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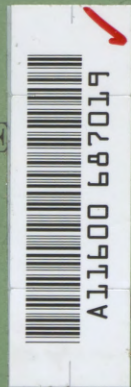
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SCIENTIFIC MANPOWER UTILIZATION, 1965-66

THE SPECIAL SUBCOMMITTEE ON
UTILIZATION OF SCIENTIFIC MANPOWER
OF THE
COMMITTEE ON
LABOR AND PUBLIC WELFARE
UNITED STATES SENATE



EIGHTY-NINTH CONGRESS
FIRST AND SECOND SESSIONS
ON

S. 2662

A BILL TO MOBILIZE AND UTILIZE THE SCIENTIFIC AND
ENGINEERING MANPOWER OF THE NATION TO EMPLOY
SYSTEMS ANALYSIS AND SYSTEMS ENGINEERING TO
HELP TO FULLY EMPLOY THE NATION'S MANPOWER
RESOURCES TO SOLVE NATIONAL PROBLEMS

NOVEMBER 19, 1965; MAY 17 AND 18, 1966

Printed for the use of the Committee on Labor and Public Welfare



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HEARINGS
BEFORE THE
SPECIAL SUBCOMMITTEE ON
THE UTILIZATION OF SCIENTIFIC MANPOWER
OF THE
COMMITTEE ON
LABOR AND PUBLIC WELFARE
UNITED STATES SENATE
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WASHINGTON : 1967

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SCIENTIFIC MANPOWER UTILIZATION ACT

FRIDAY, NOVEMBER 19, 1965

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON THE
UTILIZATION OF SCIENTIFIC MANPOWER
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Los Angeles, Calif.

The Special Subcommittee on the Utilization of Scientific Manpower met, pursuant to call, at 10 a.m., in the Metropolitan Water District Building board room, Los Angeles, Calif. Senator Nelson, chairman of the special subcommittee, presiding.

Committee staff present: Roy H. Millenson, minority clerk, Senate Labor and Public Welfare Committee, and William Spring, legislative assistant to Senator Nelson.

Senator NELSON. The subcommittee will come to order. This subcommittee will be happy to hear from Robert A. Skinner, general manager of the Metropolitan Water District of Southern California, our host.

Mr. SKINNER. Senator Nelson, distinguished guests, and gentlemen, it is a pleasure for the metropolitan water district to make these quarters available for the hearing. It is certainly a real opportunity to have you all here, and we want to extend the most hearty welcome.

I think Governor Brown told me this is the first time he had seen our quarters, and certainly this is a signal opportunity, Governor, and we are glad to welcome you and Senator Nelson. Thanks very much.

Senator NELSON. We appreciate your graciousness in permitting us to use your building here today. I thank you very much.

It is a great pleasure to be here in Los Angeles and to welcome all of you to this hearing on S. 2662, the Scientific Manpower Utilization Act.

At this point in the record we will insert a copy of the bill, S. 2662. (The bill referred to follows:)

89TH CONGRESS
1ST SESSION

S. 2662

IN THE SENATE OF THE UNITED STATES

OCTOBER 18, 1965

Mr. NELSON (for himself, Mr. CLARK, and Mr. RANDOLPH) introduced the following bill; which was read twice and referred to the Committee on Labor and Public Welfare

A BILL

To mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation's manpower resources to solve national problems.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That this Act may be cited as the "Scientific Manpower
4 Utilization Act of 1965".

5 SEC. 2. It is the purpose of this Act to facilitate and
6 encourage the utilization of the scientific, engineering, and
7 technical resources of the Nation in meeting urgent problems
8 facing the Nation or localities within the Nation, by pro-
9 moting the application of systems analysis and systems engi-

2

1 neering approaches to such problems. The problems re-
2 ferred to in the preceding sentence include, but are not limited
3 to, problems in the area of education, unemployment, wel-
4 fare, crime, juvenile delinquency, air pollution, housing,
5 transportation, and waste disposal.

6 SEC. 3. The Secretary of Labor (hereinafter referred to
7 as the "Secretary") shall carry out the purposes of this
8 Act by—

9 (1) making appropriate grants to States, and

10 (2) by entering into appropriate arrangements
11 (whether through grants or contracts, or through other
12 agreements) with universities or other public or private
13 institutions or organizations,

14 for the purpose of causing the systems analysis and systems
15 engineering approaches to be applied to national or local
16 problems of types which the Secretary, by regulations,
17 designates as being within the purview of this Act.

18 SEC. 4. (a) Any grant made under section 3 to a State
19 shall be used only for the purpose for which the grant was
20 made, and may be used by the State for such purpose
21 directly, or through the State's entering into appropriate
22 arrangements for the carrying out of such purpose (whether
23 through grants or contracts, or through other agreements)
24 with universities or other public or private institutions or
25 organizations.

3

1 (b) No grant under this Act shall be made to a State
2 unless the Secretary finds that—

3 (1) the knowledge and experience expected to be
4 gained from the employment of such grant would have
5 substantial relevance to problems within the purview of
6 this Act which exist in other States;

7 (2) the State has presented a plan setting forth in
8 detail the purposes for and manner in which such grant
9 is to be used, together with the objectives expected to be
10 achieved from the use of such grant;

11 (3) the State has designated an officer or agency of
12 the State who has responsibility and authority for the
13 administration of the program in which such grant is to
14 be employed; and

15 (4) the State agrees fully to make available to the
16 Federal Government and to other States (and political
17 subdivisions thereof) data and information regarding the
18 employment of such grant and the findings and results
19 stemming therefrom.

20 (c) There shall not be granted to any State under this
21 Act amounts the aggregate of which exceed 20 per centum
22 of the aggregate of the amounts which have been appro-
23 priated to carry out this Act at the time amounts are granted
24 to such State hereunder.

25 (d) Two or more States may combine to apply for one

1 or more grants jointly to carry out the purposes of this Act
2 with respect to one or more of the problems which they have
3 in common and which are within the purview of this Act,
4 and in any such case, the provisions of subsection (b) shall
5 be deemed to require the submission of a joint plan for the
6 utilization of the grant and the designation of one or more
7 officers or agencies having responsibility and authority to
8 carry out the joint plan. Each State participating in such
9 a joint plan shall be deemed, for purposes of subsection (c),
10 to have received an amount equal to the amount produced
11 by dividing the amount of the grant received to carry out
12 such plan by the number of States participating in such plan.

13 SEC. 5. The Secretary, in awarding grants to States and
14 in entering into arrangements with universities or other pub-
15 lic or private institutions or organizations, shall follow pro-
16 cedures established by him for the purpose of assuring that
17 the grants or other expenditures made to carry out the pur-
18 poses of this Act will be equitably distributed among the
19 various major geographic regions of the Nation.

20 SEC. 6. For the purpose of making the grants and enter-
21 ing into the other arrangements provided under section 3 of
22 this Act, there is hereby authorized to be appropriated, with-
23 out fiscal year limitation, not more than \$125,000,000.

Senator NELSON. I want especially to welcome Governor Brown, whose imaginative leadership has made California the most progressive State in the Union in this new and creative effort to apply space age technology to our most complex and troubling domestic public policy dilemmas.

Let me say at the beginning that there is no doubt in my mind that the expertise developed by American industry in making travel to the moon no longer a fantasy but simply a complex engineering problem is desperately needed to help evaluate and resolve enormously complex domestic problems.

California has led the way by hiring four aerospace firms to analyze the problems of waste management, crime, transportation, and government information handling with systems analysis tools developed in defense and space research.

The bill we are considering today grew out of the experiment originated by Governor Brown.

Problems crying out for better understanding and more imaginative solutions are all around us. Here in Los Angeles the condition of the air itself makes clear the need—the critical need—for a better, a more comprehensive, waste management program. There is a critical need for a comprehensive waste management plan for the Nation.

We face an environmental crisis of almost unimaginable proportions right now. We have polluted almost every source of fresh water in America and are well on our way to polluting the whole atmosphere.

Nothing short of a massive effort by industry and government at every level will solve this problem. This can be done only after a total analysis of the problem and development of an overall program of action.

It will probably be necessary to set air and water purity goals, just as we have set travel to the moon as a goal, and then go out and develop the hardware to get the job done.

The systems analysis approach, I think, is the basis for a sound beginning in this effort.

Since this program with the four contracts was initiated by Governor Brown some few years ago, the literature in the country is full of references to it, and I am happy this morning to be visiting in Governor Brown's State, which for 4 years was my State while I was attending college at San Jose State a few years back, and I am pleased you have taken the time to come here this morning, Governor, and express your views.

You may proceed as you wish, Governor Brown.

**STATEMENT OF HON. EDMUND G. BROWN, GOVERNOR OF THE
STATE OF CALIFORNIA, ACCOMPANIED BY HAROLD R. WALT,
DEPUTY DIRECTOR, CALIFORNIA DEPARTMENT OF FINANCE**

Governor Brown. Thank you very much, Senator Nelson and members of your subcommittee.

It is a real pleasure to welcome you to our State. California is honored that you have chosen to open these hearings here.

We are particularly proud of you, too, because of the fact that you are a graduate of one of our great colleges in California, San Jose

State, and you have added luster to its name. And I am also happy to have you come back here to California.

Today I'm afraid you are going to find few, if any, unbiased witnesses. The people whose testimony you are about to hear will sound very much like proud parents of precocious children. And, as such, of course, we would like the record to show that we regard Senator Nelson as one of those rare neighbors who recognizes superior offspring when he sees them.

I am here to record my full support of the Scientific Manpower Utilization Act. Others will testify in detail about the four experiments in which the State of California and our great aerospace industries joined to apply systems engineering to social problems. I am here to discuss the circumstances which led to this pioneering effort. I will describe the high hope that we have for such programs, and I plan to discuss generally some of the promise that this dramatic project holds for improving the quality of life for Californians and for all Americans.

California's aerospace studies are part of a constant search for excellence in government services which has led our State into many pioneering programs over many years.

Now these studies arose from a concern not only for the quality of the life we lead today, but for the kind of a world we will pass on to our children. And the concern arises from the pressures which our tremendous population growth places on schools, highways, public utilities—on every public and private institution in California—to expand to take care of this growth without destroying the very natural beauty which is the primary cause that people come to California and come to America.

Growth is not California's burden alone. By the end of this century, just 35 short years away—and I have been practicing law over 35 years and, in that time, time has moved so quickly that it is hard for me to realize that I have been practicing law over 35 years—there will be 150 million more people in America than there are today. Where there is one house today, there will be two. Where there is one hospital, one school, they will need two. They will need five times as much electricity as we generate today. They will drive 240 million cars—more than three times as many as we have on the roads today.

But California has been riding the wave of the future longer than any other State. We grow enough each year to create a city the size of New Orleans, and every 5 years by nearly enough to fill a city the size of Chicago. This means that we have to hire and train 2,500 new policemen every year. We must build classrooms for 200,000 new students every year. And we spend nearly \$1 billion a year on roads for some 10 million cars and trucks and for the 676,000 new ones we buy every year.

California is now the largest agricultural State in the Nation, but it is also one of the most urbanized. Nearly 90 percent of our people live in or near cities. We import and export more goods in foreign trade than any other State. Only New York leads us in manufacturing, and we are cutting down that lead at a fast rate. As a matter of fact, only four nations in the world produce more wealth than California at the present time.

But about one-third of our manufacturing is space and defense oriented. As such, it is subject to policies set nearly 3,000 miles from here and these policies can change on very short notice, as we have discovered in recent years with the phaseout of the Skybolt 2 years ago and the dropping of the M-1 hydrogen engine this year. I can't tell you how many people were thrown out of work by reason of that.

So shortly after the Skybolt I assembled a panel of leading executives from the aerospace and electronic companies to meet regularly with me in various places throughout the State—to meet with me and members of my staff. We were looking for two things: earlier warning of cutbacks and the possibilities of conversion in the event of a continuing drop in space and defense contracts. We started out thinking in the conventional terms of conversion to consumer production as an alternative to space contracts, but over a period of time two facts kept cropping up in those discussions.

First, fully one-half of all of the engineers and scientists trained in space research and development live and work in this State.

Second, these men shared a talent that might well be applied to the development of systems to solve nearly any problem of any kind that might be presented to them. And when we began thinking in terms of the public sector—the many unmet needs of our State—we began to realize that we had a precious and unused resource.

These were men who had been trained to think in totally new dimensions; to solve problems and create systems for carrying out missions unique in human history.

Told to get a missile to the moon, they got a missile to the moon. Polaris and Atlas didn't come from a Sears, Roebuck catalog. They came from teams of engineers at Lockheed and General Dynamics.

The record of California's aerospace and defense projects is rich in similar achievements—the Stromberg-Carlson tracking system for the pioneer Mercury orbits, United Technology's solid-propellant rocket for our first manned orbiting laboratory, Aerojet's nuclear rocket, and there are many, many others that I wish I had time to relate.

In most cases the teams that did this work are still right here in California. And as our discussions continued, we kept coming back to these questions.

If these men got John Glenn into orbit and back, could they get a father to work a little bit faster and get him home a little bit sooner?

If they can keep one man in space, can they keep another off the welfare rolls?

These engineers had designed and built systems to prevent the destruction of our cities by enemy attack. Could they design systems that would prevent our destroying the cities themselves?

About a year ago the members of my aerospace panel said they thought the answer was "Yes," and we signed \$100,000 contracts with four different firms.

North American Aviation was asked whether systems engineering could help us plan and build a transportation complex that would meet our needs for the next 50 years.

Aerojet-General was asked to investigate our methods of waste disposal, which cost California taxpayers \$300 million each year, and which each year leaves the air dirtier; the water fouler; the land more littered.

Space-General was asked to study crime. We spend \$600 million a year fighting crime. This is only in the detention and housing of the people that are charged with violation of the laws. We have passed laws that keep violent offenders in prison longer. We have enacted, I think, the Nation's best narcotic laws. We have tightened controls on firearms and we have raised our training standards for police officers, but the crime rate here, like the crime rate in the entire United States, continues to rise.

Finally, Lockheed was asked to develop a better system for information; a system that would permit one police department to get information about a suspect as fast as an airline clerk can find out whether there is a vacant seat on a plane 3,000 miles away, for example.

We believe the experimental phase of this project is over. In every case the reports said systems engineering is a feasible approach to the problem at hand. In some cases the engineers said it was the only workable approach.

Now you have had unofficial testimony to the success of the studies of New York only last week, where Mayor-Elect John Lindsay hired one of our systems engineering firms to supervise studies leading to a reorganization of New York City government. That is in the nature of a rescue mission. We in California look on the studies as a first step toward preventing the need for such rescue.

In California we have been so encouraged by the first studies that we are planning to call for bids on a fifth—a survey of our social welfare program. The nature and causes of poverty and dependency have changed since the 1930's, when most of our welfare programs were started. But the programs themselves have changed very little in response to new social and economic conditions. To the degree that they are out of touch with reality, they are ineffective. We want to know how to cut the costs of dependency by helping people avoid poverty. We want to know how to cut through the paperwork curtain that separates a social worker from the people who need his help. We hope to get the beginnings of the answers to these and other questions from this new study.

Now as you investigate the possibilities of systems engineering, you will hear claims made for it that put it in the class of sorcery. As a Governor I want to emphasize, with all of the emphasis that I have, that I do not expect magic cures from the systems approach, nor do I anticipate abdicating my responsibility as Governor for public policy to a bank of computers. Our pilot studies have been very clear on this point. The models—the computer simulators—can give us factual comparisons of the results we can expect from various approaches to problems, but they cannot make decisions. What the systems engineers can do is construct a set of facts without bias or prejudgment of the results.

Frank Lehan, of Space-General Corp., calls system engineers “the grand skeptics.” Says Mr. Lehan: “We have to be shown everything; we don't take anything for granted. We are oriented toward the cold mathematical scientific engineering approach.”

And it may well be that this “cold mathematical” approach is the only way that we can afford the compassionate goals of our society during the crucial decade just ahead.

Ironically, it is the heavy Federal investment in space and defense systems at the expense of the public sector that has led to the present major backlog of public needs.

From 1953 to 1963 Federal expenditures rose more slowly than the gross national product. During the same years, State and local outlay rose at double the rate of the GNP; from \$28 billion to \$65 billion.

As a matter of fact, Federal spending in areas outside of space and defense has actually declined in the past 20 years. And what has happened to costs at the State and local level? Here is where we have human beings. Here is where we have the people that are living in this world of ours today.

Education—up 155 percent.

Highways—up 123 percent.

Sewage and sanitation—up to 140 percent.

By 1970, the Brookings Institution estimates that State and local expenses will total \$103 billion and income, at present tax levels, will be \$88 billion—a gap of \$15 billion to be closed in 4 short years. And if you don't think every Governor and every mayor and every city council and every legislature is going to be faced with tough, hard problems in the next 4 years, I can just tell you that they are.

And yet, even with this huge deficit, large areas of the public sector are starving. Highway construction lags behind actual needs. The Federal highway program will run behind about \$2 billion. Pollution clouds air and water. To even make a beginning on smog in California will cost almost \$1 billion. Blight breeds slums faster than they can be torn down. A recent study by the Office of Education shows that 23 million Americans have never finished the eighth grade; 8 million more haven't had enough education to fill out an employment form.

Systems engineering will not turn Government fiscal night into day. But if it lives up to its present promise, it may brighten our prospect by permitting us to find less costly ways to do no worse than hold our own in important areas of public need.

Finally I want to support Senator Nelson's contention that Federal funds should be invested in such systems engineering studies in the various States. I have spoken so far of the struggle the States are having to meet their obligations in an increasingly complex society. But this is, as I said a moment ago, not only a problem of California; it is a national problem.

In a mobile nation such as ours, where people are on wheels, very few problems can be said to be truly local in character. Each of the studies California has produced could as easily be applied to any of the other 49 States. Air and water pollution, as Senator Gaylord Nelson probably knows better than any other person in our land today, do not respect State boundaries. Nor does education in these days when a family—or a baseball team—may move halfway across the continent between seasons or sessions or even games.

One factor—cost—makes these studies more national than local in scope. No State can afford to carry the burden of a fully engineered system in very many problem areas. And even those who could do so should not be asked to, since these studies will be useful in nearly all of the States.

Systems engineering is not an inexpensive way to solve problems. The State of California paid \$100,000 for each of its four studies. I am advised that this same amount in the Apollo project bought no more than a calculation of the velocity Apollo will need to escape the gravity of earth. I think it should be noted, also, that all four of these companies made substantial investments of their own funds in our projects.

But while the short-term cost of systems development is high, our studies indicate tremendous long-term savings.

In waste management, for example, it would cost \$100 million to develop a new system. The new system would cost \$1,500 million a year to operate, as against a \$1 billion yearly cost for present methods. But we would have a net gain of some \$3 billion a year because we would cut the damage caused by pollution.

In data collection, we would spend \$130 million over a 10-year period to develop a new system. But the system would cut California's paperwork bill by three times that much in its first year of operation.

As a matter of national policy, the Federal Government has invested some \$22 billion over the last 9 years in the race for space, which gives us some relationship. It puts in perspective some of the things that you are seeking with your bill. In doing so it has concentrated more research scientists and engineers in the aircraft and missile complex than exist in all of the chemical, drug, petroleum, motor vehicle, rubber, and machinery industries combined. The scientists of the space industry have demonstrated that their talents can serve causes other than space.

I submit that the engineering needs in other fields where the broad public welfare is at stake are as urgent as those in space. And I agree with Senator Nelson's thesis that we have the scientific manpower to pursue a guns-and-butter policy, if necessary.

When I appeared before your committee in July of this year with the first preliminary report on California's aerospace studies, I said that over the centuries men have stumbled on new minerals and new techniques and then hunted for a way to use them.

These studies make it clear that we have progressed to a point where we can reverse that process. We can now decide what must be done to cope with a problem facing man and design a system to do it. This is, in my opinion, an exciting turning point in man's history.

Thank you very much.

Senator NELSON. Thank you, Governor Brown.

I neglected to mention before you started your testimony that we have on my far right Mr. Millenson, who is minority clerk of the Senate Committee on Labor and Welfare, and he is here today representing Senator Javits, of New York, who was unable to be here and is a member of this subcommittee.

Governor BROWN. May I introduce Harold Walt, deputy director for the California Department of Finance, who is in charge of this planning program for the State of California.

Senator NELSON. You stated that you spend \$300 million a year in waste disposal. Is any of that being spent for research?

Governor BROWN. I don't know whether this is included within that figure, whether any moneys are being spent on research, but we

are taking advantage of many of the Federal programs in connection with research. We are doing research at the University of California.

In the smog program, for example, we have a research program here in Los Angeles. We have one at the University of California. Our air quality studies are being researched.

In water pollution, in connection with the building of this great water project, the legislature has authorized a substantial sum of money for research on the effect of this new program on water pollution in San Francisco Bay.

I can't give you those figures. Maybe Mr. Walt can help me. Can you give me that?

Mr. WALT. Senator, \$300,000,000 does include a great deal of research on air, water, gases and pollution. The university, as the Governor said, is primarily responsible for this, but we have our water quality control board interest sources, an agency in the State also working on this and perhaps a third of this magnitude is devoted to power research.

I might say the professionals in this field welcome the new approach offered by Aerojet-General Corp. in their study, and the study is really a combination of the efforts of the systems engineers, the water and waste specialists, and the State government. Together they work to produce a product none could produce individually.

Senator NELSON. I think in that project the waste management study is a classic case of using this kind of a method.

People raise the question all of the time about the cost. The testimony before the Subcommittee on Air and Water Pollution, of which I was a member for 2 years, is that air pollution is doing \$11 billion damage in this country, so we could well afford to put a few billion into research for purposes of prevention.

I think most people who have not given consideration to this kind of approach to the problem don't recognize that until you have a total evaluation of all of the courses of pollution this country—air and water and pesticides, and any other—plus the evaluation of the cost to the country of permitting pollution to continue to damage resources as a consequence, and until you have an estimate of what it would cost to eliminate the pollution by bringing all of industry and all of the municipalities and the treatment of this pollution to the highest state of the art, and then until you have made a massive investment in research in all fields for new methods and techniques for disposals of wastes and neutralizing the effect of wastes, and until that has been done by a very careful method of systems analysis, we aren't prepared to proceed. And it doesn't do any good for us to take the pollutants out or the air and put them in the water.

It doesn't do for St. Louis to clean up the water they take from the Mississippi when all of the water above them also is polluted.

I think the finest example of this case is where the techniques of the systems analysis and engineering can be applied in order to give us the basic information necessary to have some judgment of the scope of the problems that confront us, and then the information necessary to work out some techniques to meet the problem.

Governor BROWN. I agree with you 100 percent. Let me give you one specific example here in California: We have this smog situation here on which we have made great progress. Every automobile sold

in California this year must have an exhaust device; they must have it on their crankcase. Every used car that is transferred must have it on its crankcase. It is an industrial waste we have cut down, but in order to really get rid of 70 percent, according to the studies, it will cost \$65 for every used car in the State plus an installation fee. The device would cost \$65 and probably an inspection fee.

So you take the 9 million automobiles in the State of California and take, say, \$100, to each one of those cars of our State, and this is \$900 million that we will pay to get rid of smog in the State of California.

Now, it is entirely possible that there is some other form of engine that could be developed with that \$900 million; possibly an electric engine of some kind. I don't know what it is, but I think you have to think in terms, not of the next year or 5 years, to get rid of this situation, because your automobiles are going to continue, and that 30 percent will still be there, and pretty soon, with new automobiles whatever we eliminated we will accumulate from the new cars that are coming in. So over the next 20 to 25 years we may have revolutionized the type of gasoline engine we have at the present time, in order to avoid pollution of the atmosphere.

So these are things we are going to have to study, and I think that study on waste disposal pointed that out very well.

Senator NELSON. I think you are certainly correct. There has been very inadequate research in the field of the control of exhaust from automobiles. Maybe with some extensive research you may solve, totally solve, the problem.

On the pollution there might be a combination of an internal combustion engine. Obviously, they are going to have to convert some source of power such as the fuel cell, but at least we won't know until we have made an extensive investment in research.

But it turns out to be the responsibility not of any single industry or any single type of industry, but it is going to have to be the responsibility of funding in terms of the Federal Government.

Do you have any questions?

Mr. MILLENSON. Are the current Federal funds available for research by the States inadequate to cover the cost of systems analysis research?

Governor BROWN. What was that?

Mr. MILLENSON. Are there funds for systems analysis available from any source of the Federal Government now?

Governor BROWN. Yes. The Aid to Education Act provides for research, and we can put that money into any research contracts that we feel would meet the criteria set by the act.

I think that we have given to the Coordinating Council for Higher Education, the State board of education, the use of Federal funds at the present time for systems engineering research into education in all of its phases.

Mr. MILLENSON. Are there Federal funds available for research in the field of waste management?

Governor BROWN. I think there are some under the Clean Air Act. I think we can get \$1 million from that.

I don't know the effect of the Muskie bill. There are research funds in the Muskie bill on water pollution; and there are some, I can't tell you what they are, but there are certainly funds available for research.

Mr. Walt, Senator—we have one person that coordinates all of the Federal programs with the State programs. I can't keep up with them all, including the poverty programs.

Mr. WALT. I might add to what the Governor said. We feel one of the great benefits of this enlightened legislation is to bring to bear in one spot the magnitude of funding necessary for a real systems evaluation of the program. There are, as the Governor said, already Federal accounts providing funds, such as the Clean Air Act, a Law Enforcement Assistance Act, and these are bits of legislation, but the problem, sir, is the amount of money really is inadequate for a true systems evaluation of the problem.

The clean air bill provides only \$400,000 for example, for planning the type of studies throughout the country.

Really, what we are talking about is in the order of \$10 million a year for one State. The advantage of research of this magnitude in California is that the results are immediately transferred to other States. So we feel that the great step forward you have taken is to focus in one place money earmarked for systems evaluation at the various social problems rather than using the various bits of Federal legislation, which incidentally provide for systems analysis.

Senator NELSON. Are there any funds for grants to industry to engage in research in the development of new devices for disposal? For example, that is, money for research to produce a better—

Mr. MILLENSON. Garbage disposal?

Senator NELSON. Or what have you.

