0.5
Anesthesia	1.0	0.6	0.4
Pharmacy	5.0	1.0	4.0
Laboratory	7.0	5.0	2.0
X-ray	5.0	3.0	2.0
Nursing (including nursing education)	28.0	26.0	2.0
Medical records	0.5	0.5	---
Other	2.0	1.0	1.0
Total	100.0%	71.1%	28.9%

*Based on unpublished data from California short-term hospitals in Los Angeles and San Francisco metropolitan areas, 1958–1959.

Integration and Description of Steps

The processes described above will lead to conclusions concerning: (a) the basic work elements to be performed, (b) their relative importance, (c) the sequence in which they should be performed, (d) where feedback must exist so an iterative process can be used to optimize the output, (e) the work elements which can be grouped into an easily identifiable "step." In the process, planning specialists will have gathered much data, discussed present practices, formed conclusions on the most promising areas for improvement and the subsystem structure that permits the achievement and measurement of improvements.

Results of a planning study should describe the purpose, the goal, the criteria, the work to be accomplished, and the resources needed, so that the total resources to accomplish the program may be judged, and so that the time required and the estimated costs can be determined.

Cost for Implementing Specific Steps

The selection of required system analysis steps and their scheduling within a management plan are not separate entities since both will evolve through a series of iterative studies. Finally, however, it should be possible to define each selected step in terms of required resources, time and input information (and therefore sequence). As an aid in evaluating the program and to facilitate program decisions, this data should be compiled for each step in sufficient detail to permit effective reporting.

The estimates of requirements for systems analysis effort and other resources to implement these separate steps should be performed largely by analysts similar to those who would be charged with the responsibility of performing the analysis and are in the best position to judge. Competence to compile such estimates should be demonstrated by the experience and continuing programs of planning organizations.

MANAGEMENT AND SCHEDULING

In order to systematize the recommendations for subsequent system analysis it will be necessary in the hospital planning study to adapt some form of network technique (e.g., PERT) to portray the organization of elements of work, depict them, and objectively analyze the import of associated constraints and estimates of required resources. As the planning study progresses, steps in the proposed system analysis should be identified and classified into activities, end events, constraints, data functions, information points, etc., so that like classes can be grouped and combined.

These techniques will aid in making the common aspects of similar work elements more apparent in facilitating their natural association in functional areas, and the sequence of interrelationships will indicate the phasing of the required steps.

To complete the scheduling task, activity descriptions, event descriptions, time estimates, and cost estimates for all activities should be made by experienced system analysts. As these time and cost estimates are obtained, they should be used, according to standard procedures for network planning, to develop initial phasing and scheduling.

From these, the time feasibility of the proposed system analysis can be evaluated and necessary changes made in the planning to meet program constraints.

While the formalized costing and scheduling steps noted above are necessary functions to facilitate an orderly and efficient implementation program, it must be recognized that the use of such techniques alone does not provide a sufficient basis for allocating effort between steps of the overall systems analysis. Although optimization of effort is implied in the formalized management techniques, there are other analytical and judgment factors which constitute the basis for meaningful input estimates to the management plan and which must be addressed explicitly to achieve the most valuable overall results. These are inherent in the nature and magnitude of the job to be accomplished and in the characteristics of systems analysis work, as illustrated by the following considerations:

1. The Nature of Systems Analysis: It is a characteristic of most systems analysis tasks that no worthwhile output is achieved without a certain expenditure of funds and that, following the achievement of initial results, the comprehensiveness, detail, and accuracy of output is a function of the effort. Beyond a certain point, however, the additional refinement of results and the value of such refinement is not commensurate with the additional effort required, i.e., for most analytical work, there is a point of diminishing returns.

2. Variation in Inherent Difficulty: Some types of analytical studies are inherently more complex and difficult than others to formulate and perform, and therefore require more time and money to complete.

3. Data Availability: Since no analysis is better than the input data, time and resources spent on gathering data, performing correlations and reducing it to the proper input form may account for a substantial fraction of the analytical effort.

4. Output Requirements: System analysis constitutes only one step in the accomplishment of a program, and its only function is to identify preferred subsequent actions. This function may be satisfied by simple and gross outputs, or may require extreme comprehensiveness, detail, and accuracy.