Mr. WALT. Yes, sir. There is one bill, the State Technical Service Act, which we are very pleased with. The University of California has been designated by the Governor as the administration agency. The purpose here is to bridge a present gap between the research of colleges and universities and private industry, which needs to use this research. So, through this legislation we hope to get funds into industry for means of developing salt-waste disposal plants and water desalinization plants, and so forth.

Senator NELSON. Is there money available, or would there be money available in any of these programs for total waste-management evaluation?

Mr. WALT. No, there is not.

Senator NELSON. You have anything else to add, Governor?

Governor BROWN. No, that is all, Senator.

Senator NELSON. I appreciate very much your taking this time.

Excuse me. You have some more questions?

Mr. MILLENSON. Yes. Governor, referring to section III of the Nelson bill, and that is S. 2662, it says:

The Secretary of Labor (hereinafter referred to as the "Secretary") shall carry out the purposes of this Act by—

- (1) making appropriate grants to States, and
- (2) by entering into appropriate arrangements (whether through grants or contracts, or through other agreements) with universities or other public or private institutions or organizations,

Now, with respect to the grant of State programs under subsection (1), there is no provision in the bill for specific allocations to the States. As you know, in legislation before Congress, we provide the money evenly on some basis.

Do you have any thoughts as to whether this measure should be changed to make any special proportionate allocations to all the States, so each State might have an opportunity to get some of these funds?

Governor BROWN. I would rather have Mr. Walt answer that question.

If you will.

Mr. WALT. Our feeling, sir, is that the allocation to States should be on the basis of excellence and on the value of the product with results of such grants.

We feel the distribution of Federal funds for this type of research should not be made on the basis of geographical or political ways, but rather which State is best, by its own investment, prepared to give the best product to the Federal Government.

We would urge the allocations be on a competitive basis, open and free competition, among the several States, and not allocated on a pro rata basis.

Mr. MILLENSON. You just used the words " * * * how each State by its own investments * * * "

Now, that brings up another question, if I may, sir. This bill provides for grants to the States, but it provides no matching-fund arrangements.

Do you feel by your words " * * * by its own investment * * * " to point this up that there should be some matching-fund arrangement, as we have in so much other Federal legislation?

Governor BROWN. My answer to that would be during the experimental period, during the period that we are really starting out, that it should not be on a matching basis. I think if we put it on a matching basis, this might deprive some other areas that are excellent in other categories, but could not provide the necessary funds, and it would prevent them from moving into that field.

Mr. MILLENSON. In the light of what you say, would you feel that possibly we could have a higher Federal matching, say 90 percent during the first year, to encourage States to enter into this program, but still not require too much of their funds, and then have a lower Federal matching in the later years of the program? Would you still feel that way?

Governor BROWN. I put that in the same category, really, as the work you are doing in space. And in that connection, this is not a State program. It is a national program. And I think that the way we have to regard the space-age engineering contracts from here on out, I think we have to regard them as national, perhaps, rather than to think in political lines, State political lines, on this thing.

Mr. MILLENSON. One other question, if I may, sir. You mentioned the studies being undertaken by Mayor-elect John V. Lindsay in New York with respect to the problems of that great city. And here in the bill we speak of engineering approaches to be applied to national or local problems of the type which the Secretary might designate.

The bill, however, provides only for the making of appropriate grants to the States. It does not apply to the making of any grants to cities, such as New York City. You referred to Mr. Lindsay's own efforts, and I assume your own Mayor Yorty here in Los Angeles might be of a mind to undertake such programs.

Do you think the bill might be changed instead of making appropriate grants to the States, to include also cities or other units of government?

Governor BROWN. The city of New York seems to be a special problem, and I don't know how you would write legislation in that connection. New York, with a budget larger than almost any other State in the entire United States, is almost a separate problem, and I wouldn't want to—if I were voting on a bill like this or drafting it, I certainly would want to take the city of New York into the scope of these plans, but for the time being, other than the city of New York, it seems to me that it should be done on a statewide basis.

So you are going to get into parochial problems. You are going to get into city problems, and really and truly, all of our work should be directed toward problems of waste disposal, air pollution, and things like that.

I think you are going to have to forget even State lines. I think these are national problems that observe no lines at all, and if you start getting into cities and you start getting into fighting over these awards, I am afraid we are going to lose the principal purpose of the Nelson bill.

Mr. MILLENSEN. You are not suggesting we strike “* * * *” problems facing localities “* * *” from the bill?

Governor BROWN. No; in the grants I would like to see it done on the larger political entity, the States, but the city of New York is something that—if I were drafting a bill—I would like to consider.

Mr. MILLENSEN. You wouldn't include Chicago or Los Angeles?

Governor BROWN. I really don't think that we should move into that field at the present time. Don't misunderstand me. Los Angeles has big problems and so has Chicago, but how you could ever write the bill that would limit it only to the city of New York is difficult for me to say, as I am talking with you today, but I just don't want to get into some of the problems we have in the poverty program in giving these things to cities, and that is without giving the State government some opportunity to look at this thing from a regional basis rather than a purely local basis.

On a statewide basis you can separate purely urban and purely rural needs. The problem of pollution may have its origin in rural sources and its impact may be in the urban locations.

Similarly, the recreation needs of Los Angeles and New York City would affect the rural recreation areas of northern California in our State. So we have to look at our problems on a statewide basis to get the best mix of needs as long as it is from the urban centers and the rural centers.

Mr. MILLENSEN. I refer you to section II of the bill, which says:

* * * The problems referred to in the preceding sentence include, but are not limited to, problems in the area of education, unemployment, welfare, crime, juvenile delinquency, air pollution, housing, transportation, and waste disposal.

Some of these are very much State problems and some appear to me to be city problems, too. Seventy percent of the people of the Nation live in the metropolitan areas.

Governor BROWN. You take crime, for example. One of the problems in California we have is that probation is handled by the local area. We have the parole that is handled by the State area. We have

the highway patrol. We have the department of justice, and then you have your local police forces.

I agree with you wholeheartedly the problem is in the city. This is where the human beings are; this is where the problems are, not in the political entity of the States. But on the other hand, the whole purpose of whether it is crime or transportation or waste disposal, it has to move beyond the local government if we are going to solve them.

In California we have some 375 cities. We have 76 cities in the County of Los Angeles alone. If you try to put it on a city basis, you are not going to solve these problems at all; whether it is crime, waste disposal, transportation, or anything else. It will eventually get down to them, but under the purpose of this bill, to do this research, it is going to have to be done on a national level, and I think through the State government.

Senator NELSON. I think Mr. Millenson has had some very good questions.

I am sure one of the purposes of the hearings here and the subsequent one in Washington will be to have a penetrating analysis and evaluation of the bill so that any change that ought to be made will be made in it.

It was my intention in drafting the bill that the problems tackled were problems that had a universality about them, and grants can be made under the bill to States or groups of States, but not for the sole purpose of solving that State or that group of States' problems, but that the answer they come up with would be applicable to the solution of the similar problems in all of the rest of the States. And if a grant were made to private industry for some aspect of waste management, that the answer they came up with would be as applicable in New York City as it would in the Los Angeles area, or as it would in Seattle.

Therefore, we did provide in the bill that no States could receive in excess of 20 percent of the total amount of money allocated for this purpose. But it was my thought that there would be some States and some groups of States in various parts of the country that had the expertise in their universities and their State governments, in their industries, to do a cooperative effort that had applicability in all parts of the country, but which could not be done by many, many other States, and that it would be a waste of money to apply some formula in which every State gets some money to do something with it, since the major portion of them wouldn't have expertise to do it, but they would benefit from the answers that were found, no matter who did the research, whether it be private industry, universities, or individual groups of States.

Many of these problems have direct applicability to cities, and the cities would benefit from the work that is done in that field. I thank you very much, Governor.

Governor BROWN. Thank you very much, Senator.

Senator NELSON. Our next witness would be State senator, Thomas M. Rees.

Senator Rees, before we proceed I see you have a prepared text here. You may read it or extemporize from it, whatever you wish. The whole text will be printed in the record.

STATEMENT OF STATE SENATOR THOMAS M. REES, 38TH DISTRICT,
LOS ANGELES COUNTY, CALIF.

Senator REES. Thank you, Senator Nelson. I very much appreciate your subcommittee coming to visit us in California. As you know, California has taken the leadership in trying to solve the vast, basic metropolitan problems.

I am the State senator from Los Angeles County representing its 6.7 million inhabitants, at least until our reapportionment bill is going to be law.

Senator NELSON. I might say your single district is bigger than mine.

Senator REES. That is what I understand. I figure in the U.S. Senate, with apportionment by one man, one man vote, we would have three and a half U.S. Senators in our county.

I have specialized during most of my own legislative career in the area of metropolitan problems, and what I would like to point out is that metropolitan problems do not follow city and county lines. I think, though, we can develop some very lasting solutions toward metropolitan problems and at the same time preserve local initiative and the concept of home rule, which in California is very strong.

If the metropolitan areas of this country are to survive, we must tackle the grave problems being generated in these population centers on a functional, regional basis.

We will not win the uphill battle against urban degeneration unless we abandon strict reliance on existing local governmental jurisdictions to do the job.

I am not proposing that we abandon local government. Rather, I propose that we reorganize it so it can best cope with the crisis with which it is confronted.

Here in Metropolitan Los Angeles we can well see the difficulty in attempting to exercise any kind of control whatsoever of this fast-growing metropolitan complex.

Los Angeles County alone consists of 76 different cities; the Los Angeles metropolitan area, which might be defined as the basin formed by surrounding mountains, includes 5 counties.

The result of the maze of local governmental jurisdictions, many designed long ago to meet needs of long ago, is a nightmare of overlapping problems and conflicting interests. We find that regional problems, which should be attacked with a comprehensive plan, are merely being nibbled at on the edges through piecemeal efforts.

It is my belief that we can attack regional problems with regional thinking and planning without subverting the concepts of home rule and local government, which I support strongly.

Take a look at some of our problems such as air pollution, water pollution, waste disposal, transportation, parks, recreation, and planning. Each of these functions must now bow to preconceived city and county lines, despite the fact that air pollution, for instance, exists in a basin and certainly does not halt because of the existence of a city or county boundary.

The lack of coordination, the lack of a total integrated concept in approaching these major problems, could well destroy the rationale behind the existence of our major metropolitan areas. Our society

could become so encumbered with small, conflicting jurisdictions, incapable of handling these problems, that it would be impossible to solve the problems.

There is one good example of regional planning and building in our metropolitan basin which should be mentioned because of its great success. We have a basinwide flood control district which has been jointly supported by the city, county, State, and Federal Governments. As a result of this functional, regional approach to a problem, major disastrous floods which used to plague southern California are now no more.

This flood control district is an excellent example of what can be done when we forget petty, local politics. And I think there is something to be learned here which might be applied to a grave new problem as represented by the recent Watts riots.

As a matter of fact, there seems to be some cooperation developing between all levels of government in the wake of the Watts riots. The petty politics must be swept aside if we are to solve the basic Watts problems of a Negro ghetto with lack of economic, educational, and family opportunity.

There will be more Watts riots in our great urban centers because we have already moved too slow, too timidly. But we can prevent major conflagrations if we move now to develop strong Federal programs, better coordination between all levels of government and, most of all, a rejuvenated local commitment to solving these problems on a coordinated, regional basis.

I would like to specifically encourage your careful attention to the legislation you are studying, authored by Senator Gaylord Nelson, which calls for Federal funds to develop studies on major metropolitan problems. I believe this money would go to defense contractors along the lines developed here in California by our own great Gov. Edmund G. Brown.

We are now digesting four major studies developed by California defense contractors, financed by the State of California. I can tell you gentlemen that the men who have pioneered in space can apply their analytical talents to some of our major problems here on earth, in our cities, and come up with valuable insights.

We need this new thinking and we need to have modern technology applied to our great urban problems. We need the men who dream tomorrow's scientific advances to dream up new solutions to our mounting urban problems. And we need the resources of the Federal Government, and the perspective of the Federal approach, behind the study of these problems which cross even State lines.

This is no time for politics as usual or government as usual. We must develop bold new concepts to meet the mounting crisis in our urban centers.

I am not saying we should abandon local government, but I think we can develop new concepts by which local government can work together in terms of achieving one result.

Here in this 1 metropolitan area, which is defined by the basin, our famous smog basin, in which we have hills and mountains surrounding all of this county and about 4 or 5 other counties, in this 1 city or in this 1 county we have 76 separate cities. We have well over 100 school districts, 1,000 special districts. One of the special districts, of course,

is this district here, the metropolitan water district. We find in the metropolitan area, the basin, we have five different counties.

I would say that the total population of the basin, taking in the 5 counties, would be something like 10 million people. And this is an area which, as you well know, is growing at the rate of not hundreds of thousands, but of millions.

I can remember when I was a youngster—and I am not that old—I used to take the opportunity to go to the San Fernando Valley. In fact a good part of my single district is now definitely built up and we are finding more and more congestion in this basin, and are finding that really we have a nightmare of conflicting jurisdictions.

I think we have to start looking for more in terms of regional government; that is a concept of government that follows the function in terms of the problems that exist in metropolitan areas.

Now in the East, for example, we have congestion. If you look at the New York metropolitan area, you are not just talking about several cities. You are talking about quite a few States, and each and every State is going its own way, and as a result a policy is needed to solve the grinding problems of concentration in the metropolitan areas, and it is just not there.

And so I am very much interested in the work being done by your subcommittee. Now you are well aware of the studies that have developed through the leadership of Governor Brown in the aerospace industry on waste disposal, crime, and so forth.

I think you are showing leadership, and I think the type of leadership that you are trying to develop at a Federal level where we don't just talk about a State or a group of States, or like problems, must be found in the metropolitan complexes throughout the United States.

We find this, for example, in air pollution. We have a more bifurcated concept for air pollution. All permanent sources of steam-plants, factories, refineries, whatever it might be, all of these are under the jurisdiction of the local air pollution district and the motor trucks and other vehicles are under the State jurisdiction of California, because they go from county to county. Los Angeles County has taken the burden in the field of air pollution.

I can remember when I was back in Washington in 1958 attending the National Air Pollution Conference under the Surgeon General's auspices, and they used to laugh at us in California, especially Los Angeles County, calling it a smog belt.

The people from Detroit were there, the public relations men especially, saying the motor vehicle didn't cause air pollution, and it wasn't a problem, and the people from California were kind of "way out."

Now I read in the papers that smog attacks in metropolitan areas are becoming more and more severe, and air pollution has become a difficult problem, in the New York area, for example.

In California, while we have spent most of the money which has developed the basic research and the basic concept toward attacking air pollution, we find we can't solve the local problem without some type of Federal cooperation.

Let me give you one example. As I say, we have five counties in this basin. Just because there is a county line, that doesn't mean the air pollution stops at the county line and doesn't flow over. It certainly does flow over, and we have found that the very intensive

agricultural industry that we have in southern California has been definitely threatened, especially the big leaf crops.

We also found we can only go so far at the State level. Right now all cars, new cars, being sold in California must have a complete package in terms of tail pipe and crankcase device. You can't purchase a new car, with few exceptions, unless it has that series of devices on it. But what do we do about cars that have been driven from other States into California?

I think one thing that the Federal Government can do, and as I read the air pollution legislation that was passed this year, I don't really feel it is adequate, because most of the emphasis is on the disposal of solid waste, and there is relatively little emphasis in terms of the actual problem of pollution of the air. I think that the Federal Government could develop standards with respect to the design of an internal combustion engine.

I think there are 8 million gallons of gas purchased in Los Angeles each day, and of this 8 million gallons about 10 percent goes out into the atmosphere.

The basic problem is the efficiency of the automobile engine and also they could come up with a composition of gasoline or the fuel that is in the tank. I think we need stronger Federal standards in both terms of the designing gasoline and also in terms of an internal combustion engine.

I think we need further Federal research in weather control. Our problem in southern California is that we have this basin of mountains. We have an atmospheric condition known as an inversion layer where the hot air is on top and it keeps the other air from going up.

About 3 or 4 weeks ago we had a 4-day attack. It was this stagnant air. Each day as the 4 million vehicles of southern California went onto the freeways you could see this inversion layer just sitting there like a lid.

I flew from Sacramento during one of the bad attacks—it was fantastic. Everything was blue and you could see the top of the mountains. This smog layer, as we went through the layer, we could smell the ozone in the air, and then we got into the muck we call smog. Perhaps there could be research in the area of weather control. There may be some method to break this inversion layer if necessary.

I look at the other problems that plague this metropolitan area. One of them is water pollution. We find that in our inner harbor area there is enough pollution to keep fish and marine life from living. We find that we have definite problems in the San Francisco Bay area. This is an area surrounded by five or six counties. There is a definite problem of the existence of marine life, and when you find this you work into a health hazard.

We have the problem, for example, at Lake Tahoe, one of the great recreational areas of the West, and we have studies that have been developed that show if there are not steps taken—and this has to be done between States of Nevada and California—Lake Tahoe will not be fit for human recreation for another 10 or 15 years, because they are putting raw sewage in it and everything else.

There does need to be more of a concentration on how to solve the problems on the functional basis. In a way you are going to have

to ignore these lines that have very little rationale that are called cities and counties, because problems flow across cities and counties.

I will give you one good example. We have in this basin a flood control district. The citizens of this county voted themselves a bond issue of several hundred million dollars to pay for their participation in the overall Federal program of flood control, which is under the Army, the Corps of Engineers.

So we have this cooperation of the Army Corps of Engineers, which constructed the project. The State of California and the local government more or less purchased the rights-of-way and also built certain diversions that aren't considered as a Federal responsibility. As a result we have been able to solve much of our flood control problem. The 4 or 5 inches of rain that occurred this week, 20 years ago would have meant very serious flood conditions. Instead of those conditions they were relatively minor in terms of minor flooding of certain streets and intersections.

This is a concept where the Federal Government has worked with local government, and in cooperation with local government no one really feels the giant of the Federal Government is coming in and telling them what to do. It is a two-way proposition and it is based on a functional problem and not a flood control system for Orange County and another for San Bernardino and another for Los Angeles.

I think also we can see some of this if we analyze the Watts riots, because we find again the Watts area encompasses several jurisdictions within the city of Los Angeles, which has never been master planned incidentally. In the county it is part of Willowbrook and part of the city of Compton, and there has never been any program to tie all of this up.

Now in terms of property aspects and the job aspects, we now have good cooperation through the youth opportunity board, and Mr. Ganoda who developed this cooperative project with the city and the cooperation of the State, the county, and the Federal Government, and we are making some progress there.

I do think again that the role of the Federal Government should be that of a coordinator, and since the Federal Government will be supplying some funds, with these funds they can say we will only cooperate if this is done on a regional basis. We will not single-shot it by hitting separate jurisdictions.

I would like to—I never quite read a statement—I try to run through it and try to pick out the salient points.

I think the studies that are now being developed by the State of California are excellent studies, but again, these studies depend on the cooperation of all levels of government, if we are to, for example, collect all of the information concerning government and to concentrate it in one source, this means cooperation all the way through.

So to repeat, I think of the many problems that local government has, as we conceive of it, and local government is based on a preconceived line of jurisdiction that was put together 50, 60, or 100 years ago, and it really didn't anticipate the problems we have.

I look at the area of rapid transit, where I have done a great deal of legislative work, and we find in southern California if we don't develop a rapid transit system in another 10 or 15 years that people are

going to spend more time in their automobile going to and from work than they are going to be spending at work.

There is a Federal program in rapid transit, but it is a matching program, and unfortunately this community has not decided to get off their rear end and develop their own sources. I do have a strong feeling on this.

I don't think the Federal Government should come in and help the community unless they are willing to help themselves. I think Californians have been willing to help themselves. I would say my own area has not been willing to help itself in terms of a rapid transit. As the result most of the Federal funds are going directly to the San Francisco district because the people have gone to the polls and have voted for a very large general obligation bond issue to build this system, but still the money of the Federal Government that is going into this system is primarily for research. So all of the work being done in San Francisco for rapid transit will be of great help for southern California, because this is basic research that has to be done anyway.

I would think that with more Federal cooperation encouraging the regional approach, that we can have a lot more success. It is my strong feeling that if we just keep dawdling away with metropolitan problems, we are going to be in a terrible condition in another 10 or 15 years. We are going to find local government just won't be able to do the job.

I think this was one of the major issues in the New York City campaign, because in many ways local government in New York is disintegrating in handling this huge problem of concentration of people, the existence of racial ghettos, the problem of communication, trying to develop an overall concept of education, and trying to develop concepts of job training.

And so this is where I think that legislation, such as yours, can be of great help, because there are standard problems in every metropolitan area.

It is the same problem of pushing people together and the resultant harassment and air pollution and lack of economic opportunity. The existence of racial ghettos, and all of this constant throughout the Nation.

We pride ourselves, for example, on racial relations here in southern California. We thought that we had been passing a lot of good civil rights legislation in this State, but still Watts happened here, and what happened in Watts can happen in any crowded metropolitan area, especially in the North where the people come from the South to find hope.

So I am in basic agreement with your legislation, and I hope that this legislation should not be developed just in terms of Federal programs or local programs, but I think we have to look at each and every problem and we have to tailor the legislation to that specific problem. We must have cooperation of all levels of government.

If it is really a nationwide issue, we could have basic Federal auspices, but I think we have to look at each problem separately and design legislation that can hit that, so you have a combination of local initiative for the local unique problems plus the ability of the Federal Government to look at the overall picture.

Senator NELSON. Thank you, Senator Rees. The next witness is Julian Smith, chairman of the Southern California Industry Planning Seminar. Mr. Smith, we are happy to have you here. Your statement will be printed in the record. You may proceed as you please.

STATEMENT OF JULIAN M. SMITH, CHAIRMAN, SOUTHERN CALIFORNIA INDUSTRY PLANNING SEMINAR

Mr. SMITH. Senator Nelson, members of the subcommittee, my name is Julian M. Smith and I am chairman of the Southern California Industry Planning Seminar. The seminar is an informal group which meets on a monthly basis to consider problems associated with the aerospace industry, the national defense, and the southern California regional economy. During the last 2 years, the seminar has concentrated on problems involving the California economy and the outlook for changing government demand; the economics of national security; applications of aerospace technology to major public problems in California; and the implications of aerospace industry diversification. Members represent aerospace and electronics companies, chambers of commerce, nonprofit research agencies, State and local government, financial institutions, and the universities.

The Southern California Industry Planning Seminar endorses the Scientific Manpower Utilization Act. This legislation is clearly a national extension of Governor Brown's California program which was supported by the seminar prior to its inception. We believe the bill now being examined by this committee represents a realistic means of capitalizing on technology for coping with urgent problems facing the Nation, the States and various localities. It has been our observation that more funds are becoming available to support new Federal, State, and local programs in the nondefense sector. With the achievement of some of the major objectives of national defense, the systems analysis techniques developed and practiced by the aerospace community are becoming available in increasing amounts and will apply to new and different problems in the public interest. In fact, the activities of this committee demonstrate that the products of science and technology are being diverted from traditional objectives of national power to equally important applications involving domestic needs. With the completion of the first studies for the State of California, the aerospace industry has demonstrated its competence in this new endeavor and we are now justified in our belief that the problem-solving talents of the industry are well suited to the solution of civilian problems.

In direct support of today's legislation are two new programs which utilize scientific manpower to deal with law enforcement problems in southern California at the municipal level. One program is designed to speed various law enforcement processes through the increased application of computer technology to police work. A second program strengthens the government-industry alliance and stimulates scientific interest in municipal problems through the direct participation of the aerospace industry. This group has also directed its interest to the technical problems of law enforcement for several reasons. First, municipal police agencies have many technical prob-

lems similar to those of military organizations and it is expected that solution techniques can be transferred directly to law enforcement use. Second, any program which utilizes the capabilities of the defense-space industry must achieve tangible results quickly in order to win acceptance and support by government and industry. Third, the maintenance of internal law and order is among the most important domestic problems facing the Nation today. Finally, the achievement of success in combining science and law enforcement will provide advantages to local industry through the creation and expansion of new markets and products for worldwide police use.

These examples of utilizing aerospace industry problem-solving techniques in municipal problem areas have been enthusiastically supported by local government agencies and industry. We believe this particular example of technology transfer underscores the wisdom and practicality of the legislation being considered today.

Our experience with the Southern California Industry Planning Seminar suggests that the Scientific Manpower Utilization Act will bring systems analysis and systems engineering to bear on problems of education, unemployment, welfare, crime, delinquency, pollution, housing, transportation, and waste disposal at the national level. We are also of the belief that the same technology can be extended to problems involving the development and administration of natural resources, that is, the management of power and water, recreational planning, fire prevention and control, weather and oceanographic forecasting, earthquake cause and prediction, flood control and others. Thank you.

Senator NELSON. Thank you very much, Mr. Smith, for your fine contribution.

Do any of you have any questions?

Mr. SMITH. Thank you for taking the time.

Senator NELSON. Our next witness is Paul Schrade, California regional director of the United Auto Workers of America. Mr. Schrade, we are pleased to have you with us today. Do you have a prepared text?

Mr. SCHRADER. No, I don't. I have some remarks. I have made some notes.

Since I was advised by the Governor's office that this hearing was to be held in the middle of the week, and I have been to Washington and back and didn't have a chance to really prepare a written text. I think the point I want to make, at least try to make, will be brief.

STATEMENT OF PAUL SCHRADER, CALIFORNIA REGIONAL DIRECTOR, UNITED AUTO WORKERS OF AMERICA

Mr. SCHRADER. I represent some 65,000 members of the UAW, mainly living and working in California in the auto and aerospace industries. We have taken a very active part in supporting and defending the Governor in his programs to use systems engineering in solving major social problems. And we have done this in a cooperative and constructive way.

We feel that a great emphasis ought to be put on the human needs that will be served by these programs, and the problems also that will develop as a result of these programs.

We know that we can put men in space and possibly on the moon; yet we have great difficulty in putting men on jobs, good jobs, which provide decent incomes and a good standard of living. And yesterday, at our industrial union department convention in Washington, Secretary of Labor Wirtz laid great emphasis on this whole problem of meeting human needs rather than just needs of the national economy.

Although we do provide a systems approach to solve our transportation problems in California, we must also take into account the fact that the kids in the slums of Los Angeles do not have a way to get to the public beaches or to the snows that sit on our mountain tops at the present time in the Los Angeles area, and these problems likewise have to be looked upon and solved. I am not advocating a systems engineering approach to government, but I am sure with all of the new programs in education, the war on poverty, the housing, urban affairs, all of these things are going to have to be coordinated in some way, that systems engineering also can be applied to getting the kind of governmental procedures and programs worked out so that the needs of the people of the Nation are met in a much better way.

We have talked often about conversion in the industry. Back as far as December of 1940 President Roosevelt recognized the proposal made by Walter Reuther, president of our union, in converting the automobile industry to build airplanes, which were used extensively in World War II. This program was adopted by the Federal Government, and we likewise are interested in conversion of the present aerospace industry to new programs.

This is one of the important interests we have in your bill, Senator, and the proposals made by the Governor of our State for the use of the aerospace industry in solving social problems.

Now, we know that because the possibility of disarmament is upon us that there have been great changes in this industry. There have also been great changes in the kind of jobs and the number of jobs available to the people of the Nation in this industry.

We think systems engineering ought to be also applied to the use of manpower and womanpower in this industry and their needs and their problems.

I would like to point out that we are going to have some problems within the aerospace industry itself, as newly constituted, that have existed for many, many years in building our aircraft, missiles, and space systems sponsored by the Federal Government.

We face often in the aerospace industry sudden layoffs. This occurred, of course, after World War II in great numbers. Tens of thousands of engineers and scientists and production workers were laid off as a result of the cancellation of the Navaho contract, the big missile program at North American Aviation, and, of course, the same thing occurred when the Skybolt missile was canceled at Douglas.

One top aerospace executive has said if we get a contract cancellation from the Defense Department, even on Christmas Eve, we will lay off tens of thousands of people because the money is cut off.

I think this problem has to be looked into as well; not only in terms of the development of jobs; but of more jobs for the people who are unemployed and looking for work, but also in the changes that occur,

so that the least economic shock takes place for the people who are subjected to quick decisions on the part of the Defense Department or the aerospace industry.

Recently this problem was illustrated in a different way. The Douglas Aircraft Co., in its commercial airline program, DC-8 and DC-9 programs, which are growing quite rapidly, was not able to find enough workers through the recruiting program here in California.

Along with the U.S. Department of Labor, and the departments of employment of this State and of the State of New York, the Douglas Aircraft Co. worked out a massive relocation of workers from New York to California to do simple, semiskilled jobs of aircraft assembly.

We immediately protested to the Governor, and to Secretary Wirtz and to Douglas Aircraft Co., because we thought a good enough job of recruiting and training had not been done here in California.

This is where I think systems engineering can again meet a great need.

The Defense Department, for instance, in closing down bases in its operations uses a computer to develop information about the people available, the jobs available, and what is to be done when major cut-backs in its own operations take place. So it has information on people and their skills, what cities they would be willing to move to and under what conditions. They have been able to work this out in a way that the aerospace industry or the various governmental agencies have not been able to in this industry.

I am sure that the whole systems engineering approach, as it comes to the development and use of manpower and womanpower in the country can meet a significant need.

Now, I believe that there are some problems that are going to really take a great deal of Federal intervention; not only in setting up the programs, because I don't think private industry, based upon its record, based upon its own statements, is really going to do much about conversion.

I think the new programs that are being developed, mainly because the Governor of our State has proposed them with the cooperation of the industry and the proposals that you are making, Senator, really point to the whole question of who is to do the job; who is to provide the guidance and the financing for such programs. I believe the major effort has to come from the Federal Government, because the attitudes and the resources of industry, the resources of the States, are just not adequate to meet the tremendous problems that we have.

First of all, in solving the problems that we are talking about of pollution and transportation and crime control, but also in the area of manpower and womanpower development and its use.

I don't think that, for instance, in the area of smog control the automobile industry without major Federal steps is going to do anything about the design of fuel or an engine to solve the problem of smog production by automobiles.

This is going to be true in the case of safety in automobiles. The attitude of the industry, as expressed before a Senate committee this year, gives strong evidence that there has got to be Federal intervention, both in directing these programs and in financing them. And we feel that this is the way it ought to be.

I would like to propose, first of all, that the use of this industry and the people in it and the people who should find new jobs in it be handled by a conversion commission similar to the one that Senator McGovern has been talking about and submitting bills about.

I am sure that if these things are done, we can take a very close look, first of all, at the human equation and find a way to not only solve major social problems through systems engineering, but also at the problems of providing good jobs for those people who need them; providing decent incomes for people so that they can have the kind of good life that we are talking about in the Great Society.

I think it is all well and good to say the Federal Government ought to do the whole job, but I think it has become much more possible that the Federal Government can do it.

First of all, we now have behind us a backlog of legislation dealing with the problem of unemployment, poverty, of conservation and recreation, of beautifying America. All of these kinds of things should be organized in a much better way than they are at the present time. But, in addition, the financing is going to be easier, because science and technology, much of which has developed out of the aerospace industry, will provide us with the potential for creating abundance that will provide for the needs of all of the people.

We are the wealthiest nation in the world. We can create much more wealth through the use of our scientific and human resources. We have tools of cybernation to work with now we didn't have before.

We see this as a golden opportunity for the Senate of the United States and our Federal Government to step in and solve many of our social problems, as well as providing for the needs of human beings.

Senator NELSON. Thank you very much.

Mr. SCHRADER. Thank you for the opportunity to testify.

Senator NELSON. Is Dr. Nash here from Lockheed? I understand you have to catch a plane. Would you like to come up here?

Mr. NASH. I would appreciate it.

Senator NELSON. Is there anybody else who has a deadline to meet that is critical?

Dr. ZUCKERMAN. I can wait until Dr. Nash is through, if you can hear me then.

Senator NELSON. Go ahead, Dr. Nash. I have been informed you have a plane to catch.

STATEMENT OF DR. J. P. NASH, VICE PRESIDENT OF LOCKHEED MISSILES & SPACE CO.; ACCOMPANIED BY KENNETH T. LARKIN, DIRECTOR OF SPECIAL PROGRAMS, AND LOUIS J. LAULER, PROJECT LEADER, SPECIAL PROGRAMS

Dr. NASH. Senator Nelson, I am a vice president of Lockheed Missiles & Space Co. It has been our privilege to be one of the contractors selected to carry out one of the four studies that Governor Brown initiated earlier this year for the State of California.

Lockheed, of course, has carried out a great many large and complex programs for the Department of Defense, for the National Aeronautics and Space Administration, and for other organizations of the Govern-

ment; in doing this we have, of course, conducted a great deal of systems engineering work ourselves.

One thing that has threaded all of these activities at Lockheed has been the need for a complex and complete information system in any work we do. In carrying out the Polaris ballistic missile program, for example, the Agena space vehicle program, and others, and also in concert with the work of the Air Force in developing international data systems, we have become convinced that information systems will take on a role of increasing importance. This is true not only for the massive programs in which we have been directly engaged, but also for the complex systems needed for governmental operations.

It was for this reason that we took a particular interest in the statewide information system study for California—the study we competed for and won.

With me today are Mr. Kenneth T. Larkin and Mr. Louis J. Lauler, the two men directly responsible for carrying out this study for the State.

Mr. Larkin is the director of special programs at Lockheed Missiles & Space Co., and Mr. Lauler is project leader for Government information systems. With your permission I would like to ask Mr. Larkin and Mr. Lauler to make a brief presentation to you about the California system.

MR. LARKIN. I would like to describe first the way in which we went about this study, something of the methodology and techniques we used, and then later describe some of the findings of the study.

As Dr. Nash pointed out, I had the basic management responsibility for this work at Lockheed. Mr. Lauler, who will present the findings, was the project leader.

I think the logical place to start is to describe the problem to which the statewide information study was addressed. The problem was indeed a comprehensive one; namely, the information needs of the State as affected by its entire population—all 19 million people—and by all real and personal property in the State.

It was a very challenging assignment. As a matter of fact, we at Lockheed feel that this is probably one of the most sophisticated, tangible systems studies that we have ever encountered.

Before we get into the description of what we did, I feel an information system study needs a little further definition. The words "information system" do not always portray and convey the same meaning to different people.

To us, an information system doesn't necessarily mean a large computer center. We will talk a lot about such a center, but an information system can be a very simple thing. On the simplest level it can be a single filing cabinet and a single filing clerk. When we talk about information systems we are talking about things which embrace simple matters as well as complex matters.

Now, as we began the basic study, our first problem was to determine what the informational process was in the State of California. To do this we put a team of people in Sacramento and throughout the State to interview all of the basic governmental organizations in the State. We conducted more than 800 interviews. We assembled volumes of documents. We talked to many, many people—see figure 1.

We also felt that it was important to consider the information process both in a quantitative sense as well as a qualitative one.

In addition to the State organizations, we selected five sample counties and five sample cities and extended our interviews into these areas. From all the data obtained we developed a comprehensive information flow map for the State of California which Mr. Lauler will describe to you later. It is an attempt to produce in a comprehensive, quantitative, and qualitative sense the picture of who is talking to whom and what is transmitted.

The next step in the study was to come up with a concept as to what an optimum State information system would look like. Should it be centralized? Should it be decentralized? Should it be a combination of the two? What should it be? Mr. Lauler will describe in detail the concept we selected.

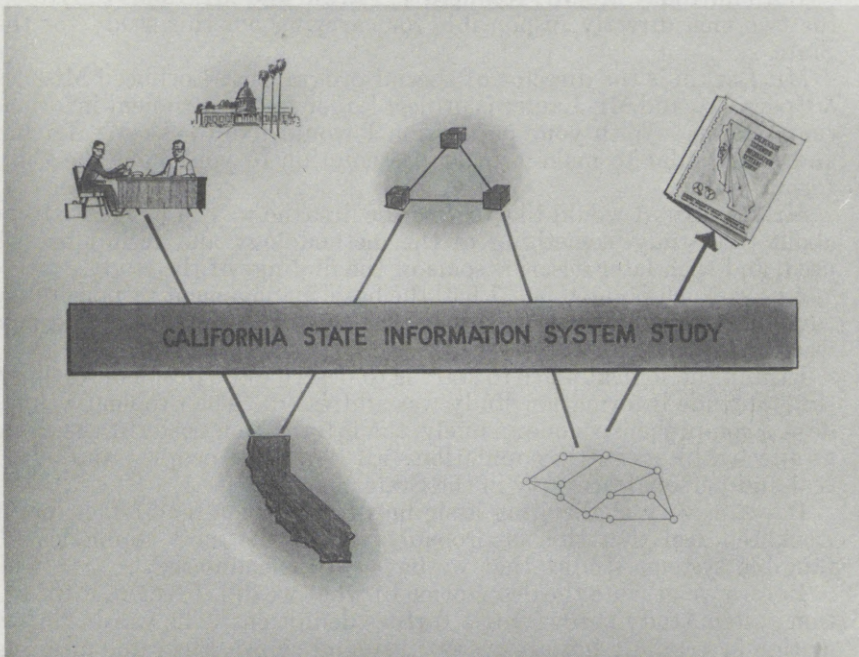


FIGURE 1

The next step in the study process was to develop an implementation plan for the chosen concept. What would the program cost? How should it be phased? What steps should take place first? The implementation plan developed into what we believe to be an effective and concrete plan. The final step in the study was documentation of our findings and recommendations. This final report was delivered to the State in August.

This briefly describes what we plan to give you in our presentation today. However, before we proceed I would like to attempt further clarification of what we mean by the term "information."

We draw a sharp distinction between the word "information" and the word "data." Information is data which exists at a time and in a form and in a place that allows it to be used effectively as a basis for action. It is not more mail in an overcrowded mail basket. It is exception reporting. It is processed data that can serve as a basis for action.

This chart shows in summary form the way information would be used, see figure 2. Here on the left are some of the basic data, as we visualize them, which will be required by the information system. First of all come the "people" data—information about people themselves—location, identification, descriptive data, and the like. Then in order are listed the data concerning parks, water use, urban renewal; data associated with vocational skills, industrial requirements

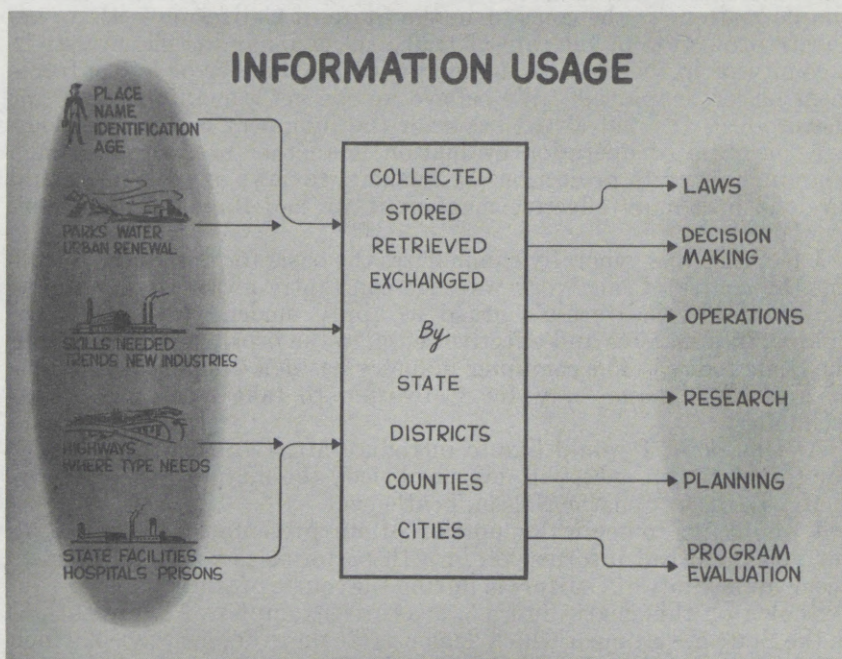


FIGURE 2

for plant location and labor force; those in the area of public transportation—highway locations and timing; and finally the physical facilities of the State—hospitals, prisons, and the like.

Shown in the upper center of the chart are the actual working elements of the information system—collection, storage, retrieval, and exchange of information. Also shown are the participants in these activities: the State, cities, counties, and districts. Here it is apparent that in the future the Federal Government must be included as a participant in this information-handling process.

Once such an information system is in existence, what are some of the things we can expect to be accomplished by it? We have listed

a number of these on the right in this chart. We might start with the decisionmaking process, a process which to be effective demands hard facts as a point of departure. I am sure that all of you are well aware that intuitive judgment is no longer enough in solving these large problems. We believe a massive system, such as described here, would indeed provide hard facts and make it possible to render judgments and decisions on a much more effective and accurate basis.

Take, for example, the medicare legislation recently enacted in the State. It was a concern of the State what the impact on our State hospitals would be as a result of that legislation. It is generally felt that it will produce hospital crowding, but it is difficult to project this quantitatively. We believe such a projection is one of the things that could come out of the information system we are describing.

Research needs are very evident. One specific need, to get down to simple matters, is the concern in the State of California with an accurate projection of the rate of traffic accidents and traffic arrests in a county or in the State as a function of the number of law enforcement officers employed. We believe we can get a quantitative feel for the problem and put a real basis for the judgment behind decisions.

A program of operation evaluation is another need of the State. Planning accurate projections of financial reviews of the State could be done in a more effective manner, if we had the total data bank available.

I feel that this generally summarizes the basis for our study. During the course of our work we were constantly aware of the opportunity within California's grasp to apply modern computer technology, in a massive and effective sense, to the broad problems facing the State today. The computer industry has in a complete sense come of age. It remains only for California to take advantage of its technology.

At this point I would like to introduce Mr. Lauler, project leader for this program, who will describe briefly the findings of our study.

MR. LAULER. Senator Nelson, gentlemen.

I would like to begin this portion of our presentation by sketching for you the broad information growth patterns, as we found them to occur in the State of California during the course of study.

Shown on this chart, figure 3, are three examples of organizations in the State government which demonstrate the different ways in which information reaches them and the methods by which this information is exchanged among them at the State level.

The first organization is a type which administers and operates through local offices. The example shown is the division of motor vehicles, which operates by means of local offices—Los Angeles, San Diego, San Francisco—and obtains information by means of these offices from people and private enterprise. The information passes vertically through the local offices to the Sacramento level.

The second type of organization is exemplified by the State welfare organization, which in California operates and administers welfare through local government—in this case, counties. In this instance, the information, which originates at the people-private enterprise level, reaches the State level in welfare by means of local government.

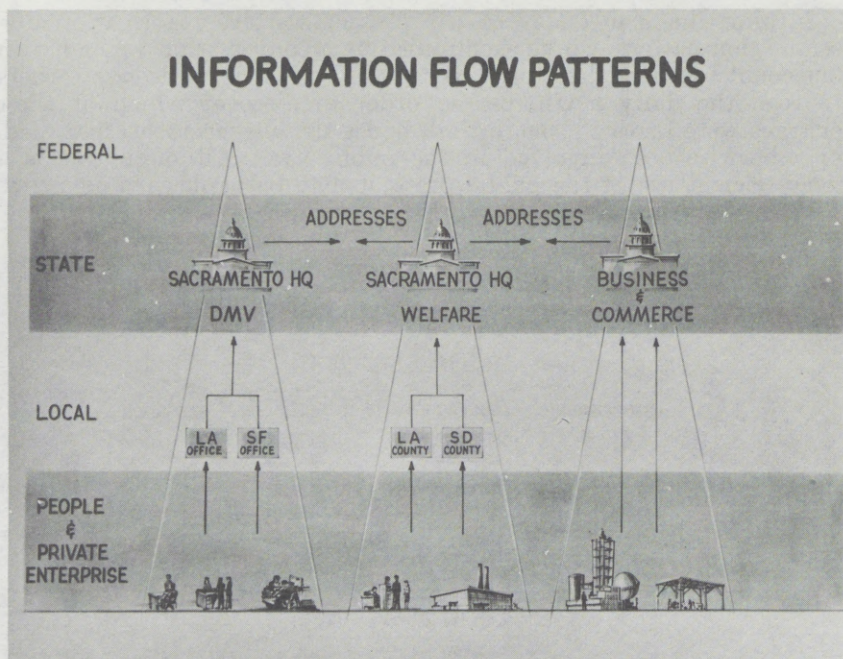


FIGURE 3

The third example of organization is a business and commercial agency or the franchise tax board, which deals directly with individuals and private enterprise.

We found, in describing the broad flow patterns, that a great mass of information flows in the vertical direction in these pyramids, and when it reaches the Sacramento level many items of information are redistributed, parceled out, or exchanged among the various organizations of the State government.

One of the most significant things we discovered early in the study is that local government is one of the most important sources of information for State government, and that any information system designed for the State of California must concern itself with local government. It must serve local government as well as work with it.

To give you an idea of the nature of the information exchanged, we have presented two examples in this chart, figure 4. I won't go into detail on the first one, because our colleagues from Space-General Corp. will discuss this system and will make known information needs in that area.

Governor Brown this morning mentioned the public assistance programs; it happens we feel there is a great need for an information system to serve these programs. Our example here shows the pattern of distributed operations, involving many organizations, which must exchange information, required information, with each other in order to make decisions at all steps of the welfare process.

I think the inadequacy of the present welfare information dissemination pattern can be exemplified by a conversation we had with one county welfare director. He told us he instructs his caseworkers to read the daily newspaper in order to discover which of their charges were arrested, put in jail, had a driving accident, had died, or otherwise been involved in the public eye. Although this is a very efficient use of the public press, it may be haphazard as far as deriving information for caseworkers on their charges.

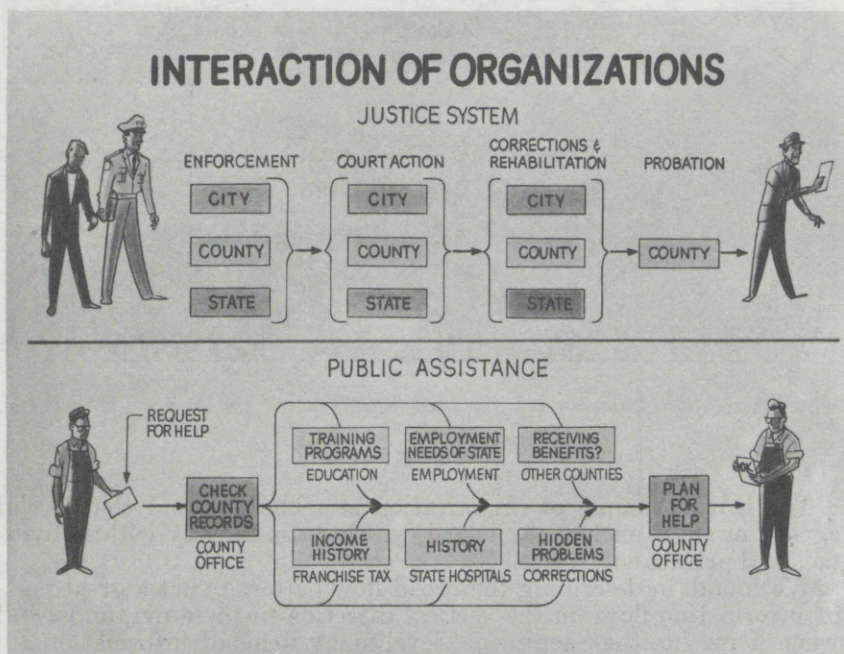


FIGURE 4

We have, throughout the State, a great deal of information of a multi-interdisciplinary nature, which gives rise to information exchange, and, therefore, to an information system. This information, if I may be a little facetious for a minute, is now handled in a paper-mill, and if you look at the projections of the paper storage requirements, you find that by 1990 you could pave a highway from Sacramento to Los Angeles with filing cabinets holding the active files of the State government, see figure 5.

Senator NELSON. Just the State?

Mr. LAULER. Just the State. If we consider local government, and these numbers were not available, the filing cabinet highway would be extended fantastically. Fortunately, the end is in sight for this filing cabinet proliferation. Already the State is moving rapidly to electronic data processing. The departments of education, employ-

ment, public health, and State welfare are all implementing or considering the implementation of electronic data processing systems to handle their paperwork problem. We think it should be a source of pride that California organizations are moving so rapidly into this new information processing field.

But on the horizon I think there is real cause for concern, because, while definite plans for EDP are being made within the organization itself, consideration is not being given to requirements of automated information exchange between these State organizations and proposed computation centers. This may result in essentially an extreme provincial situation—highly developed systems of data processing

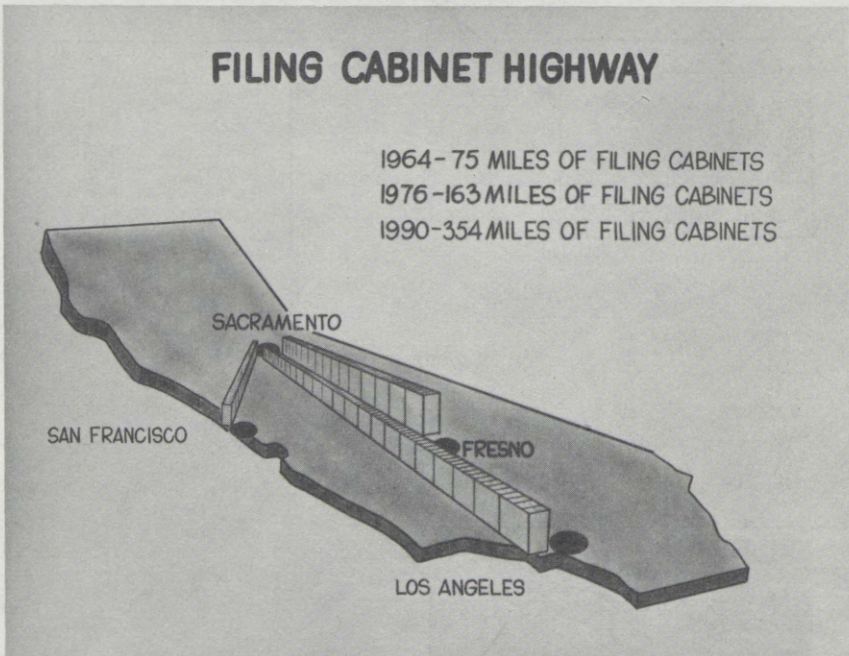


FIGURE 5

within the individual organizations, but horse-and-buggy methods of information exchange between these organizations, see figure 6. Mr. Larkin mentioned earlier an information flow map in his remarks. This chart attempts to depict graphically an information flow diagram for the State of California. What we have done here is to list, in a matrix form, all of the State organizations, such as the department of justice, welfare, public health, business and commerce, and so on, figure 7. We have also shown other organizations which interact with the State government; namely, cities, counties, Federal Government agencies, and private enterprise.