5. Relative Importance of Program Elements: The effort spent on analysis should be commensurate to some extent with the potential benefits to be derived from the program being addressed. For example, Figure 3 shows that administration accounts for 31.8 percent of non-payroll hospital expense, whereas other functions account for less than 1 percent. Likewise, Table 2 shows that nursing is the most costly labor category, with administration again accounting for a significant fraction of total cost. It follows that greater initial effort can be justified for analyzing nursing and administrative practices than for the relatively insignificant functions. It should be noted, however, that criteria other than cost must be considered also to determine priorities for analysis effort because improvements in a function which accounts for a small portion of hospital cost, or which may not even exist currently, may have a major import on the achievement of certain objectives.

To propose an allocation of effort and costs among the various systems analysis steps, these and other considerations must be incorporated into a weighting procedure. The structure and details of this procedure should be determined when the data base has been surveyed and specific objectives, functions, and practices have been identified through data correlation and discussions with medical personnel.

APPENDIX D

ENCLOSED COMMUNITIES

A Concept Paper
by
M. L. Feldman

14 January 1965

TEMPO
General Electric Company
Santa Barbara, California

ENCLOSED COMMUNITIES

By M.L. Feldman

ABSTRACT

This paper discusses the study of a project concerned with constructing and populating a completely enclosed, climate-conditioned community. Some critical economic, social, esthetic, and psychological considerations are presented. In addition, critical cost, environmental, technological, and urban problems are outlined. The supplementary benefits (spinoffs) that could result from such a project are presented and briefly discussed. The implications of placing an enclosed community within a depressed area are also discussed as an example of a feasible spinoff.

INTRODUCTION

Climate plays a major and vital role in the lives of people and in the vitality of nations. The human race grew and prospered in the mild climate around the southern Mediterranean. Civilization developed and matured in this area. As man learned to protect himself from the elements, he ventured away from this early cradle of civilization into areas with more severe climatic conditions and eventually to the four corners of the earth. His major civilized centers, however, have never been located beyond the temperate zones of the earth.

Trade and commerce have always been transportation dependent. Since water transportation has been the principal means of moving things long distances throughout most of recorded history, the world's largest cities became established on oceans and rivers. Manufacturing industries appeared near sources of raw materials and available means of transportation. The widespread availability of land and air transportation, however, has had a marked effect on this pattern. Cities no longer have to be on navigable rivers and sea coasts in order to thrive. Fast and efficient transportation systems have also made it possible for industries and people to conduct their business in areas with more desirable climates than that which exists in originally established places of commerce.

Climate is once again coming to the fore as one of the primary criteria of selection used by people and industry in their choice of home and plant sites. In the United States the growth of Texas, Florida, Arizona and California in the past 20 years has demonstrated the tremendous magnetism of a desirable climate. Retirement and vacation communities will continue to depend on climate for their economic success.

One of the most difficult technological challenges facing man is the task of controlling the elements. Progress to date has been minimal and progress in the foreseeable future will not be significant. Fortunately, progress in the direction of learning how to protect man from the elements has been significant. Man's buildings and structures can be heated, cooled and illuminated and he can keep out the wind, rain, snow, and other undesirable elements while purifying and conditioning the air he breathes.

The next step in this direction is to provide all these climatic comforts to a community as a whole. TEMPO proposes that such a project be undertaken as a viable and integral part of the program intended to develop the "Great Society." Since control of individual elements of weather is not presently feasible, one logical way to control the environment of an entire community would be to enclose the community within a protective dome structure and to control the climate within the structure. The many and varied considerations, advantages, and prospects pertinent to the implementation of this enclosed community concept provide the basis for discussions in this paper.

NEW TECHNOLOGY FOR URBAN AREAS

There is a widening gap between developing technology and its application to urban living. This schism has, and is continuing to have, a depressing effect on the lives of urban residents. Smog and air pollutants contribute to poor living and unsafe health conditions, and increasing numbers of crimes of violence and theft contribute to the unrest and mental anguish of the residents. The deterioration of metropolitan transportation is contributing to the migration of middle-class residents out of urban areas, extremes in weather conditions contribute to undesirable physical discomforts, and fiscal crises are contributing to the collapse of urban educational plants and systems.

The preceding conditions are incongruous in a nation which is: preparing to launch two men on a journey to the moon; capable of building a passenger plane to fly at 2000 mph; building submarines that can cruise under the polar ice caps; on the verge of economically producing fresh water from sea water; and economically generating electrical energy from fissionable fuels.