In the course of our survey, we logged on this chart every instance where information was exchanged between a particular organization

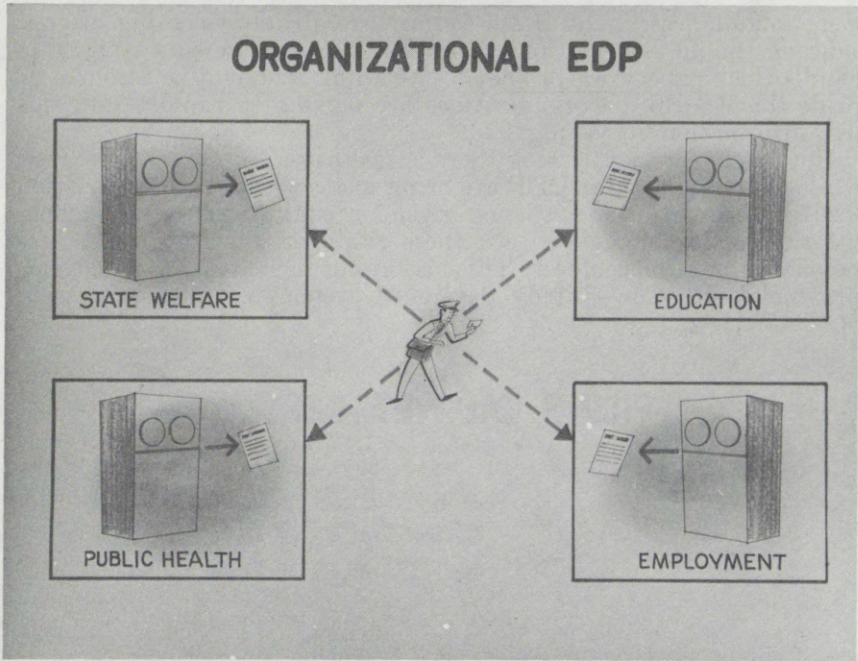


FIGURE 6

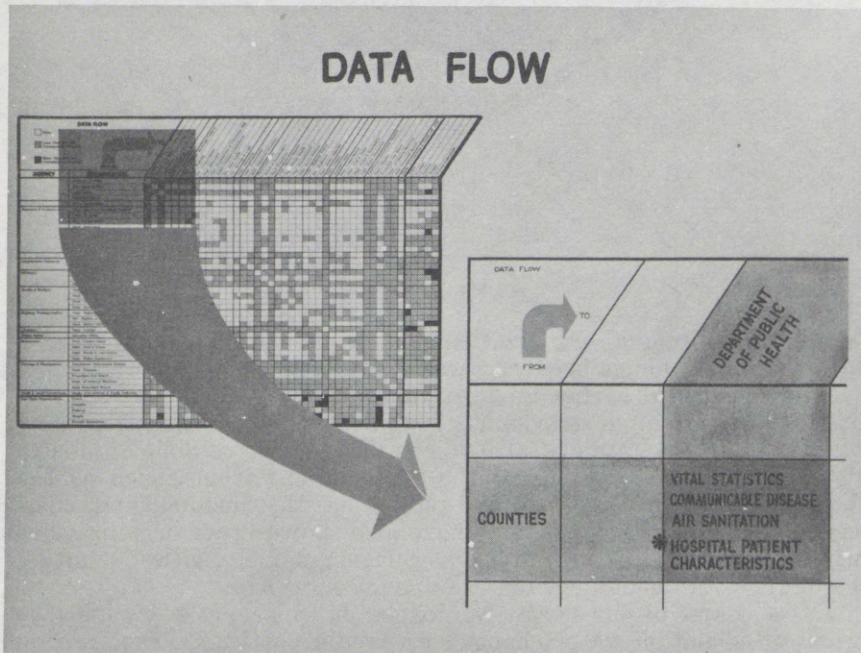


FIGURE 7

and the State government and the local government. These interchanges are shown by means of a code on the chart.

A white square indicates essentially no information exchange. Where a gray square appears, we found information exchanged on an order of approximately 1,000 documents per day; the black squares are those instances where more than 1,000 documents are exchanged daily.

The small corner shown here is a magnified section of this chart. It shows a particular information exchange; namely, the information which flows from counties to the department of public health. In this case the exchanged information will supply data to public health in the areas of vital statistics, diseases, and air sanitation.

In sum total we logged 1,015 interactions between organizations. This, incidentally, is information exchanged between organizations both at the State level and the local government level.

A great many more of these heavy exchanges exist, but also significant was the fact that we found so many white squares. Indeed we discovered organizations which wish they could get information from such-and-such an agency, but discovered it is not available.

One example here concerns hospital patient characteristics—information which the State department of public health would like to get as routine business from hospitals, but which is currently not available, except as an expensive one-time research project.

To give you an example of the extent of information exchanged between local government and State government, we prepared this chart, figure 8, in which, in the center, we have listed such State

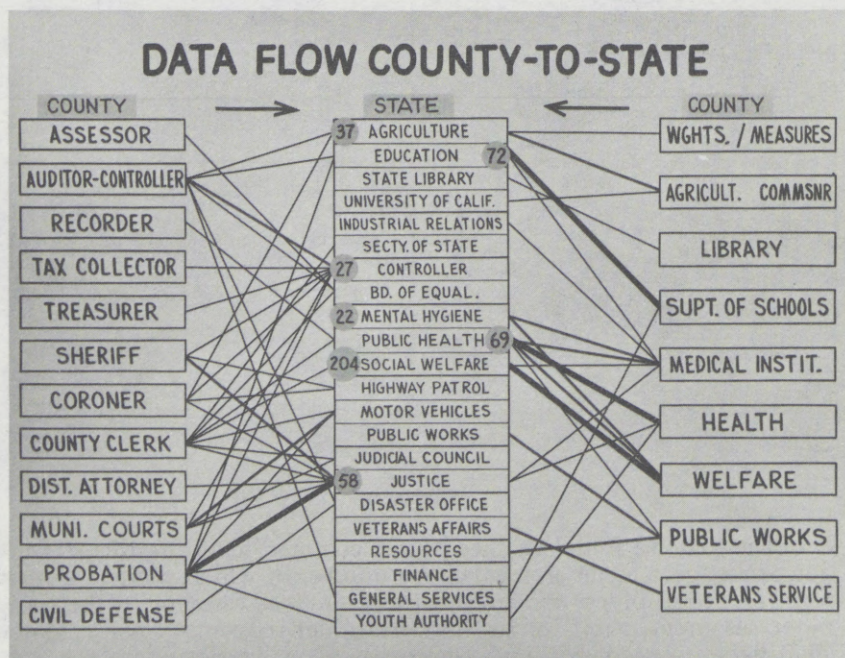


FIGURE 8

organizations as agriculture, education, and so on, which typically concern themselves with information from local government.

In the outside panels we have listed typical county organizations such as the assessor, tax collector, and sheriff. We have drawn lines between the county organizations and the State organizations, the thicknesses of which are semiquantitative depictions of the amount of information flow. Where there are thin lines there is a relatively small amount of information flow; the thick lines indicate more information flow.

The circled numbers indicate the number of reports which are routinely submitted annually between the county organizations and the State organizations. You see 27 from the controller, 204 reports to social welfare, and so on. In the aggregate there are approximately 10,000 reports per year per county submitted from local government to State organizations.

Turning aside from the information flow patterns to the statement of the problem, we find that there are several major information needs in California; we have categorized these in the four sections shown in this chart, figure 9.

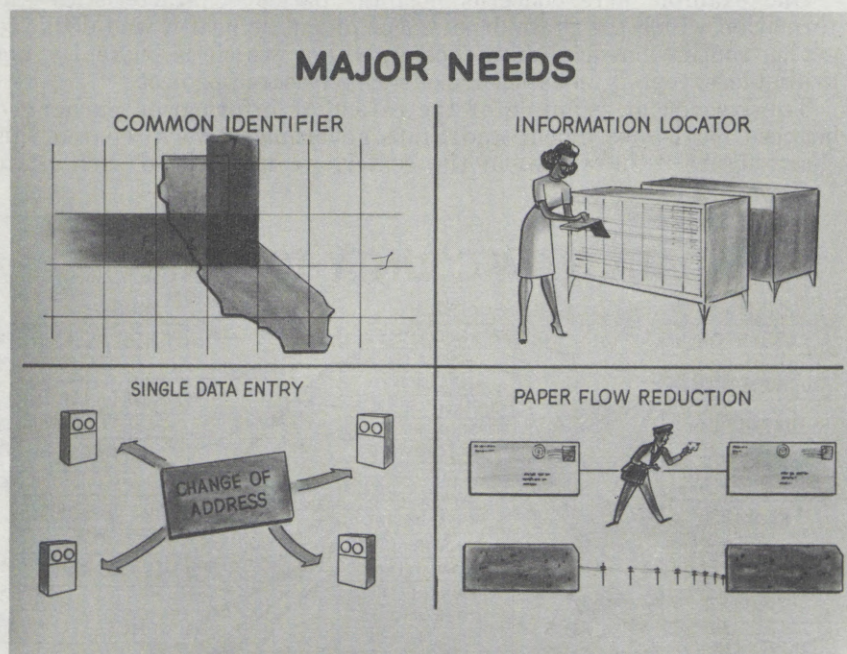


FIGURE 9

In the first we found the need for a common handling of information exchange, a common identifier, a number of which would uniquely identify geographical location to the county assessor or to the State water resources people or to the welfare department. Such common identifiers are needed in the other areas of utilization.

We also found the need for an information locator. Many organizations told us of collecting data which they suspect is also collected by someone else. Without knowledge of its location, we duplicate that collection function unknowingly.

We saw the need for a single data entry in which an information or data item reaches a particular organization, say justice or welfare, but at the same time is transmitted simultaneously to other organizations that have a need for the same precise data item.

And finally we saw, as the State organizations become more computerized, a situation where the present inadequate mailing system would be replaced by an appropriate data communication system between the computation centers.

With these needs in mind, what would be an appropriate strategy for the State of California to follow in the development of an information system? We certainly don't want to go out and suggest that we duplicate the computation centers and the computation equipment which is being implemented throughout county levels, city levels, and State levels in special districts. This wouldn't make any sense.

What we would like to do is to find a way to meld these into a system which would provide a total information system, but would still meet all purely local requirements. We identify this by means of a question mark, figure 10.

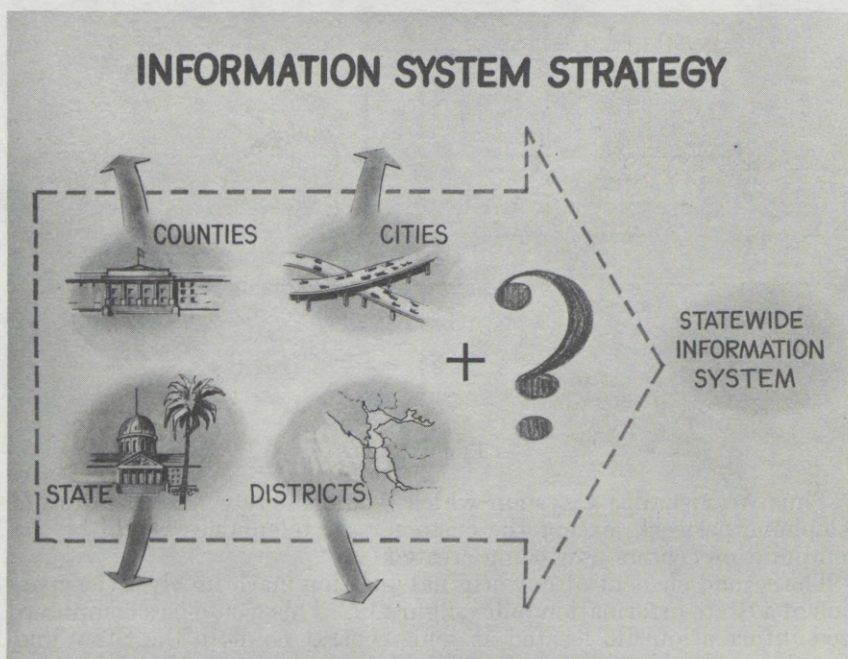


FIGURE 10

The problem, of course, is that while cities and counties are implementing their own data systems, they are moving in different direc-

tions to serve their own strictly local needs. We would like to guide them in one direction by means of the items which are indicated by the question mark.

What are these items?

No. 1 is the statewide information data work, figure 11, which would link together the electronic computation centers throughout the State, whether they be on the State, county, or city level. Such organizations as the department of justice, which requires data from counties and cities, could obtain this information on a regular basis by querying directly the indicated files. Similarly the organizations could periodically send out an all-points bulletin which would query all the organizational computer centers of other jurisdictions for needed information.

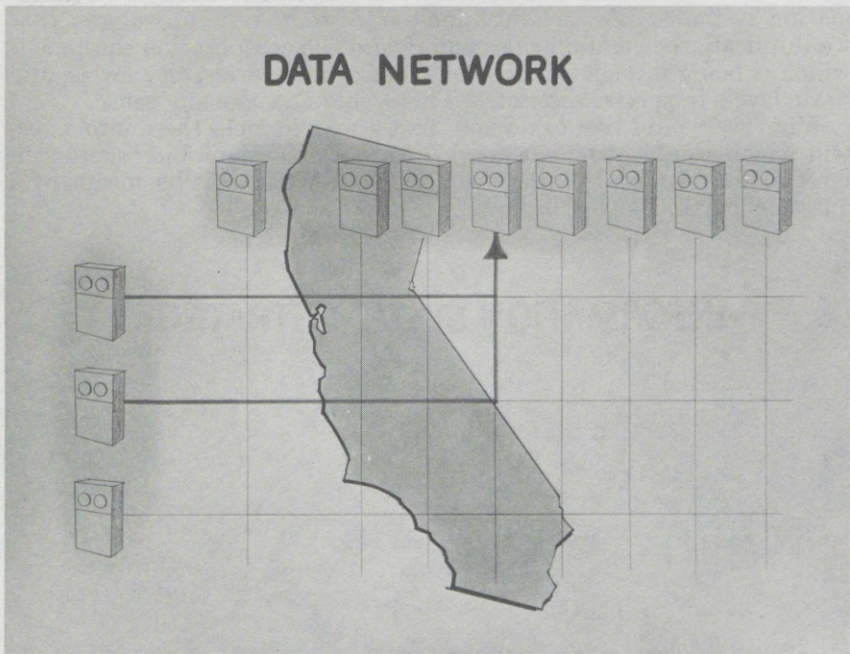


FIGURE 11

Thus we visualize a system which would operate like a statewide telephone network, except the customers or telephones would be the computation centers now being created.

The second element of our original question mark involves the creation of a State information index, figure 12. This would be a computerized information file located at some central point in the State and containing the location of all available information. We don't propose that the State go out and create a master State data bank, but we do propose that it create an index which would have the same effect as a data bank, except it would eliminate the agony of geographical centralization of all the files in the State.

In essence what we have proposed, rather than centralized information, is to centralize information about information by means of an information index that would operate just like a card catalog in a library.

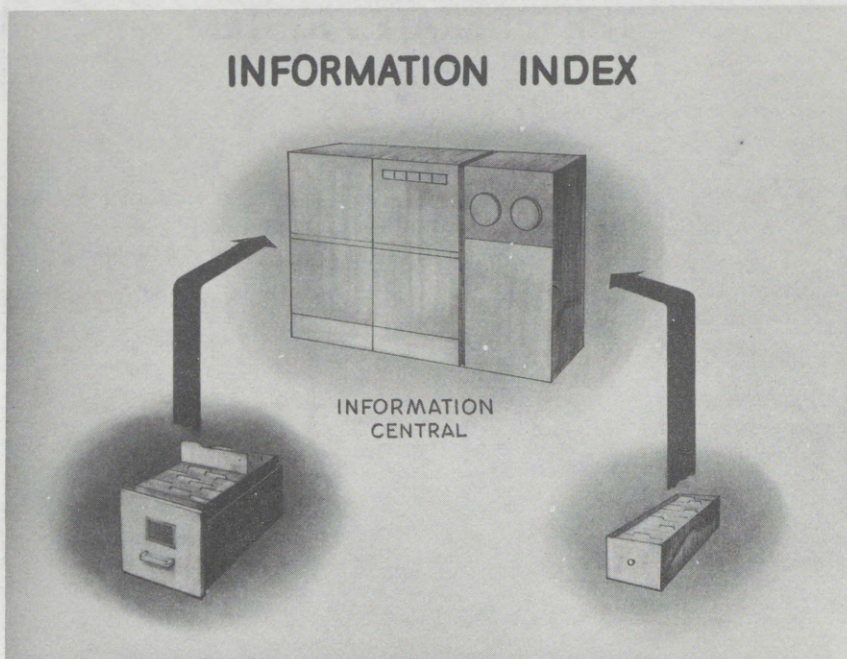


FIGURE 12

We see these two items operating together with the organizations as a federation; this is the title we have given our proposal, figure 13. We propose that the system operate as a federation in which the elements of the federation are the computer centers which presently exist or are being implemented—those of counties, districts, cities, and others, as well as the individual organizational electronic data processing installations being implemented by such State organizations as correction, finance, and the like. All of these units would be tied together by a communication network, and operated under the direction of the master index which tells each one where to obtain the needed information.

Finally, we have indicated on our chart one more word—"compatibility." The price of operating as a federation is acceptance of a number of basic rules. These rules have to be flexible enough, however, to provide the basis for local autonomy, local operation.

Let me cite an example from the business world. The railroad system of the United States is composed of independent railroads which operate together as a total transportation system. They do this by having adopted certain basic standards—such as coupling mechanisms,

maximum size of rolling stock, braking systems—and yet they operate independently. They can make their own rules as far as their profit and loss statements are concerned, but they remain a total system.

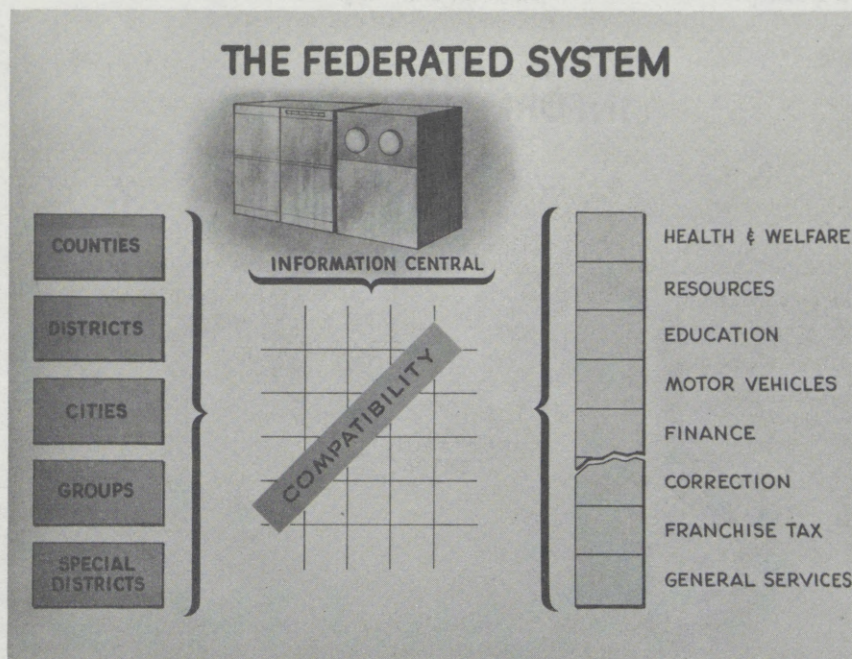


FIGURE 13

This is the basis of our proposal for a federated information system for California.

Senator NELSON. How long would the development of such a system take?

Mr. LAULER. Our development plan is a program of action, and I won't go through it in detail, but I will identify four milestones for you, figure 14.

The end of the first 3 years will mark the completion of a pilot operation in which will be established in a smaller way the basic parameters of the whole system. This pilot program will perhaps involve a county and a State department.

In 5 years the system could begin to become operational, and the State could start tying together, by means of an information index and the communication system, departmental organizations of the State with agencies of several counties until an approximate full operation status is reached in 10 years. At this point the entire system would be operated on a statewide basis.

The costs are illustrated on this chart, figure 15, which gives development cost and operating cost. This averages out roughly to \$10 million a year. We see the operating costs of the system stabilizing at approximately \$13 million per year at the end of the initial decade.

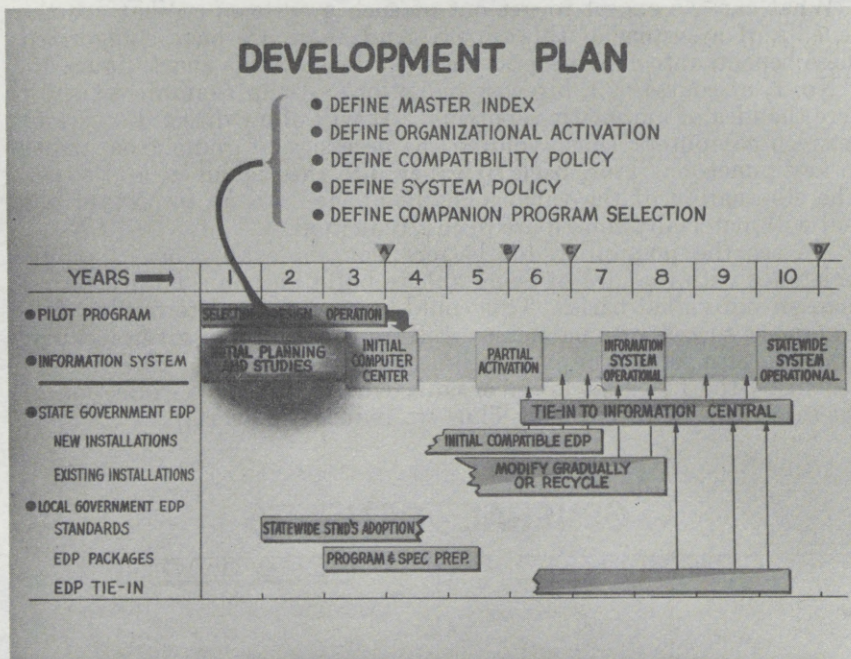


FIGURE 14

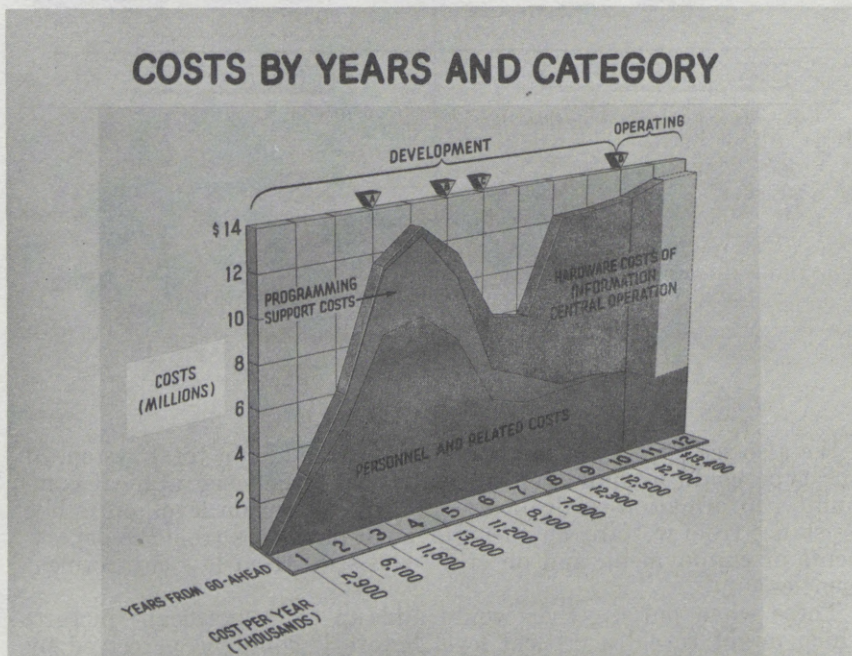


FIGURE 15

What can we expect to get out of such a system? What are the benefits of a system of this type? And again we have categorized these benefits into four general classifications on this chart, figure 16.

No. 1, of course, is a big cost reduction. As an example we show here the idea of automatic reporting. It will allow direct discussions between computers, thus avoiding the necessity of going from paper to key punch operator, back to paper into the machines, and so on. The elimination of the various chains of media is an important one and will materially contribute to cost reduction.

We see the possibility for better program evaluation in public assistance with the idea of being able to build files on a family rather than an individual basis. This could be one of the determining factors in the success of a particular welfare program in a given locality.

We foresee service improvements in which the public will directly benefit by the fact that fewer organizations will require collection of the same type information. Thus we reduce the overlap.

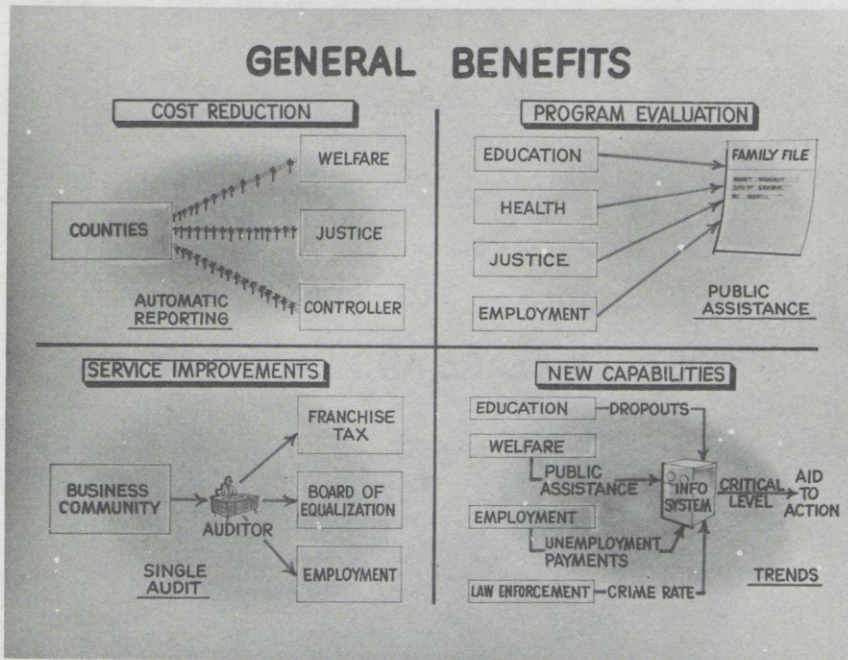


FIGURE 16

We also see an area of new capabilities in which a total system of this type could accumulate, say, within a given geographical community, information on dropouts from the education level, on public assistance from welfare, on unemployment payments from the departments of employment, and on crime statistics from law-enforcement agencies.

These when put together would add up to a significant picture, which might reveal a critical level before it could be perceived by manually examining the statistics.

To return to the idea of the cost reductions, let's examine the possibilities in California government, figure 17. The California population, as Governor Brown indicated this morning, is growing rapidly and will reach approximately 30 million people by 1980. Government services on a per capita basis show expenditures of \$150 per person within the State. By 1980 the general per capita expenditure will reach almost \$250 per person. So we have both an expanding population and expanding government services for each citizen.

Similarly the State civil service is growing to keep up with this problem. By 1980 we expect 219,000 in the State civil service work force, whereas roughly it is now 100,000. The same picture is true in county and local governments where the workforce is increasing rapidly.

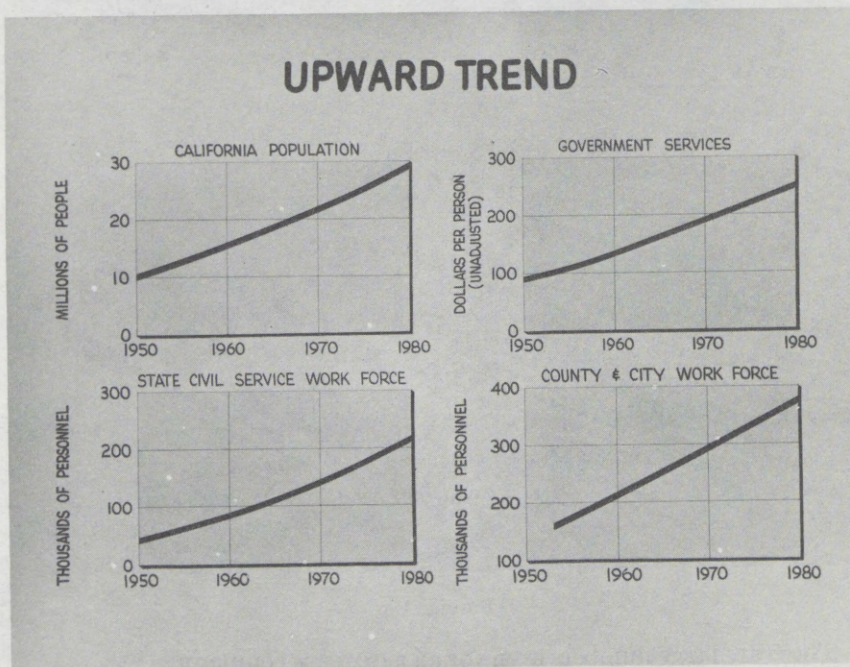


FIGURE 17

What does this mean in terms of civil service workforce? We asked what portion of their activities were directly concerned with information handling—typing, filing, and all other jobs involved in information handling. We investigated on an organization basis, on a job-cost basis, by job-code basis, and when you put all of this together it showed that 50 percent of the time of the average civil service person is actually spent in information handling. This means that approximately half of the \$1 billion payroll for civil service is dedicated to information handling, and if you extrapolate this information to 1980 you find the cost has risen to \$1.8 billion, figure 18.

Senator NELSON. That is what?

Mr. LAULER. This is the cost of information handling in 1980. The potential savings from a statewide information system is \$183 million a year.

The same is true even more dramatically when you examine the picture at the local government level. This is the same kind of analysis and includes not only the State but counties. Here you find the information handling bill is \$4.1 billion with potential savings annually of \$415 million versus operating costs of \$13 million for the statewide information system.

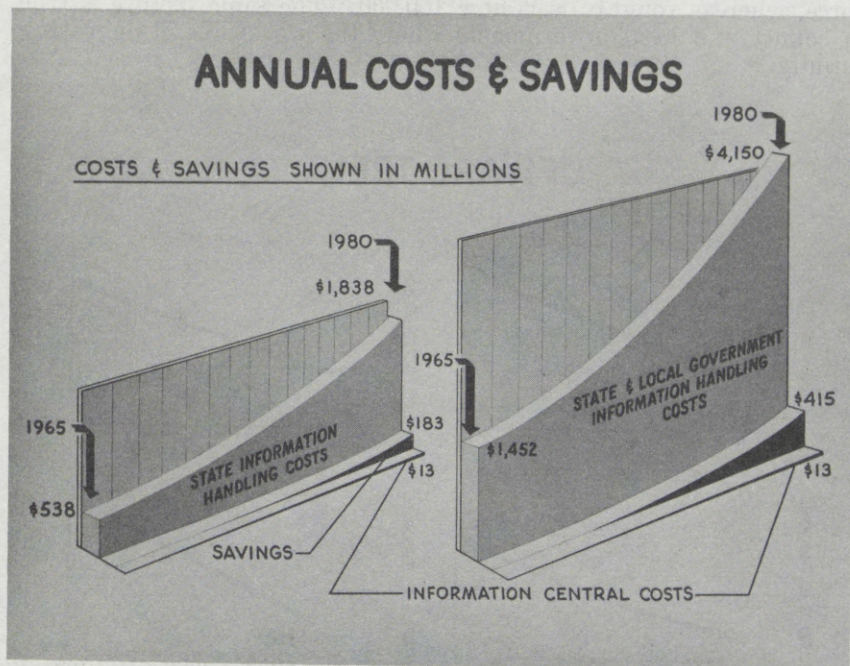


FIGURE 18

These are large numbers even for an aerospace company.

Let me complete my presentation with even larger numbers, figure 19. This shows what happens if you took all of the pieces of paper from the filing cabinets and stretched them end to end. They will reach the moon and back.

There is no message here. Let's not do it that way. Let's leave that to NASA.

Senator NELSON. Thank you very much.

Mr. NASH. We have copies which we will leave with you, Senator.

Senator NELSON. Thank you very much. At a later date we might have some questions but right now there are a number of witnesses, and I think we will go through the testimony and subsequently have more questions.

Mr. NASH. We will be happy to answer them.

THE PAPER RACE TO THE MOON

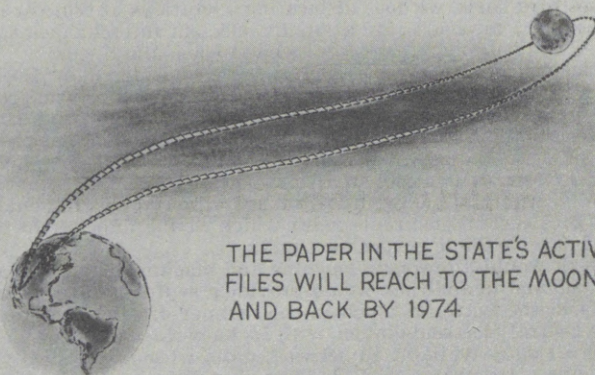


FIGURE 19

Senator NELSON. Thank you very much for taking the time to come here today. We will place the attachment to your statement in the record at this point.

SUMMARY OF THE CALIFORNIA STATEWIDE INFORMATION SYSTEM PROPOSED BY LOCKHEED MISSILES & SPACE CO.

In November 1964 the State of California embarked on a program which promises a revolutionary approach to the massive and complex problems faced by governments today. In essence, it was a decision by Gov. Edmund G. Brown to apply the techniques of systems engineering to four selected problem areas—waste disposal management, prevention and control of crime, State transportation system integration, and a statewide information system. Governor Brown's decision was predicated on his belief that California's aerospace industry could apply its systems analysis skills to the State's problems with much the same success it had demonstrated in its space age achievements. Initial evaluation of the reports that resulted from these four studies has completely justified Governor Brown's unique approach.

Lockheed Missiles & Space Co., in competition with other members of the aerospace community, submitted the successful proposals for a California statewide information system study. The contract resulting from this proposal covered a 6-month period and was funded at \$100,000.

Application of systems engineering techniques demands as the first step a thorough understanding of the existing operation. From such an understanding can be developed the overall system requirements. In turn, these requirements determine in large measure the recommended design for an improved system. This, in brief, was the path Lockheed followed in performing the study.

To get a clear understanding of the State's current operation in collecting, processing, and exchanging information, Lockheed sent a team of systems analysts to Sacramento, the State capital, and to various cities, counties, and other political units. From the more than 800 interviews conducted by these analysts, certain basic information concepts began to emerge—vertical and horizontal patterns of flow between agencies; duplications in data collection; methods of

processing, from simple manual to complex computer; unsatisfied needs in the present system; information handling rate of growth; projected costs under current methods; and many other aspects of the present system.

Once the raw data obtained in these interviews had been reduced and analyzed, the basic problem came into focus—how best to satisfy the information needs of the entire State by applying modern electronic data processing methods on a statewide network basis, without dislocating operations of those agencies already using such modern methods. Additionally, efficient interchange of data between computerized and noncomputerized units had to be maintained.

Many concepts for the overall system were considered by Lockheed before evolving one that most nearly met the requirements of the basic problem. In its final form, the concept recommended incorporated a unique approach to an integrated information system of such magnitude. Although neither completely centralized or decentralized, it preserved the best of both approaches. Termed a federated system, it consists of two essential components: (1) a statewide network which would allow eventual linkage of every governmental unit in the State, and (2) a central electronic index which would pinpoint the location of all accumulated data on file in government units.

The network would allow man-machine and machine-machine dialog throughout the system, and in addition, would provide a switching arrangement for linking all units in the network, much in the manner of a giant automatic switchboard. The central electronic index, with its knowledge of every file in the State, would make all data available to network units without physically centralizing the various files. Organizational files would remain in their original locations, but all data common to several files could be updated simultaneously from a single input of new information.

Development of the concept would extend over a 10-year period, with partial activation scheduled at the end of the first 5 years. All State unit tie-ins will be completed in 6 to 8 years, and the complete information system will be fully activated in 10 years. Savings of more than \$100 million annually in information handling costs are forecast when the system is fully activated. Annual operating costs are estimated at approximately \$13 million, with overall capital costs placed at \$100 million, accumulated over the 10-year activation period.

Specific benefits from the system fall roughly into two groups. In the first are found cost reduction or avoidance, and increased revenues. In the second are service benefits—better services provided and received by government units; and new services impossible to provide under traditional data handling methods.

The study recommendations have been endorsed by the Governor's Automatic Data Processing Advisory Committee (ADPAC), and steps have been taken toward a budget proposal for implementation of the statewide information system. California legislative approval will be sought to permit the beginning of design work during 1966.

Senator NELSON. I will call one other witness out of order. He has a commitment. It is Dr. Zuckerman, associate professor of management, University of Southern California.

We are pleased to have you take the time to appear today, Dr. Zuckerman. You may present your testimony in any fashion you wish.

STATEMENT OF DR. JOHN V. ZUCKERMAN, ASSOCIATE PROFESSOR OF MANAGEMENT, UNIVERSITY OF SOUTHERN CALIFORNIA

Dr. ZUCKERMAN. Thank you very much, Senator Nelson. My name is John V. Zuckerman, and I am associate professor of management and director of the research and development management program of the Graduate School of Business Administration of the University of Southern California.

We at USC are engaged in providing graduate education in the management of science and technology for academic students, for business executives, for members of Federal, State, and local governments, and for members of the Armed Forces.

We base our teaching on the premise that the future of our Nation will be largely determined by the skill with which we employ science and technology in the furtherance of all of our goals, both public goals and private goals.

We believe that our environment is going to continue to change very rapidly—we have already heard this morning some of the ways in which at least the information environment is going to change. We see, for example, that population growth is going to result in the geometric rather than arithmetic increase in urban problems.

While we do have the scientific knowledge and the technical skills to deal with these problems we feel that these have to be integrated with the conceptual and practical understanding of management processes, which underlie the scientific and technological changes that we want to bring about.

Systems analysis and systems engineering by themselves are not enough. We need to include explicit reference to the employment of systems management. I would include in this, the methods for planning and implementation of large-scale technological change and also the knowledge of how most effectively to motivate the teams of scientists and engineers who make up the systems analysis and systems engineering disciplines.

We have available methods for managing large-scale technical change, and we think these methods can be taught. Therefore, I believe that there should be added in your proposed act explicit provisions for the employment of system management techniques to integrate the systems analysis and systems engineering activities so they can be employed effectively.

We call this kind of management "The Management of Change," and with this kind of inclusion I would heartily endorse your proposed act.

I would be glad to answer any questions you might have, Senator Nelson.

Senator NELSON. What do you mean by adding systems management techniques to system analysis?

Dr. ZUCKERMAN. In some of the earlier testimony we have noticed there are some people problems involved in the implementation of any of these programs.

For example, State Senator Rees pointed out there are some jurisdictional difficulties in the State.

Mr. Schrade pointed out that there were human beings involved in the technical enterprises themselves.

Dr. Nash and his associates pointed out that in order to get the information accepted some people are going to have to give up some jurisdictional boundaries and operate—as it were—a railroad, with central controls.

We all know how difficult it is to get the railroads in the United States to change certain kinds of operating rules, because we have resistance to change.

Management technology includes principles which will help implement change, and it seems to me that proposals by systems engineers should include in the development plan the means by which resistance to change would be overcome.

Senator NELSON. I suppose you could submit to the committee at a subsequent date in writing some clarifications and examples?

Dr. ZUCKERMAN. Yes; I would be glad to amplify this for the committee.

Senator NELSON. We will be conducting further hearings in Washington next year, and we include the record along with the testimony, with this testimony, but it might be helpful if you have the time to submit to us a rather detailed clarification of what you are talking about.

Dr. ZUCKERMAN. I will be glad to do that, Senator.

(At the time this hearing went to press the material referred to had not been supplied.)

Senator NELSON. Thank you very much.

STATEMENT OF JOSEPH RYAN, REPRESENTATIVE, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Senator NELSON. I will now call on Mr. Joseph Ryan, representative of the American Institute of Aeronautics and Astronautics.

Mr. RYAN. Thank you very much for the time.

May I first apologize for Mr. Richard Horn, our president, who unfortunately had to be in Washington, D.C., because he was required to work on the scientific board.

Senator NELSON. Do you have a prepared statement?

Mr. RYAN. No; I have been asked by the president to request you to permit us to submit some subsequent statement to the committee.

Senator NELSON. We would be pleased to accept a statement and include it as part of the record.

Do you know when you will have one ready?

Mr. RYAN. When do you require it?

Senator NELSON. Well, there is no—

Mr. RYAN. I would say—shall we say prior to Christmas? Prior to the 30th of December?

Mr. NELSON. That will be fine.

(At the time this hearing went to press the material referred to had not been supplied.)

Mr. RYAN. I represent the American Institute of Aeronautics and Astronautics, composed of all professions and engineering and scientists engaged in the aerospace field.

As such we therefore have quite an awareness of the workings of the aerospace industry and how it works.

We wish to go on record, and it will be substantiated by Mr. Horn's statement, to heartily endorse your proposed bill. And we would like to state also, if it is so desired, and I am sure it will be in his statement, that we would like to offer the assistance of the institute with technical advice for the committee, if you see the need of this. This is considered as an offer from our society to you.

Senator NELSON. I appreciate that very much.

Mr. RYAN. We do believe that the States' primary effort in trying to solve this problem of humanities and assigning pilot studies to the aerospace companies has been a wise one, because these aerospace companies in conjunction with some 65 technical sciences and arts, which go into the humanities, which go into other sciences and also the systems approach. It is not possible to create a vehicle, whether it is

a space vehicle or an airplane, without taking into consideration, each and every time, human beings and materials as well as the impact upon the community it serves.

So we do feel that we would like to support very, very definitely the tremendous technology encompassed not only in the aerospace field but the others, because they must develop systems, which is the way to continue a project and to serve humanity. As has been demonstrated here, it is not only localized but it is a spreadout and integrated problem.

Mr. MILLENSEN. Mr. Ryan, am I to gather from your suggestion your institute would be willing to help on this? You are implying it would be, or it might be a good idea to have an advisory committee to the Secretary of Labor written into this bill?

Mr. RYAN. Either written into the bill, or if your committee decides you need technical people qualified who can be gathered together, who would assist you, we stand ready to serve because we have a responsibility to the Nation.

We are taxpayers. We make our living here, and certainly our brainpower should be employed, and we are saying whatever way you see fit to ask us to aid and assist, we will stand ready to do so.

Senator NELSON. I would think as a matter of fact it would be an advisory committee of some kind. It operates in the nature of an aid, so to speak, to the Government. The Government ought to include it in the bill. It is a very good suggestion.

Do you have any further questions?

Is there anybody else here who has something urgent who would like to testify?

I will call on Robert Mang, American Friends Service Committee on Legislation.

Is he here?

He is not.

We will take one more witness and conclude at 1 o'clock.

Is Mr. Thomas Rowan, vice president and manager of advanced systems division, Systems Development Corp. of Santa Monica here?

Mr. Rowan, you may proceed to present your testimony in any fashion you wish.

Mr. ROWAN. Thank you.

I will read it, and as requested confine it to 20 minutes.

STATEMENT OF THOMAS C. ROWAN, VICE PRESIDENT AND MANAGER OF ADVANCED SYSTEMS DIVISION, SYSTEMS DEVELOPMENT CORP. OF SANTA MONICA, CALIF.

Mr. ROWAN. Gentlemen, I would like to spend the first few minutes in attempting to provide some perspective and a broader context in which to understand the application of system science to the civil domain.

I use the broad term "system science" to encompass all of the functions of system analysis, system design, and system implementation. However, before dealing briefly with each of these, I would like to take a moment to recapitulate the evolution of the system concept.

While, for example, the terms "system analysis" and "system design" may have a modern ring, the underlying concept can be traced back to

the ancients. The Babylonians, Greeks, and Phoenecians, among others, viewed the universe as a system of interacting phenomena. They went as far as attempting to apply their rudimentary mathematics to the understanding and prediction of the relationship between these celestial phenomena and everyday events in the world about them.

In more recent times, the physical, biological, behavioral, and social sciences have approached the problems within their respective purviews in terms of system concepts and constructs. Thus, for example, both the atom and the universe are dealt with as systems; both the individual man and society are dealt with scientifically as biological, psychological, sociocultural systems. One of our major problems today is to discover the principles of interaction among such systems.

Traditionally, these scientific efforts have been conducted in the university environment. They have been oriented primarily toward the search for and accumulation of basic knowledge and not toward solution of specific developmental problems.

During World War II, the best scientific and engineering talent of the country was called from the classroom and the traditional laboratory in order to apply what science and technology could offer to the war effort. As a consequence of this unprecedented concentration of scientific and engineering talent, both in this country and elsewhere, came such systems as radar, ballistic missiles, atomic energy, the jet aircraft and such developments as antibiotics, and advanced surgical practice. One of the lesser publicized results of this wartime scientific and engineering effort was the emergence of a powerful new discipline—Operations Research.

At the end of World War II, there was a mass exodus of scientists and engineers from wartime laboratories back to the university. While understandable, this was alarming to many responsible people in Government. They could foresee a continuation of the need for advanced scientific and engineering activity as technology continued to play an increasingly important role in the development of U.S. programs.

Among those who were concerned was Air Force General Hap Arnold who was instrumental in forming Project RAND. This new organization became the mechanism, some two decades ago, for applying interdisciplinary teams of scientists and engineers to Air Force problems and also for developing some of the basic techniques of system analysis.

During these past 20 years, we have seen dramatic changes. Today, there are numerous organizations, both Government and private, profit and not-for-profit, who have further developed and expanded the application of the scientific approach to extremely massive and complicated problems, not only in space and defense but in the civil sector. The New York Port Authority, for example, is recognized as outstanding in its capability to apply advanced operations research and system analysis to their problems.

There are in addition a number of institutes affiliated with major universities that are applying system technology to some of the major problems of business and industry. Two examples are the Stanford Research Institute and the Denver Research Institute.

Additionally, a few outstanding consulting organizations have developed a considerable systems capability. One of these is the Arthur D. Little organization. There are also a number of nonprofit organizations active in applying system technology to nonmilitary problems. Among these are the Bell Telephone Laboratories, Battelle Memorial Institute, and the System Development Corp.

These citations are not meant to be exhaustive, of course. Furthermore, each type of organization represents a somewhat different combination of skills and orientation. However, in the aggregate, they represent a considerable national resource.

Undoubtedly, the greatest single resource for system technology resides in the defense community—particularly the aerospace industry.

Recently, we have seen the emergence of attempts to apply these capabilities to some of the major problems of contemporary life as witnessed, for example, by the forward looking partnership of the State of California and four aerospace industry organizations, both defense and nondefense, which have over the past 20 years, contributed to the development of a family of technologies, exemplified in operations research, management science, system engineering, computer and information science, and an array of tools, such as linear programming, dynamic programming, sensitivity analysis, cost-effectiveness analysis, decision theory, multivariate analysis, mathematical modeling and simulation. These technologies and tools are being applied today in the solution of socioeconomic problems. While their application has been limited by insufficient recognition of their utility and insufficient funds, they are important to the system development process of analysis, design, and implementation.

The first step of this process, system analysis, is a framework that permits the judgment and experience of experts in numerous fields to be combined in order to yield results that transcend any single discipline.

The process of system analysis basically implies a sequence of activities such as the following:

1. Definition and detailed description of the boundaries of the system.

2. Functional description of the system in terms of the component subsystems and their operational interactions.

3. Determination of objectives and criteria of optimal system performance.

4. Examination of reasonable alternative configurations of system elements that approximate optimal system performance and the determination of the consequences of each configuration in terms of feasibility, acceptability, and cost effectiveness.

5. Finally, objective presentation of these alternatives and the supporting evidence to the responsible decisionmakers so that they may make appropriate decisions with respect to selecting one of the alternatives for design and implementation, keeping in mind, of course, that a legitimate outcome may be to make no changes.

Although this process is straightforward in concept it can be exceedingly complex and difficult in application.

The complexity of application is commensurate with the complexity of the problem. Thus, the great socioeconomic problems of our time are so complex and massive in scope that their analysis require more

than the individual analyst. They require an integrated team approach.

My own experience, as well as that of others, clearly indicates that a nominal interdisciplinary approach is inadequate. The individual scientists, engineers, and technicians must become members of an integrated team interacting in a common environment on a day-to-day basis with a common problem-oriented focus. The development of this capability is a hard-won, time-consuming, and costly process.

This is particularly evident as we venture away from the realm of hardware systems which are dominated by the physical sciences and engineering, into that of socioeconomic systems, in which additional skills and resources are mandatory. I should like to cite one example of this. Some years ago, when SDC was studying hospital automation for the Veterans' Administration, we felt it necessary to form teams that included not only our engineers, scientists, and technicians, but also VA hospital administrators, physicians, dieticians, and others who were experienced and understood the nuances of the operation under study. The success of this experience confirmed our belief in the need for full representation of the skills and experience of the system scientist and technician as well as those specialists engaged substantively in the problem area under consideration.

Apart from any other contribution made by the defense community in the systems area, perhaps the most important is the development of a dramatic capability for organizing and managing the manifold resources involved in large-scale, complex, development projects conducted under severe performance and time constraints. Particularly, as we move from preliminary analysis toward development and implementation in socioeconomic areas, this capability will become an even more invaluable resource.

I should like to turn now to a discussion of some of the important operational problems that SDC has encountered in the use of system techniques in projects in several substantive areas in support of a variety of Government agencies. Among the most recent of these was our role as technical monitor for the State of California with the four aerospace contracts.

One important problem concerns the disparity between the natural dimensions of a socioeconomic problem and political boundaries. Clearly, for example, the sources and effects of air pollution or crime are not confined within the boundaries of individual cities, counties, or even States. Moreover, meaningful solutions require interjurisdictional approaches to such problems by means of regional compacts and joint-powers agreements which allow coordinated action across traditional geopolitical boundaries and through various levels of government.

Senator NELSON. When you find problems of that kind you don't anticipate that the techniques of the systems analysis will solve that? All the systems analysis would do—it would seem to me—would be to evaluate what the problem was; turn the information over to the political arena, where the problem would have to be implemented?

Mr. ROWAN. Precisely, Senator. My point is this legislation can facilitate the recognition of that. I believe it will be appropriate.

Another important problem is highlighted by the fact that each of the four aerospace studies resulted in a recommendation to undertake

long-range programs in their respective problem areas. It is reasonable to expect that adequate programs anywhere in the Nation will require similar long-term commitments. In general, political tenure seldom coincides with the duration of the proposed efforts. Thus, the best solutions to be derived from the application of system analysis may be, in the short run, politically unproductive and thus call for statesmanship of a high order. This, in turn, implies that the public will have to be educated with respect to the wisdom of adopting solutions that accrue to their benefit only incrementally over a relatively long period of time.

Senator NELSON. If you will let me interrupt here.

We built interstate highway systems which cross every jurisdiction in America, and it will cost \$50 billion before we complete it. It involves every conceivable political jurisdiction, from towns to villages to cities. It involves the condemnation of private property and extends over periods from the initiation phase in 1955 to the completion about 1970. That is a 15-year period.

What is there in that problem of developing a waste-management plan, which would involve a cooperative effort in the Great Lakes River Basin, for example, among all of the States involved in that basin? What is there in that problem that is any more difficult than the problem of building a highway across the country?

Mr. ROWAN. I think, Senator, that there are probably several differences, but one that comes to mind first is that we have over the years accepted, to use the jargon, the system objectives of a highway system. They are reasonably easy to present to the public.

I can think of other public works, such as the construction of dams, again generally speaking, acceptable because the objectives can be spelled out clearly, and for the most part understandable tradeoffs between costs and effect can be presented.

Although, as you well know, the area of the construction of dams is not quite a straightforward, but when we move away from those into some of the certainly old problems, but newly recognized as large and complex problems, like waste disposal, I think we have a long period of education of the public to go, and certainly one of the things of this bill might be that through rational and objective system analysis a kind of a political arena might present itself to try to get some of this education done.

Senator NELSON. I would suspect that the education in terms of air pollution and water pollution is about complete.

Mr. ROWAN. Let us hope so.

Senator NELSON. People are having difficulty in drinking the water and breathing the air. That constitutes the kind of education they appreciate.

Mr. ROWAN. It remains to be seen they are prepared to spend the billions, even though, as you know much better than I, on a straightforward cost-effectiveness basis, there is no way to put a value on clean air, sociological or psychological value. It is a good investment to clear up the air.

Eleven billion dollars I notice in Fortune was one estimate. Were the cost certainly a tenth of that—

Senator NELSON. That would be one of the objectives I assume of management to study to compute the cost of waste, the cost of cleaning up the water, and the cost of cleaning up the air.

In particular, before you can use one part of the cost factor, that would demonstrate it is more economical to keep it clean than to have to clean it up.

Mr. ROWAN. Yes.

Senator NELSON. The other factor is you will destroy the whole recreation industry of America that is based on the fresh water.

According to that factor, I would assume the waste-management study would be one of the factors that would be developed to demonstrate the cost of polluting water. I think the waste-management program would be a much simpler one to get funding for from the public than almost any other one, because I think it is more of an understandable program involving factors that are easier to compute results say rather than a crime study or a welfare study or something like that.

Mr. ROWAN. I think that is true. Let us hope it is closer to the highway analogy than the other.