The enclosed community can be used to generate answers to some of the problems now facing existing urban areas. If the solutions to these problems that are developed for the domed community are feasible and satisfactory, they may be found to be directly applicable to established urban areas.

THE ENCLOSED COMMUNITY CONCEPT

Feasibility of an Enclosure

Modern technologists claim that they can construct domes at least 2 miles in diameter and 1 mile in height. Buckminster Fuller has stated that such a dome can be built for about $2 a square foot. A dome of this size would enclose about 2000 acres of land. The optimum size of a structurally supported dome or similar superstructure is not known, but could possibly be far greater than 2 miles. However, any deemed amount of space could be enclosed by means of an interconnected cluster of domes. At $2 a square foot, the cost of a 2 mile diameter dome is estimated at $200 million. With population densities of 100 per acre, which are common all over the world, this could amount to a dome cost of about $1000 per resident. Today, people pay a premium for desirable climatic conditions. This is readily apparent in California in the form of high land costs which often amount to $1000 to $5000 per family member over the cost of an equivalent-sized or even larger piece of land in a state with less-desirable year-round climate.

The effective application of advances in modern technology could provide significant reductions in dome cost. This would bring the dome cost per resident down to ever more acceptable and economically attractive figures.

Advantages of an Enclosure

An enclosed community has many desirable features and advantages as a place to live. The first and most obvious is the climate control feature. The ability to regulate the climate of an entire community would make it possible to locate the community in many areas that are not presently desirable for living because of adverse climatic conditions and it would make life more comfortable and enjoyable in many areas where extremes in weather are the rule rather than the exception.

The advantages offered by climate control in an enclosed community would make it possible for people to live and work in places where a hostile environment and external conditions are not conducive to supporting life, such as the environments under the oceans, on the moon, and in extreme desert and snow-bound regions on earth. Experience gained in the design, construction and operation of an enclosed, controlled-climate community would also result in an opportunity for a non-defense, non-space project to generate information of significance to the aerospace and defense industry, and to develop equipment that would permit habitation and survival in the hostile environments of planets being considered in space exploration programs. From such experience systems can emerge to protect man in these new environments and to more effectively use his capabilities.

Although the use of a dome to enclose a city represents a significant initial expense, there are significant offsetting savings that can be realized and the overall cost may be reduced. For instance, simpler and economical construction designs would suffice for the enclosed structures, storm sewers would not be needed, and equipment savings would accrue because most heating and cooling would be done centrally. This latter feature eliminates the necessity for many less-efficient, more expensive, individual heating and cooling units. Vehicles used for transportation within the city could be small, open, and inexpensive. Clothing would be lightweight and wardrobe investments would be smaller.

The use of a dome represents a major contribution to climate control from the point of view of uniform heating and cooling. The elimination of sudden fluctuations in temperature and humidity should contribute to a healthier and more comfortable way of life for all residents of the enclosed community. People living under the dome would be sheltered from radioactive particle fallout resulting from nuclear testing. (A domed city might even be designed to serve as a massive fallout shelter in the event of a nuclear conflict.) The central conditioning system would keep the air of the community fresh, clean and free of smog, dust, bacteria, and pollen. The climate within the dome need not be maintained constant, but would be varied for seasonal effect or even from hour to hour during the day and night.

Micro control would be possible within each family's own living quarters. The community might be heated to 65 degrees with each family then free to adjust its own temperature above that desired. An enclosed community would have novel transportation needs for handling visitors from other communities, for distributing goods shipped from other areas and for movement of its own citizens, since it would not be desirable to have either railroads or super highways within the domed community. New secondary distribution schemes would probably have to be developed, however, to move people and goods from the terminals of standard transportation systems at the edge of the dome to their destination within the new community. Perhaps, a novel system, similar in function to the canals in Venice might be developed as an internal mode of travel which would be novel, effective, and enjoyable.

An enclosed community would contribute to the United States' prestige throughout the world. It would indicate to other nations of the world that the United States is actively engaged in bettering the living conditions of people. The data obtained from the design, construction, and administration of an enclosed, climate-controlled community could be made available through the United Nations for use by the other nations of the world. These data would be of significance and importance to many countries where growth is severely restricted by adverse climatic conditions. Making these data available would be an effective way of aiding less-developed countries since it furnishes them with American "know-how," which, in reality, is one of the major differences between the United States and lesser-developed nations.