Senator NELSON. Yes.

Mr. ROWAN. Let me say at this point perhaps that this problem of education has another side.

That is the problem involving the glamour that often surrounds the application of technology to new areas. I want to stress that the determination of system program objectives cannot be left to the technologists alone. This must be a joint effort between the elected officials who are responsible to the public and the specialists who are attempting to develop the program. The purposes, uses, and goals of any program must derive from the values and mores of the public. Thus, some of the trade offs implicit in the judgment to follow or not to follow a particular course of action, are not necessarily subject to rational analysis. Therefore, it is imperative to remember that system analysis, is a technology that applies the scientific method to the allocation of limited resources among a variety of competing demands, given a set of objectives. In and of itself, it cannot nor is it intended to determine those objectives.

Another problem I want to mention deals with the generalizability and transferability of the product resulting from the application of systems technology to particular problem areas. It is my opinion that, at least at the present stage of our capability, solutions developed to a problem in one geographic area are not likely to be wholly transferable. Rather, what will be generalizable is the experience gained by the analysts and the techniques and tools that they adapt from the defense effort or that they develop in pursuit of their tasks.

In summary, I want to emphasize that system analysis is not a panacea. It is not a black box into which one drops problems at one end and automatically receives solutions at the other. While I do not want to detract from the value of all the knowledge and experience that can be transferred from the defense community, I believe we should recognize that problems of the civil sector are no less difficult, and perhaps are more so, and require the utmost creativity. It is clear that one of the reasons that the four aerospace contracts look so promising is that these companies have applied some of their most creative people to the effort.

As indicated earlier, I believe that the contribution of managerial know-how from the defense community is at least as important as the contribution to be derived from the technology itself.

It would be misleading to leave the impression that this is an inexpensive process. We have all become inured to the tremendous costs of solving a defense problem. I wonder if we are prepared for the total system cost implicit in the solution of problems such as air pollution, or waste disposal.

It is my conviction that these and other problem areas indicated in the scientific manpower utilization bill are badly in need of attention. I am further convinced that the scientific and technological community has much to offer toward the solution of these problems. I further feel that this bill marks a signal step in the direction of the marshaling existing scientific and technological resources to the solution of the critical problems we face in our society.

Thank you, Senator.

Senator NELSON. Thank you very much for your presentation.

Do you have any questions?

Mr. MILLENSEN. You referred, sir, to the New York Port Authority and the work they are doing there.

Mr. ROWAN. Yes.

Mr. MILLENSEN. As we know, it is an interstate unit.

Are you suggesting, then, that the bill should include a provision to make appropriate grants to interstate agencies also in addition to making grants to States?

Mr. ROWAN. No. No, sir. My only point I wanted to make there was that the difference between the state of affairs we faced at the close of World War II and today is that there is a vast amount of scientific and technical talent that ought to be marshaled for attacking some of these problems, and that it is found in lots of places inside government. And I think that the port authority is an outstanding example of applying the very best of technology to reasonably complicated problems.

Senator NELSON. Thank you very much.

We will adjourn out of consideration for others, because I don't each lunch, ordinarily. I would be just as happy to continue. I understand other people do.

So we will adjourn until 2 o'clock.

(Whereupon, the hearing was recessed at 1:10 p.m., to reconvene at 2 p.m.)

AFTERNOON SESSION

Senator NELSON. We will resume the hearing. Our witness is Dr. Dwight Culver, Manager, Life Support Systems Division, Aerojet-General Corp. Go ahead, Dr. Culver.

STATEMENT OF B. DWIGHT CULVER, M.D., MANAGER, LIFE SUPPORT SYSTEMS DIVISION, AEROJET-GENERAL CORP., AZUSA, CALIF.

Dr. CULVER. I have prepared a text which is rather lengthy, and I am going to discuss only major points of the report, which was prepared for the State of California on the waste management problem.

I am sure that all of you here are aware of one or more aspects of the waste and pollution problem confronting California today. Nevertheless, I would like to show you a few pictures which will help to paint the problem a little more vividly in your minds. The mere

fact that such pictures can be taken in our State today indicates that a problem exists for which there is no ready solution.

This study had as one of the major objectives the determination of whether aerospace technology and the techniques of systems engineering could fruitfully be applied to the problem of waste management in California. A further goal of this study was to set forth a plan which could be used in California for attacking the problems produced by the increasing amounts of waste generated in the State.

Waste management is a complex problem. First, I would like to discuss some of the reasons why we believe that California is confronted with a serious problem which is going to take a great deal of effort to solve. We are dealing with a complex problem and the ingredients of complexity are these. California is growing at a rate considerably faster than the national average. Between today and 1990, we will have doubled our population.

We live in a time of changing technology. This changing technology results in a per capita generation of waste which is increasing with the passage of time potentiating those increases due to population growth. Consider these ingredients of our waste disposal dilemma.

The changeover from straight-run gasoline to the unsaturated catalytically cracked gasoline has materially contributed to our own special variety of air pollution, the so-called photochemical smog.

With the advent of disposable glass bottles, the glass content of our trash has increased significantly and has added to the difficulty of recovering useful materials from domestic refuse.

Nuclear energy is in its infancy but even now presents us with a major problem in the disposal of fission products.

The conversion to oxygen furnaces in the steelmaking industry is rapidly reducing our means for reuse of scrap iron and as a consequence automobile junkyards are growing throughout the Nation.

Perhaps one of the most difficult problems presented us by our changing technology is the increasing use of plastics in almost every phase of modern life.

Plastics are one of our most durable substances, almost completely immune to biological decomposition. If we bury them, they remain almost indefinitely in their original state. If we burn them, they contribute hydrocarbons and oxides of nitrogen to our atmosphere.

There are some inherent characteristics of waste which make our job difficult. Waste by itself causes us no problem until we release it into our environment. Once waste enters the environment in which we live, it becomes a pollutant.

Pollutants have the inherent tendency to become disseminated. The gases from our factories and automobiles becomes diluted and spread in our air far beyond their place of origin. The liquid wastes from industry and domestic sewage eventually find their way into our ground water basins and into our streams and harbors. Even our solid wastes, by contaminating ground water, can become disseminated far beyond their place of burial. Thus, we are dealing with materials that have no respect for political jurisdiction.

This lack of respect for political jurisdiction is augmented by poorly defined and fragmented government responsibility. Responsibility for liquid waste at the State level lies with the State water quality

control board which has an advisory relationship only to the regional water pollution control boards which pass their regulatory authority down to sanitation districts and municipal departments. Solid wastes fall under the department of public health and the county and municipal health departments. Gaseous wastes are shared by the State motor vehicle pollution control board and the local air pollution control districts.

Perhaps this fragmentation of responsibility would not make our task in California more difficult were it not for the fact that almost every effort that we make to dispose of solid wastes converts them either to gaseous wastes or to liquid wastes. While, in turn, treatment of liquid wastes frequently present us with solids which have to be disposed of and gases which invade our atmosphere. The more carefully we treat our gaseous wastes, the larger the accumulation of solids we have to deal with. Thus the very nature of waste treatment demands a unified approach. This, then, provides the basis upon which we begin to see the complexity of our messy problem.

The knowledge that pollution is increasing and spreading from its source to distant places can only be the first step toward understanding the problem. Perhaps our major difficulty is in assessing the effects of pollution. It is not the existence of pollution which troubles us but rather the things that pollution does to the things of value in our lives. In order to plan for effective waste management and to allocate the large sums of money necessary to manage wastes, we must have a means for measuring the cost of pollution to the people of California. No meaningful estimate of the cost of pollution to the people of our State has ever been made. The fact that it is a complex job of heroic proportions does not mean it does not have to be done. Our study has shown that it can be done; and once we have measured these costs, we can go to the public and ask how much money are you willing to invest in a waste management system in order to avoid these losses.

Such cost information alone is not yet enough. In California and in the whole Nation, we are beginning to demand more from our environment than it simply be economically productive. There is a growing demand that the environment in which we live be made esthetically pleasing. The beer-can-littered beaches of southern California are almost a thing of the past. We hear demands that our harbors and rivers be returned to their former state of beauty, that the smog be cleaned up so that once again we can enjoy viewing the mountains and that unsightly dump grounds and junkyards be hidden from view. President Johnson has taken a leading role in championing the cause of a more beautiful America. In his message to the Senate and House of Representatives in May 1965, he wrote:

Today's new conservation must shift from the classic role of protecting threatened nature. It must restore beauty where it has already been destroyed. It must deal with the dangers which urbanization and growth and technology offer to the world we live in. It must make an effort to put beauty within reach of those who live in our cities, and make it part of the daily life of every American. For its concern is with restoring and enhancing the entire relationship between man and the natural world which is the source of so many treasured human values.

The fact that esthetic demands are changing means that the design of any system for managing pollution must be aimed at a constantly moving target. The system designer must ask his customer how clean,

how beautiful do you want your environment and he must be prepared to put a dollar sign on proposed systems to meet a variety of levels of environmental cleanliness and then together, customer and contractor must establish environmental standards or goals for a waste management system to meet.

What have we said so far? We have said that waste management is a complex problem because of the tendency of pollutants to disseminate and to change from one form to another. We have said that the fragmented responsibility in the State for waste control adds to the problem, that the problem is growing not only at a rate based upon population growth but accelerated by a change in technology. We have said that it is extremely difficult to measure the effects of pollution in meaningful terms. We have said that the problem is made more complex by the changing esthetic demands of the public and that these demands place the goals or target of a waste management system on a judgmental basis where to a great extent the money made available for handling waste will depend upon value judgments of the public.

Waste management system boundaries: In order to get on with the task assigned us in the waste management study for California, it was necessary for us to define what we meant by a waste management system. This definition encompassed the functions performed by the waste management system and the interfaces between this system and the other systems of the social community. The system collects waste, transports, processes, and disposes of it, reclaims useful materials and takes into account the dilution and reaction of pollutants with the environment. The system is responsible for monitoring wastes as they are discharged into the environment and responsible for monitoring pollution levels of the environment.

In order to provide manageable limits for the waste system, we have arbitrarily excluded the regulation of waste generation; saying instead, that any waste which can be collected is the responsibility of the waste management system. One important effect of this arbitrary decision is that the waste management system is not responsible for the prevention of waste generation. Were this arbitrary limitation not invoked, we would find the waste management system regulating industrial use of containers, making decisions about the raw materials which industry could use and in fact, invading all aspects of industrial economy.

We do say, however, that since the waste management system possesses the greatest amount of information about the costs of various pollutants, it is responsible for keeping society appraised about these costs. The system's responsibility for providing information should include recommendations to substitute one type of material for another in order to develop wastes which are more tractable.

At the output end, the waste management function cannot be responsible for the effects of pollution upon others. It cannot be made responsible for crop damage due to pollution, the health of man exposed to smog or any of the other systems which may be affected by pollution. But we believe the waste management system should be responsible for assisting the establishment of the relationship between levels of pollution and their effects upon the various affected systems. Society must establish quality standards for our environ-

ment which are low enough to protect itself. The waste management system must be responsible for operating in such a way that the environmental quality standards are met.

Amounts of waste generated today and projected for 1990: With this concept in mind, we proceeded to measure the amounts of waste generated in California today and develop methods of projecting the amounts of waste which are to be anticipated by the year 1990. The liquid waste sewage and industrial liquid are in billions of tons per year and solid wastes are in tens of millions of tons per year. Thus the actual figures for sewage for 1965 are 3.3 billion tons per year. For the year 1990, they are 6.2 billion tons per year. Industrial liquid for 1965 will be 830 million tons and for 1990, 2.5 billion tons per year. Municipal refuse for 1965 amounts to 12 million tons per year and this will increase by 1990 to slightly over 40 million tons per year. Agriculture solids presently amount to 13.3 million tons per year and we project them to increase by 1990 to 22.3 million tons per year.

In the generation of gaseous waste we have separated hydrocarbons, oxides of nitrogen, sulfur oxides, carbon monoxide and aerosols because our projections take into account the effect of automobile emission control devices which will be required beginning next year. These devices will have a considerable effect in the reduction of hydrocarbons and carbon monoxide, but very little effect upon oxides of nitrogen and sulfur oxides. The amount of total hydrocarbons for this year is 2.3 million tons. For the year 1990, it will be 3.3 million tons. Oxides of nitrogen go up from 800,000 tons to 1.5 million tons. Sulfur oxides increase from 300,000 tons to 600,000 tons. Carbon monoxide this year will amount to 10.2 million tons and will increase by 1990 to 11.3 million tons per year. Aerosols will increase from 500,000 to 900,000 tons per year. The total tonnage of pollutants thrown into the atmosphere of California this year will be approximately 15 million tons and assume significant proportions when one realizes that this amounts to considerably more than 10 percent of the total steel tonnage produced in the United States during this year.

Some systems analysis aspects: In our effort to apply systems analysis to the waste and pollution problem of California, we searched for specifications which a waste management system would have to meet since system specifications provide the starting point for a design effort.

We looked first at air pollution and found that the State of California Department of Public Health over the past 6 years has been in the process of establishing atmospheric quality standards for the State. These standards are being set at three levels: The adverse level, serious level, and emergency level. The adverse level is defined as that point where sensory irritation, damage to vegetation, reduction in visibility or other such effects may occur. The serious level is one at which alteration in body function may lead to chronic disease, and the emergency level is one at which acute sickness or death in sensitized persons may occur. The identification of these levels in terms of pollutants is an extremely difficult one and only a few have been identified even on a tentative basis.

The public health service has also set automobile emission specifications for some materials which contribute to pollution. The exhaust

concentrations are based upon projections of automobile population in the Los Angeles basin between now and 1970 and the hope exists the required reduction in the amount of pollutants put out by automobile exhausts will reduce concentrations in the atmosphere of southern California below the adverse level by 1970. The Los Angeles County Air Pollution Control District supports these standards, but feel they fall short of meeting the county's needs.

The State recognizes that we need air quality standards for ozone, hydrocarbons, and all other possible constituents of smog which cause adverse effects of any kind. The Department of Public Health is exercising great caution by not establishing a standard until sound scientific evidence is available to support the level set. Until the setting of standards, the effects of smog will continue to increase in California beyond those of today.

The present area of reduced visibility in California, during conditions favorable for air pollution, is approximately 70,000 square miles and it is the home of 97 percent of California's population.

When we turn our attention to the problem of environmental standards for water, we see further evidence of the difficulty of establishing standards; there are water quality standards of a variety of sorts. We note that both the World Health Organization and the U.S. Public Health Service agree on the total dissolved solvents at 500 parts per million. The Public Health Service standards for sulfate and chloride are 20 percent higher than those set for the World Health Organization. The establishment of drinking water standards in this country goes back to 1914 and represents a great deal of experience.

Despite this long experience, if now we look at the quality of water distributed by the metropolitan water district, we see that presently in Los Angeles the water contains 704 parts per million of dissolved solids and exceeds the Public Health Service limit for sulfates by 47 parts per million. There is absolutely no indication that the water being supplied to southern California homes is detrimental to health. There is very little complaint on the part of the residents of Los Angeles about the quality of the water. Consequently, it is difficult to believe that the Public Health Service's standards have been set on any meaningful basis.

If we turn our attention to the maximum permissible concentrations for the Sacramento River at Knight's Landing which is near the lower reaches of the Sacramento River, concentrations which have been set by the Central Valley Water Pollution Control District, we see that in most cases, the river water with respect to inorganic components is of considerably better quality than that being delivered to the homes of southern California. This observation is also true when we look at the proposed water standards for the California water plan. One might conclude that water in the Sacramento River and in the California water plan system is kept at a significantly better quality because of its use for agriculture purposes. However, we know that most crops can tolerate water considerably inferior to that required for human consumption.

I use these comparisons only to illustrate the difficulty in setting meaningful water quality standards and I use them to reinforce our statement that prior to designing an effective pollution control system

in the State of California, we need meaningful environmental quality standards to serve as basis for system design.

Despite the general lack of environmental quality standards, we tried in our study to project the effects of three different systems for the handling of California wastes and developed rough order-of-magnitude cost estimates for these systems. The goal in doing this was to establish whether a systematic approach to the management of waste was feasible and if feasible, whether it would be meaningful to California in terms of cost savings.

The first system can only be called a system in the broadest interpretation of the word in that it represents the continuation of handling wastes in the manner presently used in California and incorporates only the expansion of the existing processing techniques to dispose of the increased amounts of wastes generated as a result of population growth and technological change. Since our present waste-handling techniques do today result in the pollution of our environment, the expansion of this system to meet the loading of 1990 would result in increasing pollution of our environment, since we can already see that our environment has a limited capacity for the dilution and conversion of pollutants. This first system we term the expanded existing system. The expanded existing system will incur the direct costs of operation, maintenance, and equipment depreciation of \$1.1 billion per year by 1990. The indirect costs attributed to crop damage, reduced industrial productivity, metropolitan obsolescence, recreational losses, etc., will amount to \$7.4 billion per year or a total cost assignable to this way of handling waste of \$8.5 billion per year.

The second system which we projected for the year 1990 is one utilizing all of our present technology in the most efficient way, taking advantage of integrating the treatment of solids, liquids, and gases wherever feasible. The direct costs assigned to this system are considerably greater than those of the expanded existing system and amount to \$2.2 billion per year. This system, however, because of its more comprehensive treatment of waste and its more appropriate disposition of unused materials results in an environment which is markedly improved over that of the existing method and, consequently, the indirect costs are greatly reduced and amount to only \$1.5 billion per year.

The third system which we projected for 1990, we have termed the development system since it would incorporate new and novel means of transporting, treating, reclaiming, and disposing of wastes. The goal in the development of improved techniques is primarily one of improving efficiency and reducing costs and, consequently, the direct costs for this system are less than the previous system amounting to \$1.5 billion per year. The performance specifications for this system are the same as those of the state-of-the-art system and thus the same improvement in the environment and, consequently, the same reduction in indirect costs result. As a consequence of this exercise, we are firmly convinced that a planned approach to the development of waste management in the State of California is feasible and must be implemented. In its implementation, however, it is impractical to consider the State of California as one integrated system since topographical features, geological, and meteorological conditions and

other factors such as population density, land usage, and transportation patterns vary widely throughout the State. Consequently, we have tentatively identified seven separate regions within the State which we believe from our preliminary analysis represent regions in which a systematic approach to waste management would be practical.

Recommendations for future work: Let me tell you then what we recommend as a result of our study. The region which we have identified as the Central Basin-San Francisco Bay region is the one with the greatest number of pressing problems. We recommend that immediate steps be initiated to develop a coordinated waste management system for this region. The steps involved in developing a system for this region are the steps followed in almost any development cycle. They begin with a primitive need which is purely a statement that someone believes that there is a problem. The succeeding steps are a feasibility study, a preliminary design, a detail design, an acquisition phase, and then system operation. These steps do not proceed smoothly from one to the next, however, without careful planning and guidance. This element is indicated by a parallel activity for system management and the development and updating of a program plan for the guidance and monitoring of this effort through all of its phases.

The systems management and program planning can be the function of either industry or government. Both approaches have produced notable results in the aerospace industry and we have no reason to believe that they would not produce similar accomplishment in this State and community problem. We believe that it is more advantageous for the State to go to some outside organization for systems management since there will be large fluctuations in the manpower needs as the program proceeds through the various steps leading to systems operation.

It is difficult to have clear insight into all of the details of all of the activities which will be involved in the various steps listed here. However, as a result of our study, we can look in more depth into the feasibility study.

This is the first step toward the acquisition of an operating system. The feasibility study outlined here does not merely represent more information gathering, but serves as the working foundation for everything which is to come later. Let me discuss in a bit of detail the feasibility study. The primitive needs have been voiced by a large multitude in the Central Valley and San Francisco Bay area. There is unhappiness with the encroachment of bay waters into the delta region. There is unhappiness with the increasing salt content in the agricultural lands in the Central Valley. There is unhappiness in San Francisco Bay with pollution of the waters and smog in the air. We need, however, to go from this statement of primitive need to a real definition of the problem.

We require an "analysis of needs" in terms of effects. What are the health effects? How does the pollution cause discomfort? What are the economic costs in terms of agricultural losses, in terms of cost to industry? What are the requirements in this region for recreation and for a beautiful and pleasing environment in which to live? When these needs have been defined in reasonably concrete terms, the feasibility study then turns to an analysis of what must be done in order to develop a solution. The amounts and types of waste being

generated in this region must be measured and projections must be developed for the coming years during which the system will be in service. Data must be developed to provide a measurement of the capacity of the environment for receiving diluting and processing wastes. Quantitative relationships between pollution levels and the effects measured in the "analysis of need" step must be developed and then decisions must be made about the system boundaries and the interfaces which this system has with other activities of man of this region. When we have done this, then we have truly defined the problem and we are now in a position to initiate a search for plausible solutions.

A variety of plausible solutions must be identified and these can be sorted on the basis of which of these are potentially useful in terms of physical reliability, economical worth, and financial feasibility.

The set of potentially useful solutions should have varying capability to reduce environmental pollution and will vary in their costs of implementation and operation. Their performance capability in terms of reducing pollution must be described in the same terms used during the "analysis of need" in order that the public or their representatives can make a selection of the type of system they want to buy. Only after there is clear understanding of potential costs and cost savings can the decision be made to enter upon the next step, that of preliminary design.

It should be pointed out that feasibility study is a difficult one and extremely costly. Already large amounts of money have been spent in this region of California just trying to measure the amounts of pollution in the environment. The study and understanding of the relationship between amounts of pollution and their effects in the terms used under the "needs analysis" is a major research program in itself. The measurement of environmental processing capacity is another major research program. We anticipate that for this region a feasibility study to a depth adequate to permit proceeding to the next step in the development program will consume 3 to 5 years and cost between \$8 and \$10 million. Final costs and time spent to this point will depend upon other research and development programs being conducted by the State and Federal Government to provide fundamental information on the two research areas identified.

In addition to the need for a number of models and computer programs, our study has identified the need for a national environmental simulation facility for the study of the complex problems associated with environmental processing capacity and the relationship between pollution and effect. In an artist's conception of this facility is a geodesic dome covering approximately 10 acres providing the capacity for experimentally determining the complex interactions of pollutants with environmental factors which can be controlled experimentally. This simulator would deal not only with gaseous pollutants but with liquid and solid pollutants and the interchange among all three States. Other simulators on a smaller scale are located in an attached building and are for the study of interactions of pollutants with environmental factors using only one or two variables. A central building is a supporting laboratory facility. A standby powerplant, shops, and maintenance facilities are to the left of the powerplant and

in the foreground are the administration building and the animal and plant laboratories.

We feel this facility will make significant demands upon a broad spectrum of aerospace sciences and because of this and the fact that California is a most suitable demonstration region for nationwide waste management problems, this facility should be located in California.

May I have the first slide?

Can we dim the lights slightly?

(The slides referred to appear in the study summary, pp. 72-92.)

Dr. CULVER. In our study we first tried to define what the problem in waste management was. This summarizes the complexities of the problem we found.

First is the growing population in California, and I have a slide to detail that a little more in a minute.

The impact of changing technology is very large in the waste management problem.

New kinds of material, which have to be gotten rid of—the plastics are invading all of our consumer markets—are especially hard to dispose of in a way which does not clutter the atmosphere or the lands.

The natural characteristics of pollutants is that they do disseminate far and wide from their point of origin. This point was made this morning.

The changing state of waste is another characteristic. Any removal or treatment process usually converts waste from either a solid state to a gaseous state, from a liquid to a solid, or from a solid to a liquid state.

This has some impact, not only on how you treat waste, but also on how you organize waste, and I want to discuss that in a little more detail in a minute.

Fragmented responsibility for waste control is another part of the problem. It affects every pollutant and is extremely hard to assess. We need to know what the effects of pollutants are before we can tell or decide to what extent we will go in order to treat waste, to recover waste, to clean up our environment.

The last factor, a major factor, that we are confronted with in developing a system for treating waste is that there is a change in the esthetic demands in this country. This country does demand improving conditions of environment far above levels which are important not only for health. But we want a level of cleanliness today which will enhance our recreation and enhance our esthetic enjoyment of our environment.

This is a problem for the systems designer, since the output specification of his system is apparently constantly changing.

May we go to the next slide.

The growth in California, which is shown by the bottom line, is considerably exceeding the rate of growth of the Nation as a whole.

The amount of waste that is produced in California is not only proportional to the number of people, but is increasing at a rate faster than the growth of the population due to our increasing industrialization and due to the changing technology of our society.

Next slide.

Fragmented responsibility for waste control. In California we have a separate system responsible for liquified waste, solid waste, and gaseous waste.

The liquid waste responsibility extends from the State water control board and goes down to the sanitation district and through the municipal department.

The solid waste extends from the department of public health.

The gaseous waste is really composed of two groups. There is the State motor vehicle pollution control board, for fixed sources, stationary sources, with the local air pollution control district.

In California we do have good communication at the State level among all of these responsible agencies, however, no central responsibility, and there is a need for a central responsibility because of the characteristics of wastes themselves. That is, their ability to change state, as we treat them.

People are responsible for getting rid of solid wastes and have to, at the same time, be concerned where they burn their solid wastes for air pollution problems, as an example.

May I have the next slide.

Our study looked at the amount of waste that is being generated in California today, and we then made projections for the amounts of waste that would be present in California in the year, to be produced in the year 1990.

Liquid sewage presently is 3.3 billion tons per year in California. By 1990 we estimate the generation to be 6.2 billion tons per year.

Industrial liquids at the present time are 620 million tons per year and will go up to 2.5 billion tons per year.

Municipal refuse presently being produced is 12 million tons, and we anticipate a considerable raise to 40 million tons per year.

Agricultural solids are 13 million tons per year and increasing to 22.3 million tons per year in 1990.

When we turn to gaseous wastes, we have separated the various elements of gaseous wastes, which we are mainly concerned with here in California. This is primarily because we have to take into account the automobile exhaust control devices, which we anticipate to be in effect by the year 1990 in making those projections.

The devices will reduce the rate of increase of hydrocarbons considerably without having a comparable effect upon the oxide of nitrogen.

The general size of the photochemical smog is such that without a material reduction in oxide of nitrogen, we will not reduce the effect of smog, even though we do reduce the hydrocarbon content. This is the other constituent which reacts under ultraviolet radiation to produce the irritants which cause that trouble.