The enclosed community would also function as a tourist attraction and might contribute measurably to increasing the flow of tourists to the United States. It would also serve as a strong attractive force drawing visitors to it from other sections of the United States.

PLANNING FOR AN ENCLOSED COMMUNITY

Since enclosing a community removes one degree of freedom from the community system, this can have a profound effect on many of the aspects of community life. Each of these aspects should be carefully and individually analyzed to assure that the implications of an enclosed community with respect to each one are fully appreciated and understood. For example, housing in an enclosed community could be drastically different than present-day housing.

Roofs over buildings and home heating and air-conditioning units would probably be unnecessary. No consideration need be given to structural strength to withstand wind forces. However, since the dome itself will be expensive and space within the enclosed area will be at a premium, the tendency may be to build vertically to conserve horizontal area. High-rise construction may require more structural strength than would be required for wind resistance, thus eliminating any opportunities for savings that might have resulted from the elimination of wind stress as a consideration in building design.

The cluster concept and area densities will be key considerations for building within the domed area. It will not be feasible initially to enclose all the free space required by a community within the domed area; therefore, additional community green space will have to be provided in the area outside and immediately surrounding the dome complex.

The psychologica implications associated with living within an enclosed area combined with human factors considerations, such as amount and type of space per individual, constitute challenging problems for the most capable psychologists and human factors engineers.

The transportation needs within an enclosed community might be reduced by decentralizing some functions and centralizing others. For example, with modern trends in teaching moving in the direction of programmed instruction, language laboratories and closed-circuit TV, there may no longer be a reason for children to gather in a central school. They could conceivably study at home or small groups could participate in scattered neighborhood classrooms.

By making the optimum use of today's communication capabilities, there is no reason for thousands of housewives to journey to the supermarket. They might do their shopping at home, viewing the day's specials in color over closed-circuit TV. This would also permit locating all supermarkets in one area, thus simplifying food distribution systems. There would also no longer be a need for a person-to-person transfer of funds, since an information utility could permit transferring funds from the purchaser's bank account to the supermarket's bank account. Such automated handling systems could also be integrated into a stock and inventory control system.

Other facilities could be centralized into a community center. For example, all medical and dental facilities could be located in this center. This would aid in the design of a community transportation system by channeling the traveling into service centers. Such a centralized medical facility, combined with a community information utility, would make it possible for long-range medical records to be kept on all residents. A community medical record system would permit the accumulation of long-range data on the effects of current medical practices, which is one of the major weaknesses of our present medical treatment system. This community medical system would be linked with other community medical information systems which would contribute toward the development of a nationwide data bank of medical diagnostic and prognostic information. Other centralized community facilities could include municipal offices, facilities, and services, utility offices and assorted service centers.

These problems are complex if optimum solutions are to be developed and they are worthy of study by the best talents within the United States. They are also typical of the many problems that must be resolved for realization of the enclosed community concept.

THE DOME FOR AN ENCLOSED COMMUNITY

Plastics have come of age as a material of utilitarian value. It is now possible to enclose large areas with a protective plastic covering. Inflatable buildings are being used as rapidly erectable warehouses; movable domes are being installed over large stadia; clear plastic shells are being installed over swimming pools (the Shelbourne Hotel in Atlantic City); and plastic roofs are being proposed for enclosing downtown shopping areas (Victor Gruen's proposal for Boston).

A feasibility study should be concerned with the structure of the dome itself. Materials should be analyzed with respect to their suitability, i.e., dome structural materials, the dome size (diameter and height) most feasible using various suitable materials, the anticipated life of various materials for dome use with respect to ultraviolet sensitivity and the advantages and disadvantages of clear, translucent, and opaque materials. Sandwich materials should be considered as well as inflatable domes.

Consideration should also be given to various types of frameworks to be used as supporting structures for the dome. This analysis should not be limited to plastics alone, but should also consider steel, aluminum and pre-stressed concrete domes. It should also include analysis of the thin metal construction know-how developed by the aerospace industry as part of their rocket casing work since this, in combination with plastics, might provide an attractive and practical dome. However, studies of non-transparent or non-translucent materials will also require that daylight-type lighting be investigated.

The feasibility study should also cover wind, earthquake, lightning, and tornado resistance calculations for materials selected as promising. Heat-transmission and heat-loss calculations should be made for the more promising materials and structural configurations. Where justified, supplementary studies for the development of materials with specifically improved properties should be delineated and proposed.

INDUSTRIAL CONSIDERATIONS FOR AN ENCLOSED COMMUNITY

The factors related to the economic base of the community should be studied. Analyses should be made of the optimum size of the community and the optimum mix of services and non-services activities to provide a dynamic atmosphere in which people can live and work and in which a community can thrive.

Such an economic study should include analyses of areas where enclosed communities might be erected, because the geographical location of the community could have a definite effect on the industries or businesses that should be encouraged to settle or start operations within the new community. Therefore the study should suggest several areas where it would be feasible and desirable at the present time to erect an enclosed community such as:

- Pennsylvania: Scranton-Wilkes-Barre area
- New York: Amsterdam-Gloversville area
- West Virginia: Between Charlestown and Kentucky
- North Caroline-Tennessee: Gatlinburg-Ashville area
- Georgia-Alabama: NW location below Chattenooga in State of Dade region. Above Gadsen.

The industrial or economic base for the enclosed community should be analyzed for each selected area. These analyses should include factors such as the raw materials available in the area, the industrial and business attractions of the area, and the value of the domed community as a tourist attraction.

In addition these analyses should give sober consideration to the types and distribution of types of people (college-trained professionals and scientists, high school graduates with vocational skills, tool makers, unskilled laborers, etc.) who might be encouraged to become residents of the community and the varieties of industries that could use the skills and talents of these people. Consideration should also be given to the educational system to be developed to train people for the industries and to keep the skills of the residents compatible with the needs of the community, as well as to prepare the residents to fit into the larger, exterior environment of the United States and the world.

Finally, it is necessary to evaluate fully, the effect that such a community would have on the area in which it is constructed. For example, recognition should be given to the possibility that residents of nearby towns may be lured to the domed community and industries attracted to the domed community might place existing industries located in nearby communities at a disadvantage. The implications of such events should be understood and the potential countermeasures that may be employed by those who might stand to lose as a result of such occurrences should be anticipated and structured into workable plans.

SOCIOLOGICAL IMPLICATIONS OF AN ENCLOSED COMMUNITY

Failure in the past to pay adequate attention to the sociological implications of everyday urban considerations such as community design, land-use trends, transportation patterns, influxes of low-income peoples, deterioration of sections of the community, increasing land cost, increasing taxes, decreasing tax base, increasing crime rates and increased areas conducive to criminal activity, has resulted in almost insurmountable problems for many existing urban communities. These are indicative of the factors that must be recognized as potentially troublesome and they should be analyzed both by themselves and as interrelated variables if an enclosed community is to avoid the serious problems that have arisen in American cities that have neglected these considerations. A sociological study should define areas that must be investigated and should prepare plans for study programs designed to generate the inputs that will permit the design of a community capable of avoiding socio-economic distress in the future.

In addition, studies should be performed to determine that enclosed communities will indeed find acceptance by large numbers of potential residents. The problems of educating the populace to this novel concept should also be addressed, as should the problems associated with resident selection.

COMMUNITY SERVICES FOR AN ENCLOSED COMMUNITY

A community designed around the latest developments in modern technology must reflect these developments in the services made available to the residents of the community. This community should have a broader utility base than is normally expected in today's American communities. This represents an area where recently developed aerospace technology can make a major contribution. For example, it is now perfectly feasible to locate a power generating facility in a totally enclosed community since the evolution of nuclear-fuel power stations makes this a practical reality in many areas competitive with coal- or oil-fired central-station generated power.

Communication and information processing have progressed to the point where startling innovations can be made in services. A recent Bell Telephone development makes it possible for ailing children to listen to their classes while sick at home and to ask questions of their teachers from their sick beds. Closed-circuit, regular and airborne TV make it possible to make each home a classroom. Equipments have been demonstrated which permit a TV teacher to quiz a remote audience and to obtain the gross results immediately in order to get a feeling for how well he is being understood and to record individual results for use later in grading individual students. Systems are under development which will permit the student to interact with the remote TV lecturer. Such innovations are necessary before TV can begin to play an active role in the educational system of an enclosed community.