As a matter of fact we are generating for these constituents 15 million tons of gaseous pollutants per year. This is something over 10 percent of our national steel production per year.

Next slide.

To take a systems engineering approach to the handling of waste management, one has to define the system which we are dealing with. We made some arbitrary decisions in order to pursue our study. Within this system waste management involves the collection, transportation, processing, and disposal. Can that be sharpened up?

Disposal processes waste to the environment and then the environment reacts with those wastes. Also included within this system is the function of recovery.

We have interfaces with the affected systems downstream which are agriculture, industry, public health, and upstream from the system, the generators of waste.

We have said arbitrarily that the system is not responsible for the prevention of wastes, but is responsible for receiving any wastes, which are generated and can be collected and must take care of this waste.

The reason we have made our boundary at this point and eliminated prevention as a responsibility is this: the system would get into complex economical struggles dealing with other parts of the economy.

We cannot tell people who manufacture Coca-Cola that they may not use disposable bottles. If we did, then we are getting into their economy, and we cannot tell companies what kind of raw materials they may use. However, we do have the responsibility of informing society of the impact of their decisions to use such things as disposable bottles in the terms of the cost to the system. So society then can make the decision what regulations are needed in order to assist the waste management system in doing its job.

The system, of course, to be efficient, has to be fed back the monitoring of the performance of the system in terms of what is going on in the environment and of what is being produced at the output locations and any particular treatment device.

Next slide.

We have taken our concept and our projections and tried to answer the question, is it meaningful to try to develop an integrated systematic approach to the handling of waste? We did this by postulating three systems, which might be in operation by the year 1990.

The first system which we postulated is really a system which is an expansion of what we have today, waste being treated in 1990 in the same fashion and to the same degree as it is being treated here in California today.

In this so-called expanded existing system, we estimate that the direct costs for the operation of this system in terms of operation and maintenance, equipment renewal, but not including research and development, would be \$1 million—I am sorry—\$1,100 million per year just to take care of the waste we anticipate will be generated by 1990.

We have made some crude estimates on indirect costs and these estimates are for such things as crop loss, the loss of land value or certain applications because the land is all used up. There is a loss of industrial productivity. These kind of costs will amount by 1990, if we go this way, to \$7,400 million a year to the State of California.

The environment in California under these circumstances would be considerably worse than the environment is today, because the environment is only limited to the ability to absorb waste.

Our second system, which we have termed "state of the art system," is a system which utilized all of the technology there is available and proven to be useful today. It treats wastes as completely as possible to treat within our capability today, but integrates the system in the most useful fashion.

And in this system, the direct cost, operation and maintenance and so forth, is \$2 billion for the year 1990; however, this system results in

a remarkably increased improved environment, and the indirect costs are therefore reduced to \$1 billion per year to the State.

Now, there are more efficient ways of doing the things today within the state of the art, if we postulate research and development being applied. Such a system, therefore, would cost less, and this is our development system, but it would have the capability to treat wastes to at least the extent that our advanced state of the art system would treat wastes, and therefore would have the same effect on cleaning up our environment and reducing the indirect costs.

This system we postulate would cost in 1990, \$1.7 billion per year. We admit that these are first order rough estimates. We feel, though, that they are good enough for us to be able to say that major savings can be achieved in California by taking a systematic approach to the handling of wastes.

Next slide, please.

California, however, cannot be treated as an entire system. California is topographically and meteorologically divided into a number of regions, and we have identified these separate seven regions, and we feel that each region should be handled as a system by itself.

There is very little exchange of waste or pollutants between these various regions. We have tried to minimize this amount of exchange in identifying the boundaries for these regions.

The recommendation which we make to the State of California is that one of these regions be selected as a pilot region for the development of waste management system.

The region we have selected is the one which has the greatest and most pressing problems, and this is the Central Valley, San Francisco Bay area region.

To implement such a program, we take recourse—may I have the next slide—to a development system which is in almost all ways similar to the development cycle for any major system.

The words describing each of the systems under the development cycle can be chosen differently, however. These are the recognized designations.

You need to start out with a primitive statement of need, and in the San Francisco Bay-Central Valley region we have this statement of need, and that is air pollution. People do not like the environment as it is developing in those areas.

We next move to the feasibility study, preliminary design, detailed design, acquisition phase, and system operation. These, as was pointed out this morning, don't go from one step to the next without systems planning, systems management, and the development and updating of a program planned concurrently with the work.

With the work carried out in the five steps it is a major necessity in having a systems approach to this problem. We cannot identify in detail at this point all of the particulars that need to be done under each of these steps, but for the first step—may I have the next slide—the feasibility study, we can in some detail identify those things which need to be done.

The first thing we need, of course, is to define the problem. We need to analyze, really, the needs of this problem in terms of health, personal comfort, economic costs, recreation, and esthetics. It is true to say that this is difficult to do.

Really, to get a concrete estimate of what these things mean is a major research program in itself.

The "analysis of solution," as I have termed it here, puts in some boundaries around the problem. In further defining the problem, we need to know what the waste generation, types of waste, and amounts are.

We need to know what the capability of the environment is to process wastes.

We need to know the relationship of pollution effects, system boundaries, and interfaces, and their effect.

We need to make some decisions about where the system boundaries lie and what other systems this system interfaces with.

Once we have done this, we can start to identify plausible solutions; establish potentially useful solutions in terms of physical reliability and economic worth and financial feasibility and present this information to the decisionmakers before the next step, preliminary design, is made.

It is our recommendation to the State that this feasibility be undertaken as soon as possible. This is not another study as such. This is the first step in taking concrete action.

We discovered in our study the applicability of some of the techniques and tools of the aerospace industry, not necessarily common only to the aerospace industry, but used widely therein, such as mathematical modeling, computer programs. In addition we have defined the need for a physical simulation facility in order to study some of the complex interrelationships between the environmental factors and pollutants.

We feel that such a facility will help give us the basic data that will allow us to really complete a problem definition.

This data is basic not only to one region, not only to California, but is of national use.

And so we recommend to the Federal Government that they consider the development of the national environment simulation facility to do some of this very important work.

That is all I have, Senator.

Senator NELSON. Thank you very much.

Roy, do you have any questions?

Mr. MILLENSON. No, Senator.

Senator NELSON. I assume, after going through the testimony, if we have some questions we may want to send you, you will be willing to respond?

Dr. CULVER. I would certainly be happy to do so.

Senator NELSON. Thank you. Your study will be inserted in the record here, along with the illustrations in it.

Dr. CULVER. Thank you.

(The study referred to follows:)

CALIFORNIA WASTE MANAGEMENT STUDY

BY B. D. CULVER, M.D., AEROJET-GENERAL CORP.

SUMMARY

The Aerojet-General Corporation Report to the State of California proposes a course of action for the State to take, over the next fourteen years, in achieving an optimum system for managing liquid, solid, and gaseous wastes.

California now has a waste management system but it is based entirely upon an "input" concept; that is, the problem is assumed to be one of "disposal" at least cost and attention is focussed upon kinds and quantities of unwanted materials and the shortest distance to a "dumping place". In this study, the controlling considerations are "output". Three classes of output are identified:

- (1) The degree of environmental pollution to be permitted;
- (2) The waste bound natural resources to be reclaimed; and
- (3) New natural resources to be developed by waste management methods.

The second concept is that waste management deals with one single system—the environment—which, in turn, is divided into three closely related subsystems—air, water, and land. At the present time in California, there is a large number of virtually independent State, regional, and local bodies regulating, collecting and disposing of different wastes.

The report points out that unless these diverse and dispersed activities are properly articulated, and unless the interfaces between solid, liquid, and atmospheric wastes are recognized, no effective waste management system can be developed.

A corollary to this concept is the realization that wastes cannot be efficiently managed in geographic plots dictated by the boundaries of political jurisdictions, but that the geographic boundaries must stem from the analysis of the waste system itself. These considerations lead inexorably to a concept of a statewide plan, large operating regions, and a multiplicity of "independent" but articulated activities within each region.

A new aspect of the approach is the establishment of the goal of optimizing the waste management system for the total population rather than for the waste possessors. This may represent a breakthrough. It is achieved by identifying standards of environmental quality which are optimum for the public and recognizing a scale of worths for such optimum qualities. By comparing these worths with the costs of maintaining these levels of environmental quality, for the first time a means is devised of optimizing the system for society as a whole.

The second new aspect in this report is the recognition that political, legal, and social factors must enter into the design of the system. The study recognized that considerations related to politics, legal constraints, established social institutions, jurisdictional boundaries, private versus social action, sources of funding and popular acceptance have not heretofore been controlling forces in designing either military or civilian systems, and, in fact, make the straightforward optimization of the strictly technical elements an extremely complex process. The study demonstrated, however, that the logic of system analysis allows an ordering of the total problem including these factors and the presentation of alternatives to the decisionmakers in clear and unambiguous terms.

The approach used in this study has three strengths:

1. It leads to a valid long-range plan as distinguished from a rearguard action of "containment" that amounts to a slow retreat. It seeks a steady state system that can be planned into the distant future as contrasted to a short-range program of expediency.
2. It is based on a recognition of the full spectrum of environmental quality values ranging from conditions of simple survival through levels of safety, freedom from direct impairment of animal and plant life, adequate physiologic performance and comfort, to levels of maximum aesthetic enjoyment of the environment.
3. Finally, it recognizes the need to select operating regions large enough to include in the same system those who gain and those who pay; in other words, it permits the worths and costs to be internalized in the same system.

INTRODUCTION

I would like to show a few pictures (illustrations A through I) which will help to paint the waste and pollution problem confronting California today vividly in your minds. The mere fact that such pictures can be taken in our state today indicates that a problem exists for which there is no ready solution.

This study had as one of its major objectives, the determination of whether aerospace technology and the techniques of systems engineering could fruitfully be applied to the problem of waste management in California. A further goal of this study was to set forth a plan which could be used in California for attacking the problems produced by the increasing amounts of waste generated in the State.



ILLUSTRATION A



ILLUSTRATION B

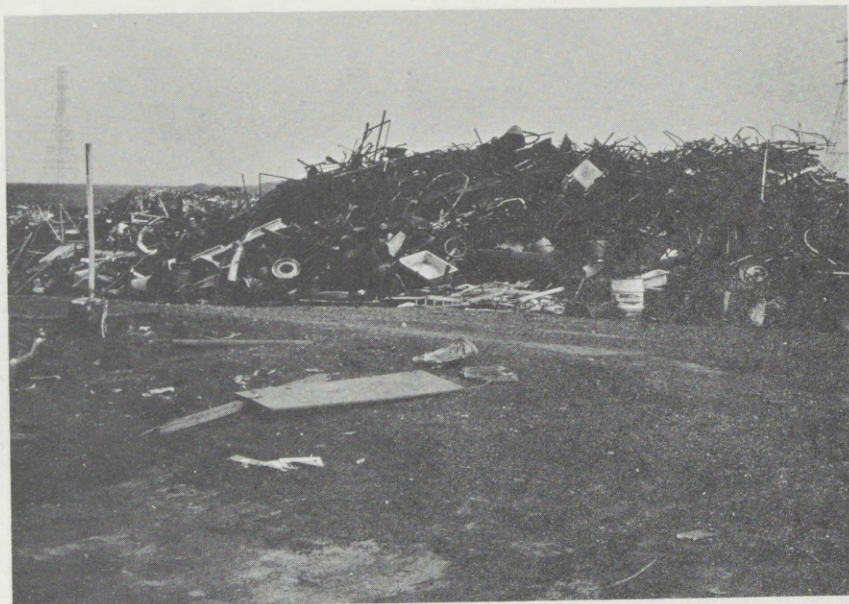


ILLUSTRATION C



ILLUSTRATION D



ILLUSTRATION E

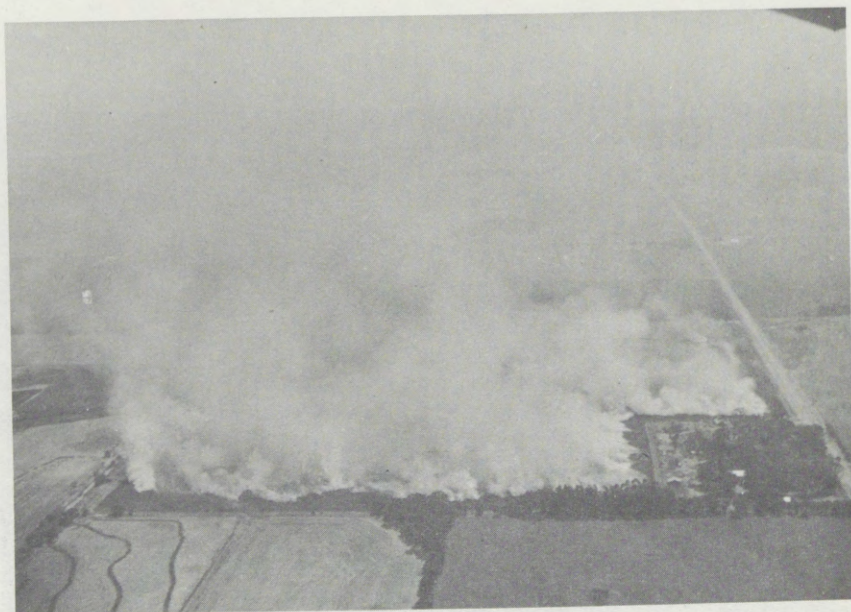


ILLUSTRATION F



ILLUSTRATION G

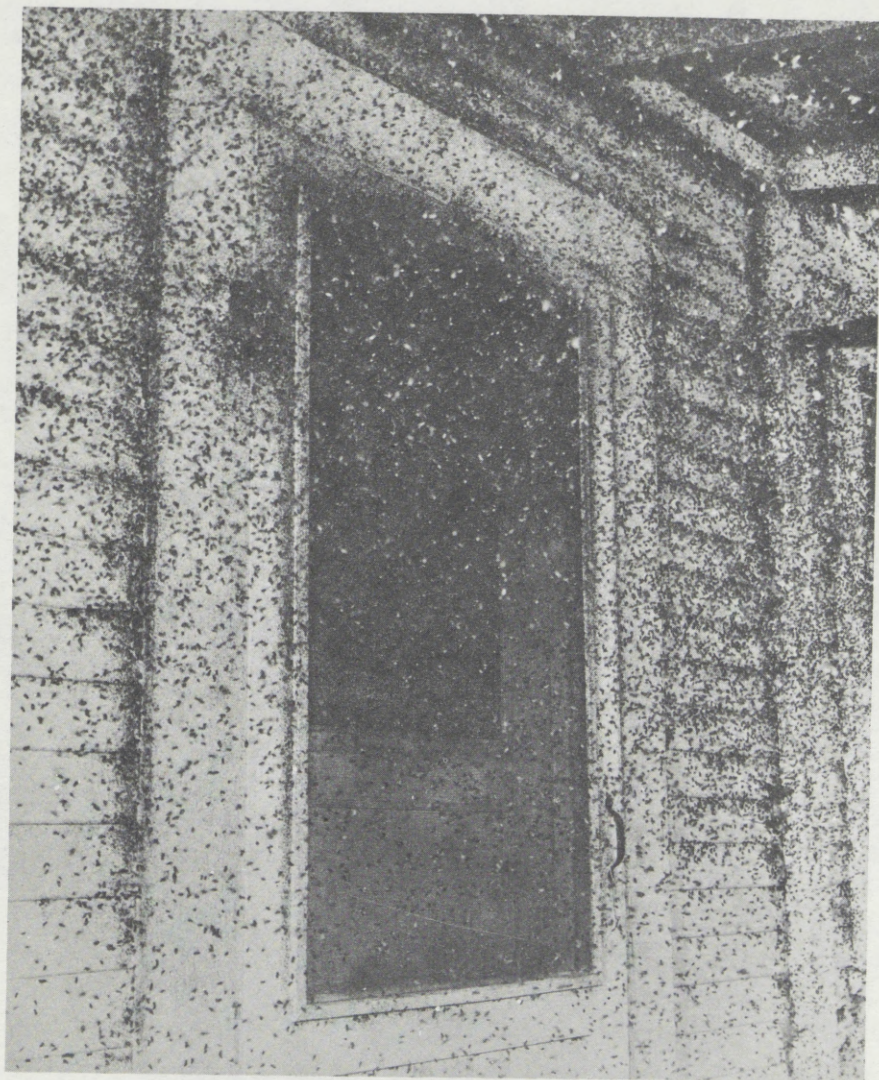


ILLUSTRATION H

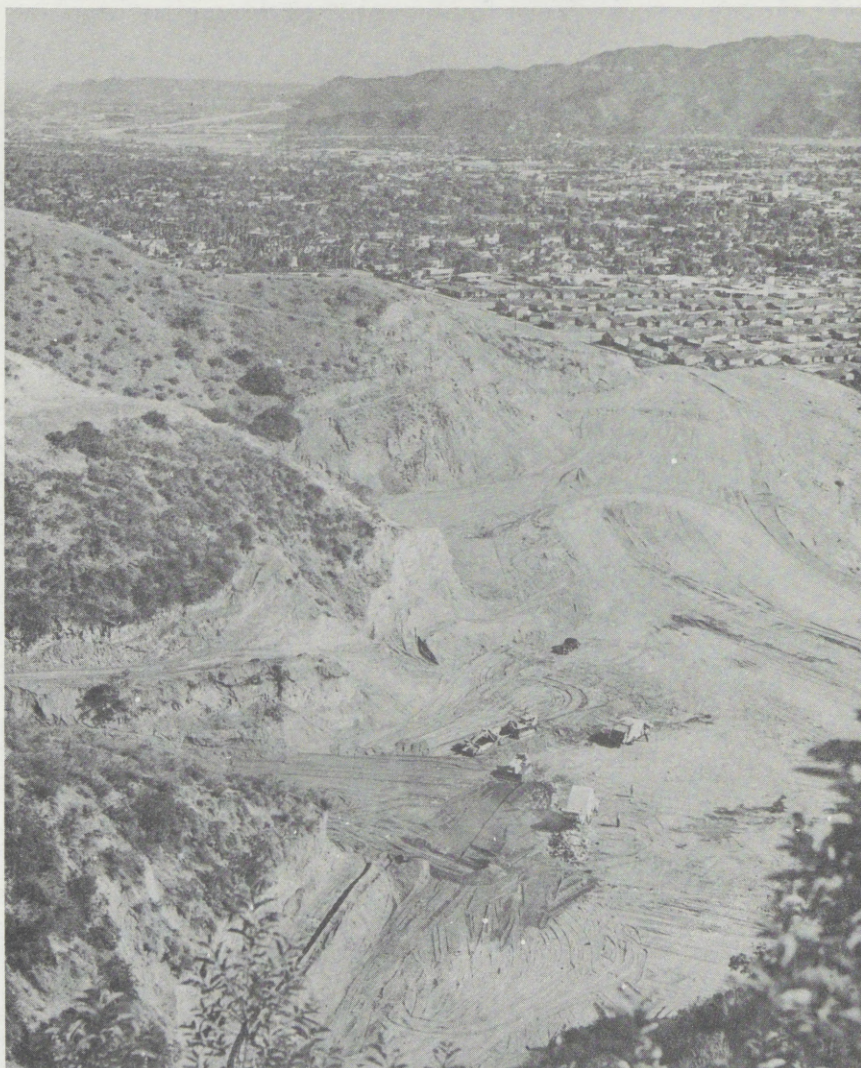


ILLUSTRATION I

WASTE MANAGEMENT IS A COMPLEX PROBLEM

First, I would like to discuss some of the reasons why we believe that California is confronted with a serious problem which is going to take a great deal of effort to solve. We are dealing with a complex problem and the ingredients of complexity are these (Figure 1):

1. California is growing at a rate considerably faster than the national average as can be seen on this chart. Between today and 1990, we will have doubled our population.

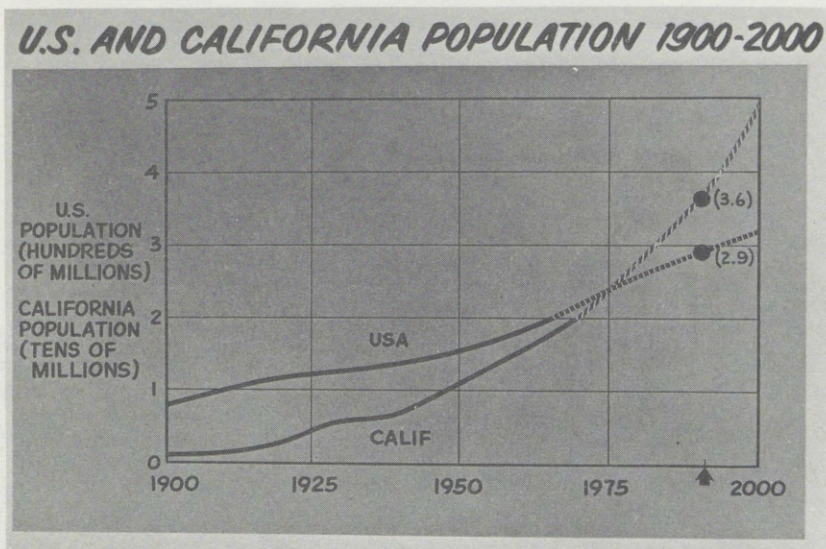


FIGURE 1

CHANGING TECHNOLOGY

- CATALYTICALLY CRACKED GASOLINE
- DISPOSABLE BOTTLES
- NUCLEAR ENERGY
- OXYGEN FURNACE
- PLASTIC CONTAINERS

FIGURE 2

2. We live in a time of changing technology (Figure 2). This changing technology results in a per capita generation of waste which is increasing with the passage of time potentiating those increases due to population growth.

3. There are some inherent characteristics of waste which make our job difficult. Waste by itself causes us no problem until we release it into our environment. Once waste enters the environment in which we live, it becomes a pollutant.

Pollutants have the inherent tendency to become disseminated (Figure 3). The gases from our factories and automobiles become diluted and spread in our air far beyond their place of origin. The liquid wastes from industry and domestic sewage eventually find their way into our ground water basins and into our streams and harbors. Even our solid wastes, by contaminating ground water, can become disseminated far beyond their place of burial. Thus, we are dealing with materials that have no respect for political jurisdiction.

4. This lack of respect for political jurisdiction is augmented by poorly defined and fragmented government responsibility (Figure 4). I apologize to you for this chart which is far too busy and far too complex to use in any presentation. I can only assure you that this chart has been greatly over-simplified and in no way really shows the extent of fragmentation and overlapping of responsibility for liquid, solid and gaseous waste. Responsibility for liquid waste at the State level lies with the State Water Quality Control Board which has an advisory relationship only to the regional water pollution control boards which pass their regulatory authority down to sanitation districts and municipal departments. Solid wastes fall under the Department of Public Health and the county and municipal health departments. Gaseous wastes are shared by the State Motor Vehicle Pollution Control Board and the local air pollution control districts.

5. Almost every effort that we make to dispose of solid wastes converts them either to gaseous wastes or to liquid wastes. While, in turn, treatment of liquid wastes frequently present us with solids which have to be disposed of and with gases which invade our atmosphere. The more carefully we treat our gaseous wastes, the larger the accumulation of solids we have to deal with. Thus the very nature of waste treatment demands a unified approach.

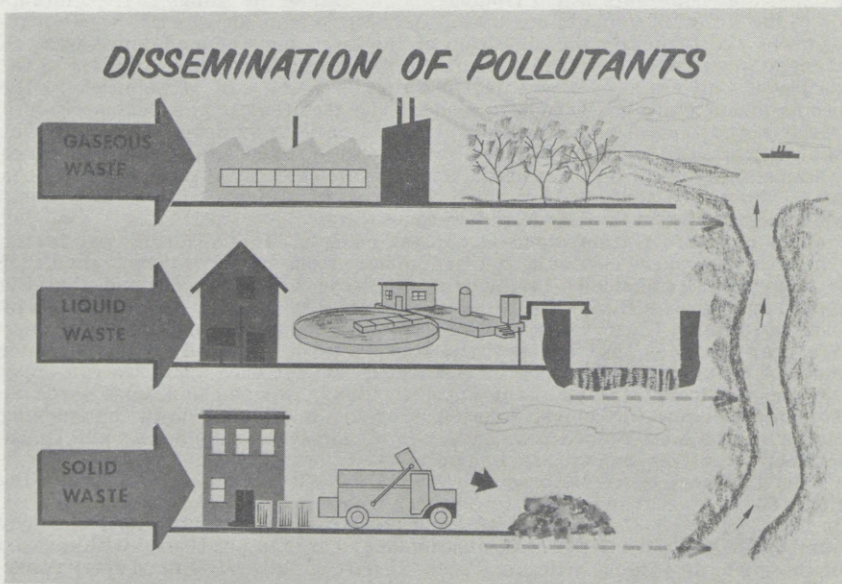


FIGURE 3

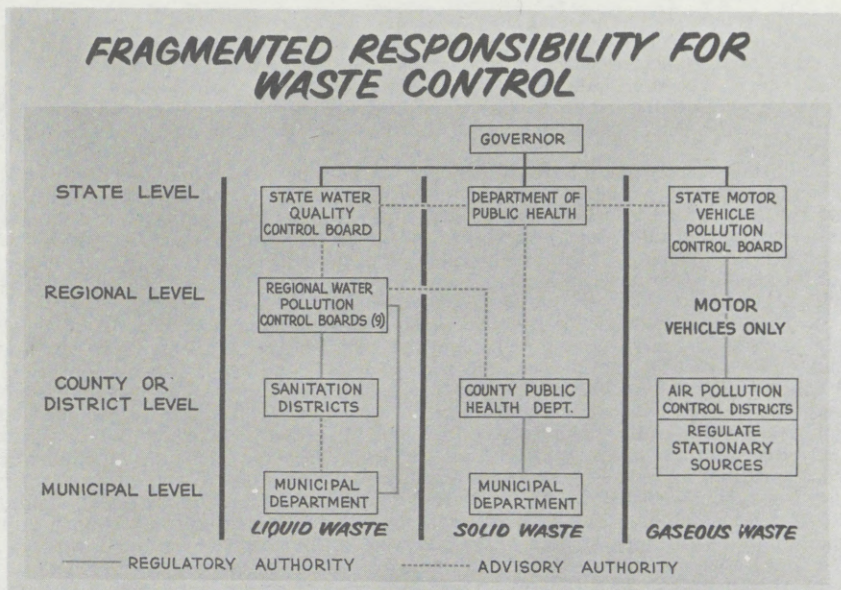


FIGURE 4

The knowledge that pollution is increasing and spreading from its source to distant places can only be the first step toward understanding the problem. Perhaps our major difficulty is in assessing the effects of pollution. It is not the existence of pollutants which troubles us but rather the things that pollutants do to the things of value in our lives. In order to plan for effective waste management and to justify the allocation of the large sums of money necessary to manage wastes, we must have a means for measuring the cost of pollution to the people of California. No meaningful estimate of the cost of pollution to the people of our state has ever been made. The fact that it is a complex job of heroic proportions does not mean it does not have to be done. Our study has shown that it can be done. Figure 5 shows some of the effects of pollution which we must measure in terms of cost. Once we have measured these costs, we can go to the public and ask how much money it is willing to invest in a waste management system in order to reduce these losses.