Teaching machines permit each student to proceed at his own pace independent of the other students and away from the other students. The important part of the teaching machine is the program that goes with the machine. Special programs might be required for students in enclosed communities. Experiments currently underway permit students in one state to learn by interacting with a computer in another state. Although a prohibitively expensive way to teach at the present time, these experiments are forerunners of teaching methods required for an enclosed community.

New data storage, retrieval and display techniques will make it possible to make a central library of books, art, and music immediately available to each home in a community. These same techniques can make available to the housewife the latest styles, the newest arrivals in her favorite stores, the gourmet special of the day at the local restaurant, and the specials at the supermarket. Other accessories may permit housewives to select the items they want delivered from the dress shop to punch out her order to the supermarket. The centralized computer utility will permit housewives to keep accurate tab on the family's financial records. It will also handle bill payments for purchases made through this facility. This same facility will serve all the businesses of the area in the same manner.

The medical records of the community can be kept in a centralized computer utility which will keep the doctors of the community in contact with national diagnostic and medical literature information centers. A variation of this system can be used to assure that the prescribed medicine is given to the proper patient in the hospital and that accurate laboratory test results are reported for the patient.

A feasibility study should determine what is feasible in the required utilities and should be concerned with determining the critical size of the community required to justify any "new" utilities or portions of them. Such a study should also submit designs for development programs required to perfect features of these utilities.

SUPPLEMENTARY BENEFITS OF AN ENCLOSED COMMUNITY

Conducting a study of an enclosed community could be justified on the basis of the advantages already discussed. There are four other major benefits, however, that could accrue from a project of this nature.

1. The enclosed community could be erected in a poverty pocket of the United States. This new concept in cities could serve to attract new industry to the area and tourists to see the city of the future.

2. The talents and capabilities of the aerospace and defense industry could effectively be applied to the design of the enclosed community which might develop into a significant non-defense-oriented growth business opportunity for this segment of the economy.

3. Some or all of the features of the community under the dome could be used in non-enclosed new cities and applied to existing cities and to the problems of urban living.

4. An enclosed community could be erected in any area not now inhabitable because of severe climate conditions which would furnish insight into the problem of providing good liveable space for people from many of the world's overcrowded lands.

Alleviation of Problems in Poverty Areas

Certain regions of the United States are currently suffering from economic regression while the nation as a whole is enjoying an unprecedented period of prosperity. This paradox can be explained partly in terms of economic considerations, such as the automation of coal mines and the obsolescence and demise of historical industries. However, there are many other contributing factors, one of the most insidious being the downward spiraling deterioration trend that occurs once an area begins to decay. Industries and residents remaining in decaying areas are faced with increasing tax rates and decreasing services. The increasing tax rate drives out more industries, the more affluent residents leave with the departing industries, more of the remaining residents become welfare burdens, and the quality of instruction in the areas' schools falls off.

In areas where the level of education has been permitted to fall below minimum desirable standards, a deterrent to the attraction of new industries is created. Low educational standards are reflected in the abilities of workers produced by the education system, and it follows that industrial managerial, professional, and scientific personnel are reluctant to move into areas with low educational standards and poor educational facilities. Even regions that once had appeal for vacation, recreational or climatic reasons lose this appeal when the physical appearance and resources of the area degenerate as a result of economic distress.

The economic level and overall well-being of the populace in depressed areas cannot be readily improved without outside help. Yet to produce something more than a transient, artificial uplifting, the outside help should be oriented towards helping the region to help itself. This defines the need to determine and implement the forces that will produce substantial economic, educational, technological, and other activities in the region and at the same time invite spillover into the region from the rest of the country. Constructing an enclosed community within such an area could act as such a force and it could initiate the chain of events that would raise the area to an economic level comparable to the national average.

Cities and towns are capital investments just as production equipment and factories are considered to be in industry. In more affluent areas where the decay process is slow and controllable, it would be in the long-term best interests of cities and their residents to plan and carry out a continuing modernization program in order to keep the "capital equipment" of the city in optimum condition. When cities fall into disuse and disrepair, as they have in some of the currently poverty-stricken areas of the United States, perhaps they should be replaced.

A new concept in communities has much to offer a depressed area. With the proper coordination and planning the enclosed community could contribute to the complete rehabilitation of the area surrounding the city. For example, if a site for an enclosed community is selected with inherent scenic beauty and recreational features, a sightseeing and vacation-land potential can be developed which would contribute to a firm and diverse economic foundation for the area. This kind of region is always attractive to the type of people industry seeks for its management, professional, and technical employees.

The educational system of an enclosed community can be designed to serve the community and to assure a continuing flow of the type of labor that local and neighboring industries require. A well-planned city with efficient services, a wisely structured tax base and a good educational system can offer to new industries desirable plant location sites with the expectation of a continuing supply of good labor and an attractive economic future with a reasonable tax load.

The enclosed community could be designed to include a college or university. This would contribute toward relief of the space shortage problem in existing colleges and at the same time it will create the intellectual climate required to round out the attractions of the city. As an approach to the poverty problem, enclosed communities would result in the creation of desirable places to live, which would, in turn, initiate an influx of industry, people, and business into the poverty areas.

Opportunities for the Aerospace Industry

The U. S. aerospace industry has advanced technology immeasurably in order to develop missiles, space probes, and manned, earth-orbiting and space vehicles. This industry has many talents and capabilities that could be oriented toward the problems of urban America but which have not been focused in this direction.

In addition to the obvious things to be considered, there are many problems related to everyday activities which must be considered such as the movement of people and things, the protection of people from each other, fire, and illness, the education of the old and young, and information storage, retrieval and display and the provision of industries with employment opportunities. The development of solutions to problems of this type can present a challenge to the best talents within the aerospace industry. The problems are so complex as to require competent systems management competences in their handling to assure that each subproblem is treated in the proper context and that the subsolutions can be assembled to a satisfactory overall solution to the main problem. Thus the enclosed community concept represents a significant new business opportunity for the aerospace industry.

ESTIMATE OF DEVELOPMENT EFFORT

It is estimated that the type of project definition and feasibility study discussed in the preceding sections of this paper would involve five man-years of effort by a planning and advanced-studies organization such as General Electric, TEMPO. The study program should be organized and staffed to make maximum use of the knowledge and talents of city authorities, administrators, and technical experts concerned with the problems of applying aerospace technologies, such as those developed by NASA, to the solution of city problems. This team of experts should work in conjunction with the team of scientists, engineers, and analysts under contract to perform the study.

APPENDIX E

BIBLIOGRAPHY

CITY PROBLEMS AND PREDICTIONS

America in the Sixties: The Economy and the Society, ed. Fortune, Harper and Bros., New York, 1958.

City Problems of 1960, ed. by John Gunther, U.S. Conference of Mayors, Washington, D.C., May 1960.

City Problems of 1963, ed. by John Gunther, U.S. Conference of Mayors (Honolulu, Hawaii), Washington, D.C., June 1963.

City Problems of 1964, ed. by W.H. Baldinger, U.S. Conference of Mayors (New York, N.Y.), Washington, D.C., May 1964.

City Problems of 1965, ed. by W.H. Baldinger, U.S. Conference of Mayors (St. Louis, Mo.), Washington, D.C., June 1965.

Issues of the Sixties, ed. by L. Freeman and C.P. Cotter, Wadsworth Publishing Co., Inc., San Francisco, 1961.

Gruen, Victor, Who is to Save Our Cities, Harvard Business Review, Graduate School of Business Administration, Harvard University, Boston, (May/June 1963)

Johnson, Lyndon B., Problems and Future of the Central City and Its Suburbs, Congressional Record, no. 99, 89th Congress, House of Representatives (GPO), Washington, D.C., March 2, 1965.

NASA, Scientific and Technical Information Division, Space, Science, and Urban Life (Dunsmuir House Conference, Oakland, Calif.), NASA SP-37, by S.S. Edwards and A.V. Karpen, NASA, Washington, D.C., March 1963.

Weissbourd, Bernard, Segregation, Subsidies, and Megalopolis, Center for the Study of Democratic Institutions, Santa Barbara, Calif., 1964.

AEROSPACE AND URBAN TECHNOLOGIES

Advances in Space Science and Technology, vol 6, ed. Frederick I. Ordway, III, Academic Press, New York, 1964.

Booth, R.E., et al. The Uses of Technology and Information, Data Processing Magazine,(June 1965).

Furash, E.E., Jr., Businessmen Review the Space Effort, Harvard Business Review, Boston, (September/October 1963).

Gilfillan, S.C., The Prediction of Technical Change, Review of Economics Statistics, vol 34, (November 1952).

NASA, Scientific and Technical Information Division, Applications of Space Biomedical Research to Problems of Rehabilitation, Transforming and Using Space-Research Knowledge, NASA SP-5018, by S. Davis Bronson, June 1964.

NASA, Scientific and Technical Information Division, Economic, Political, and Sociological Implications of Expanding Space and Scientific Knowledge, Space, Science and Urban Life, NASA SP-37, by J. Herbert Holloman, March 1963.

Parker, J.S., Space Technology's Potential for Industry, Fourth National Conference on the Peaceful Uses of Space, Boston, May 1964.

Price, Derek J. De Solla, Science Since Babylon, Yale University Press, New Haven, Connecticut, 1961.

Stover, Carl F., Technology for Cities, National Civic Review, (June 1964).

Van Dyke, Vernon, Pride and Power: The Rationale of the Space Program, University of Illinois Press, Urbana, Illinois, 1964.

TRANSFER AND UTILIZATION OF TECHNOLOGY

Haase, P. and F. Lynn, Technology and the Industrial Future, Frontier, IIT Research Institution, (September, 1964).

NASA, Scientific and Technical Information Division, The Commercial Application of Missile/Space Technology, by J.G. Welles, et al, Denver Research Institute and NASA, University of Denver, Denver, Colorado, September 1963.

NASA, Scientific and Technical Information Division, The NASA Program for Technology Utilization, Transforming and Using Space-Research Knowledge, NASA SP-5018, by Richard H. Brenneman, June 1964.

NASA, Scientific and Technical Information Division, Practical Results from NASA Space Science and Applications Program, by H.E. Newell, March 1965.

NASA, Scientific and Technical Information Division, Transformation of New Knowledge for Economic Growth, NASA-UCLA Symposium and Workshop, by Werner Z. Hirsch, Los Angeles, June 2, 1964.

NASA, Scientific and Technical Information Division, The Usefulness of Aerospace Management Techniques in Other Sectors of the Economy, Transforming and Using Space-Research Knowledge, NASA SP-5018, by T.K. Glennan, Jr., June 1964.

National Bureau of Economic Research, The Rate and Direction of Inventive Activity: Economic and Social Factors, Princeton University Press, Princeton, N.J., 1962.

Rogers, E.M., Diffusions of Innovations, Free Press of Glencoe, Glencoe, N.Y., 1962.

Rosenbloom, R.S., Technology Transfer-Process and Policy, no. 62, National Planning Association, Washington, D.C., July 1965.

Welles, J.G. and R.H. Waterman, Space Technology: Pay-Off from Spin-Off, Harvard Business Review, (July/August 1964).

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) TEMPO General Electric Company Santa Barbara, California	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

APPLICATION OF AEROSPACE TECHNOLOGY TO URBAN COMMUNITY PROBLEMS

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (Last name, first name, initial)

Feldman, Max L.; Gonzalez, Louis A.; Nadel, Aaron B.

6. REPORT DATE 23 September 1965	7a. TOTAL NO. OF PAGES 105	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. NASA Purchase Order No. 5177 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) RM 65TMP-53 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	

10. AVAILABILITY/LIMITATION NOTICES

Qualified requestors may obtain copies of this report from the Technology Utilization Officer, Western Operations Office of the National Aeronautics and Space Administration, Santa Monica, California

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Western Operations Office (WOO) NASA, Santa Monica, California

13. ABSTRACT

Technological solutions to critical problems of urban communities in the United States are, to a large extent, dependent upon feasible past, present and predictable technologies. The research reported was undertaken to identify and isolate specific critical city problems amenable to technological solutions and to determine and suggest technologies resulting from past and current NASA programs applicable to the solution of these problems. The study focuses on major city problems deserving immediate attention and suggests applications from a broad scope of NASA-developed technologies. An evaluative matrix is included in the report which relates categories of critical city problems to categories of NASA aerospace technologies. Four individual concept papers are appended to the report as examples of areas where programs could be initiated to aid in the resolution of serious urban problems utilizing NASA technologies.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Aerospace Technology Transfer						
Urban Community Problems						
Technological Solutions of City Problems						
Urban Physical Environment Problems						
Urban Social Environment Problems						
Urban Economic Environment Problems						
Urban Public Health Problems						
Urban Security Problems						
Urban Research Trends						
Urban Technology Impact						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ________________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ________________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through ________________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

Unclassified

Security Classification