Such cost information alone is not yet enough. In California and in the whole nation, we are beginning to demand more from our environment than that it simply be economically productive. There is a growing demand that the environment in which we live be made aesthetically pleasing (Figure 6). The beer can littered beaches of Southern California are almost a thing of the past. We hear demands that our harbors and rivers be returned to their former state of beauty, that the smog be cleaned up so that once again we can enjoy viewing the mountains and that unsightly dump grounds and junk yards be hidden from view. President Johnson has taken a leading role in championing the cause of a more beautiful America. In his message to the Senate and House of Representatives in May 1965, he wrote:

"Today's new conservation must shift from the classic role of protecting threatened nature. It must restore beauty where it has already been destroyed. It must deal with the dangers which urbanization and growth and technology offer to the world we live in. It must make an effort to put beauty within reach of those who live in our cities, and make it part of the daily life of every American. For its concern is with restoring and enhancing the entire relationship between man and the natural world which is the source of so many treasured human values."

EFFECTS OF POLLUTANTS DIFFICULT TO ASSESS

- CROP AND MATERIAL DAMAGE
- REDUCTION IN PRODUCTIVITY-LABOR AND INDUSTRY
- TOURISM LOSS
- DOWNTOWN OBSOLESCENCE
- VALUE OF CLEAR AIR

- CROP LOSS DUE TO HIGHLY SALINE WATER
- INDUSTRY COST TO PROCESS POLLUTED WATER
- RECREATIONAL LOSS

- EFFECT OF POLLUTION ON LAND VALUES
- EFFECT OF POLLUTION ON FORESTS AND WILD LIFE
- LIMITATION TO INDUSTRIAL DEVELOPMENT

FIGURE 5

CHANGING AESTHETIC DEMANDS

- BEER CAN BEACHES
- POLLUTED WATERS
- REDUCED ATMOSPHERIC VISIBILITY
- UNSIGHTLY DUMPGROUNDS AND JUNK YARDS
- CHANGING SOCIAL OBJECTIVES

FIGURE 6

The fact that aesthetic demands are changing means that the design of any system for managing pollution must be aimed at a constantly moving target. The system designer must ask his customer how clean, how beautiful do you

want your environment and the designer must be prepared to put a dollar sign on proposed systems to meet a variety of levels of environmental cleanliness. Then together, a customer and designer must establish environmental standards or goals to be met by a waste management system.

COMPLEXITIES OF WASTE MANAGEMENT

- GROWING POPULATION
- IMPACT OF CHANGING TECHNOLOGY
- DISSEMINATION OF POLLUTANTS
- CHANGE OF STATE OF WASTE
- FRAGMENTED RESPONSIBILITY FOR WASTE CONTROL
- EFFECTS OF POLLUTANTS HARD TO ASSESS
- CHANGING AESTHETIC DEMANDS

FIGURE 7

WASTE MANAGEMENT SYSTEM

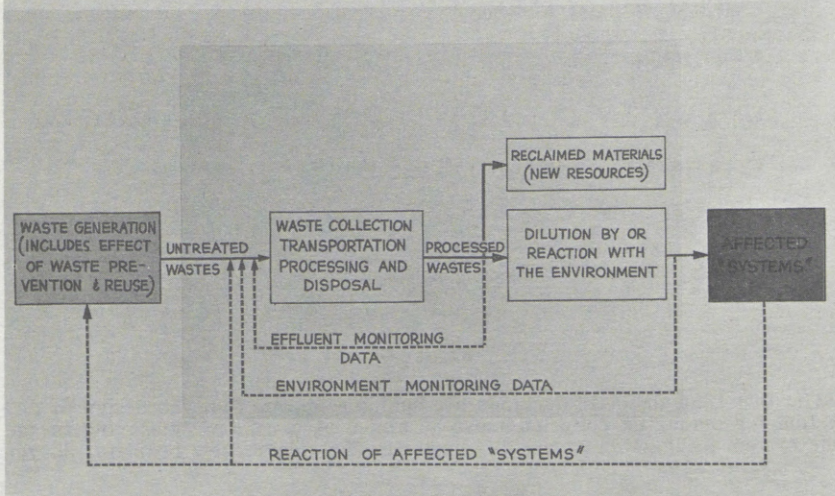


FIGURE 8

What have we said so far? (Figure 7.) We have said that waste management is a complex problem because of the tendency of pollutants to disseminate and to change from one form to another. We have said that the fragmented responsibility in the State for waste control adds to the problem, that the problem is growing not only at a rate based upon population growth but accelerated by a change in technology. We have said that it is extremely difficult to measure the effects of pollution in meaningful terms. We have said that the problem is made more complex by the changing aesthetic demands of the public and that these demands place the goals or target of a waste management system on a judgment basis where to a great extent the money made available for handling waste will depend upon value judgments of the public.

WASTE MANAGEMENT SYSTEM BOUNDARIES

In order to get on with the task assigned us in the Waste Management Study for California, it was necessary for us to define what we meant by a waste management system. This definition encompassed the functions performed by the waste management system and the interfaces between this system and the other systems of the social community. Figure 8 provides the definition for the waste management system. The system collects waste, transports, processes and disposes of it, reclaims useful materials and takes into account the dilution and reaction of pollutants with the environment. The system is responsible for monitoring wastes as they are discharged into the environment and responsible for monitoring pollution levels of the environment.

In order to provide manageable limits for the waste system, we have arbitrarily excluded the regulation of waste generation; saying instead, that any waste which can be collected is the responsibility of the waste management system. One important effect of this arbitrary decision is that the waste management system is not responsible for the prevention of waste generation. Were this arbitrary limitations not invoked, we would find the waste management system regulating industrial use of containers, making decisions about the raw materials which industry could use and in fact, invading all aspects of industrial economy.

We do say, however, that since the waste management system possesses the greatest amount of information about the costs of various pollutants, it is responsible for keeping society apprised about these costs. The system's responsibility for providing information should include recommendations to substitute one type of material for another in order to develop more tractable wastes.

At the output end, the waste management function cannot be responsible for the effects of pollution upon others. It cannot be made responsible for crop damage due to pollution, the health of man exposed to smog or any of the other systems which may be effected by pollution. But we believe the waste management system should be responsible for assisting the establishment of the relationship between levels of pollution and their effects upon the various effected systems. Society must establish quality standards for our environment which are low enough to protect itself. The waste system must be responsible for operating in such a way that the environmental quality standards are met.

AMOUNTS OF WASTE GENERATED TODAY AND PROJECTED FOR 1990

With this concept in mind, we proceeded to measure the amounts of waste generated in California today and develop methods of projecting the amounts of waste which are to be anticipated by the year 1990. In Figure 9, we present figures for solid and liquid waste. The liquid waste sewage and industrial liquid are in billions of tons per year and solid wastes are in tens of millions of tons per year. Thus the actual figures for sewage for 1965 are 3.3 billion tons per year. For the year 1990, they are 6.2 billion tons per year. Industrial liquid for 1965 will be 830 million tons and for 1990, 2.5 billion tons per year. Municipal refuse for 1965 amounts to 12 million tons per year and this will increase by 1990 to slightly over 40 million tons per year. Agriculture solids presently amounts to 13.3 million tons per year and we project them to increase by 1990 to 22.3 million tons per year.

The generation of gaseous waste is shown in Figure 10. We have separated hydrocarbons, oxides of nitrogen, sulfur oxides, carbon monoxide and aerosols because our projections take into account the effect of automobile emission control devices which will be required beginning next year. These devices will

have a considerable effect in the reduction of hydrocarbons and carbon monoxide, but very little effect upon oxides of nitrogen and sulfur oxides. The amount of total hydrocarbons for this year is 2.3 million tons. For the year 1990, it will be 3.3 million tons. Oxides of nitrogen go up from 800,000 tons to 1.5 million

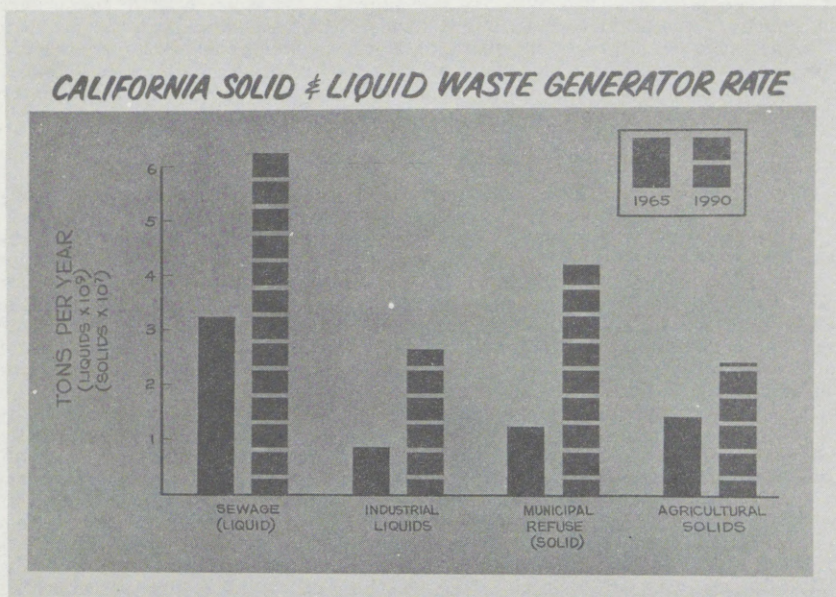


FIGURE 9

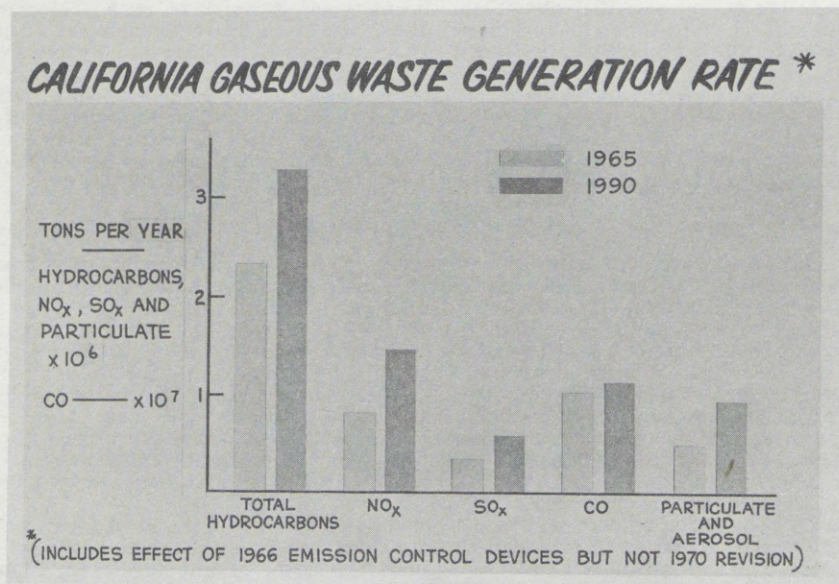


FIGURE 10

tons. Sulfur oxides increase from 300,000 tons to 600,000 tons. Carbon monoxide this year will amount to 10.2 million tons and will increase by 1990 to 11.3 million tons per year. Aerosols will increase from 500,000 to 900,000 tons per year. The total tonnage of pollutants thrown into the atmosphere of California this year will be approximately 15 million tons. This assumes significant proportions when one realizes that this amounts to considerably more than 10% of the total steel tonnage produced in the United States during this year.

SOME SYSTEMS ANALYSIS ASPECTS

In our effort to apply systems analysis to the waste and pollution problem of California, we searched for specifications which a waste management system would have to meet since systems provide the starting point for a design effort.

We looked first at air pollution and found that the State of California Department of Public Health over the past six years has been in the process of establishing atmospheric quality standards. These standards are being set at three levels: The Adverse Level, Serious Level, and Emergency Level. The Adverse Level is defined as that point where sensory irritation, damage to vegetation, reduction in visibility or other such effects may occur. The Serious Level is one at which alteration in body function may lead to chronic disease and the Emergency Level is one at which acute sickness or death in sensitized persons may occur. The identification of these levels in terms of pollutants is an extremely difficult one and only a few have been identified even on a tentative basis.

Figure 11 shows the concentrations that have been identified at the Adverse Level. The Public Health Service has also set automobile emission specifications for some materials which contribute to pollution. The exhaust concentrations are based upon projections of the automobile population in the Los Angeles basin between now and 1970 and the hope exists that the required reduction in the amount of pollutants put out by automobile exhausts will reduce concentrations in the atmosphere of Southern California below the Adverse Level by 1970. The Los Angeles County Air Pollution Control District supports these standards, but feels they fall short of meeting the county's needs.

AIR QUALITY STANDARDS

SUBSTANCE	U.S. INDUSTRIAL THRESHOLD LIMIT (PPM)	FIRST ALERT STAGE (PPM)	AMBIENT AIR QUALITY ADVERSE LEVEL (PPM)
CARBON MONOXIDE	100	100	120 FOR 1 HOUR 30 FOR 8 HOURS
HYDROCARBON	500	—	—
NITROGEN DIOXIDE	5	3	0.25
OZONE	0.1	0.5	—
SULFUR DIOXIDE	5	3	1.0 FOR 1 HOUR 0.3 FOR 8 HOURS
OXIDANT INDEX	—	—	0.15
PARTICULATES	—	—	SUFFICIENT TO REDUCE VISIBILITY BELOW 3 MILES

FIGURE 11

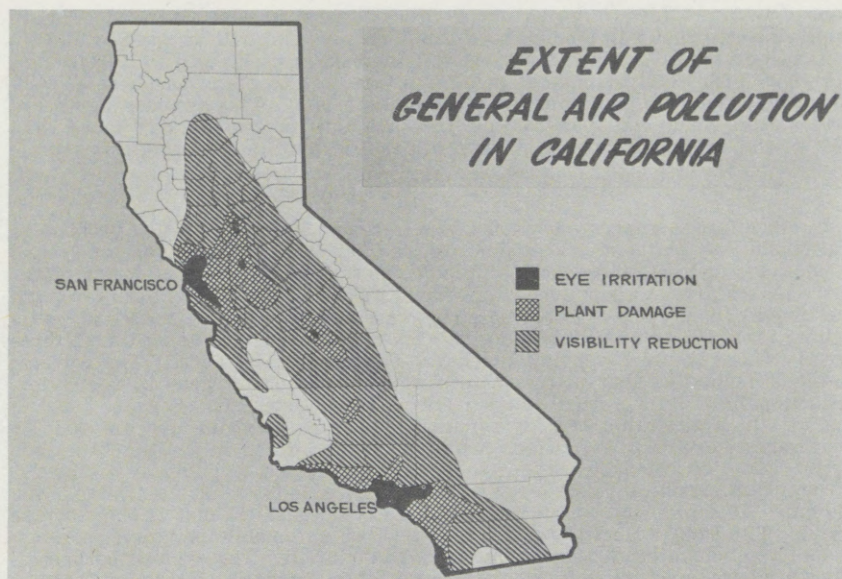


FIGURE 12

The State recognizes that we need air quality standards for ozone, hydrocarbons and all other possible constituents of smog which cause adverse effects of any kind. The Health Department is exercising great caution by not establishing a standard until sound scientific evidence is available to support the level set. Until the set of standards is complete and devices and techniques are available to meet these standards, the effects of smog will continue to increase in California beyond those of today shown in Figure 12. The large shaded-in area overlying the map of California indicates the present area of reduced visibility in California, during conditions favorable for air pollution. This area is approximately 70,000 square miles and it is the home of 97% of California's population. The dark green areas are those where plant damage occurs and the smaller yellow areas are those in which eye irritation presently occurs.

When we turn our attention to the problem of environmental standards for water, we see further evidence of the difficulty of establishing standards. In Figure 13, we show water quality standards of a variety of sorts. The first two columns present drinking water standards set by health organizations. We note that both the World Health Organization in the first column and the U.S. Public Health Service (1962 revision) agree on the total dissolved solids at 500 ppm. The Public Health Service Standards for sulfate and chloride are 20% higher than those set for the World Health Organization. The establishment of drinking water standards in this country goes back to 1914 and represents a great deal of experience. Despite this long experience, if now we look at the quality of water distributed by the Los Angeles Metropolitan Water District, we see that presently in Los Angeles the water contains 704 ppm of dissolved solids and exceeds the Public Health Service limit for sulfates by 47 ppm. There is absolutely no indication that the water being supplied to Southern California homes is detrimental to health. Furthermore, there is very little complaint on the part of the residents of Los Angeles about the quality of the water. Consequently, it is difficult to believe that the Public Health Service's standards have been set on any meaningful basis.

If we turn our attention to the maximum permissible concentrations for the Sacramento River at Knight's Landing which is near the lower reaches of the

Sacramento River, concentrations which have been set by the Central Valley Water Pollution Control District, we see that in most cases, the River water with respect to inorganic components is of considerably better quality than that being delivered to the homes of Southern California. This observation is also true when we look at the proposed water standards for the California Water Plan. One might conclude that water in the Sacramento River and in the California Water Plan System is kept at a significantly better quality because of its use for agriculture purposes. However, we know that most crops can tolerate water considerably inferior to that required for human consumption.

PRESENT WATER ENVIRONMENTAL STANDARDS AND SELECTED PRESENT VALUES

CONDITION	WHO INTER-NATIONAL (1958)	U.S.P.H.S. (1962)	PROPOSED CALIF. WATER PLAN	SACRAMENTO RIVER MAX. PERMISSIBLE CONCENTRATION	METROPOLITAN WATER DISTRICT
	PERMISSIBLE LIMIT	RECOMMENDED LIMIT			
DISSOLVED SOLIDS (ppm)	500	500	400	525	704
SULFATE (ppm)	200	250	100	130	297
CHLORIDE (ppm)	200	250	100	130	92
SODIUM (%)	—	—	50	60	63
HARDNESS AS CaCO_3 (ppm)	—	—	160	200	195 (SOFTENED FROM 330)

FIGURE 13

I use these comparisons only to illustrate the difficulty in setting meaningful water quality standards and I use them to reinforce our statement that prior to designing an effective pollution control system in the State of California, we need meaningful environmental quality standards to serve as basis for system design.

Despite the general lack of environmental quality standards, we tried in our study to project the effects of three different systems for the handling of California wastes and estimated rough order-of-magnitude cost for these systems. The goal in doing this was to establish whether a systematic approach to the management of waste was feasible and if feasible, whether it would be meaningful to California in terms of cost savings. The annual costs of the systems which we postulated to be in operation in 1990 are shown in Figure 14.

The first system can only be called a system in the broadest interpretation of the word in that it represents the continuation of handling wastes in the manner presently used in California and incorporates only the expansion of the existing processing techniques to dispose of the increased amounts of wastes generated as a result of population growth and technological change. Since our present waste handling techniques do today result in the pollution of our environment, the expansion of this system to meet the loading of 1990 would result in increasing pollution of our environment, since we can already see that our environment has a limited capacity for the dilution and conversion of pollutants. This first system is represented by the first bar. We term this the Expanded

Existing System. As is indicated on this chart, the Expanded Existing System will incur the direct costs of operation, maintenance and equipment depreciation of \$1.1 billion per year by 1990. The indirect costs attributed to crop damage, reduced industrial productivity, metropolitan obsolescence, recreational losses, etc. will amount to \$7.4 billion per year or a total cost assignable to this way of handling waste of \$8.5 billion per year.

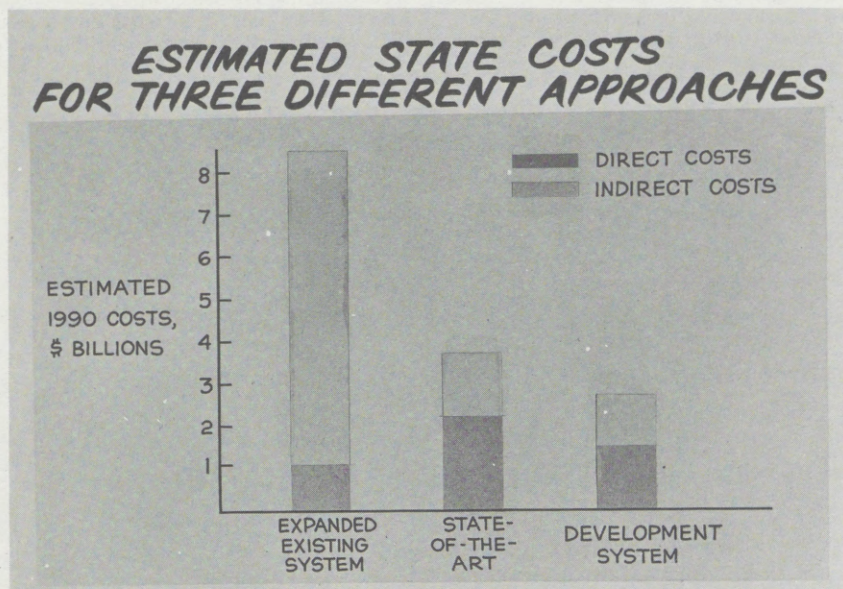


FIGURE 14

The second system which we projected for the year 1990 is one utilizing all of our present technology in the most efficient way, taking advantage of integrating the treatment of solids, liquids and gases wherever feasible. The direct costs assigned to this system are considerably greater than those of the Expanded Existing System and amount to \$2.2 billion per year. This system, however, because of its more comprehensive treatment of waste and its more appropriate disposition of unused materials results in an environment which is markedly improved over that of the existing method and consequently, the indirect costs are greatly reduced and amount to only \$1.6 billion per year.

The third system which we projected for 1990, we have termed the Development System since it would incorporate new means of transporting, treating, reclaiming and disposing of wastes. The goal in the development of improved techniques is primarily one of improving efficiency and reducing costs and consequently, the direct costs for this system are less than the previous system amounting to \$1.5 billion per year. The performance specifications for this system are the same as those of the State-of-the-Art System and thus the same improvement in the environment and the same reduction in indirect costs result. As a consequence of this exercise, we are firmly convinced that a planned approach to the development of waste management in the State of California is feasible and must be implemented. In its implementation, however, it is impractical to consider the State of California as one integrated system since topographical features, geological and meteorological conditions and other factors such as population density, land usage and transportation patterns vary widely throughout the state. We have tentatively identified seven separate

regions within the state which we believe from our preliminary analysis represent regions in which a systematic approach to waste management would be practical.

RECOMMENDATIONS FOR FUTURE WORK

The region which we have identified as the Central Basin—San Francisco Bay region is the one with the greatest number of pressing problems. We recommend that immediate steps be initiated to develop a coordinated waste management system for this region. The steps involved in developing a system for this region are the steps followed in almost any development cycle (Figure 16). They begin with a primitive need which is simply a statement that someone believes that there is a problem. The succeeding steps are a feasibility study, a preliminary design, a detail design, an acquisition phase and then system operation. These steps do not proceed smoothly from one to the next however without careful planning and guidance. This element is indicated in Figure 17 by a parallel activity of system management together with the development and updating of a program plan for the guidance and monitoring of this effort through all of its phases.



FIGURE 15

The systems management and program planning can be the function of either industry or government. Both approaches have produced notable results in the aerospace industry and we have no reason to believe that they would not produce similar accomplishment in this state and community problem. We believe that it is more advantageous for the state to go to some outside organization for systems management since there will be large fluctuations in the manpower needs as the program proceeds through the various steps leading to systems operation.

It is difficult to have clear insight into all of the details of all of the activities which will be involved in the various steps listed here. However, as a result of our study, we can look in more depth into the feasibility study shown in Figure 18.

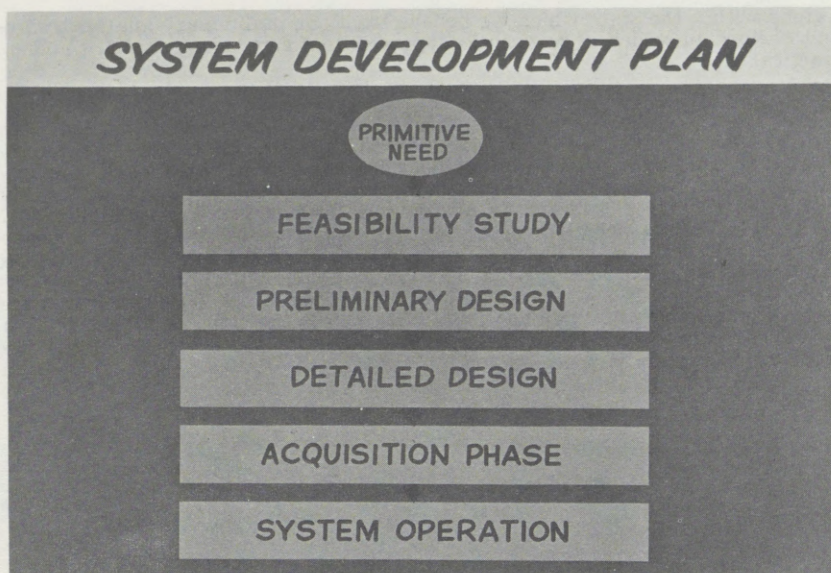


FIGURE 16

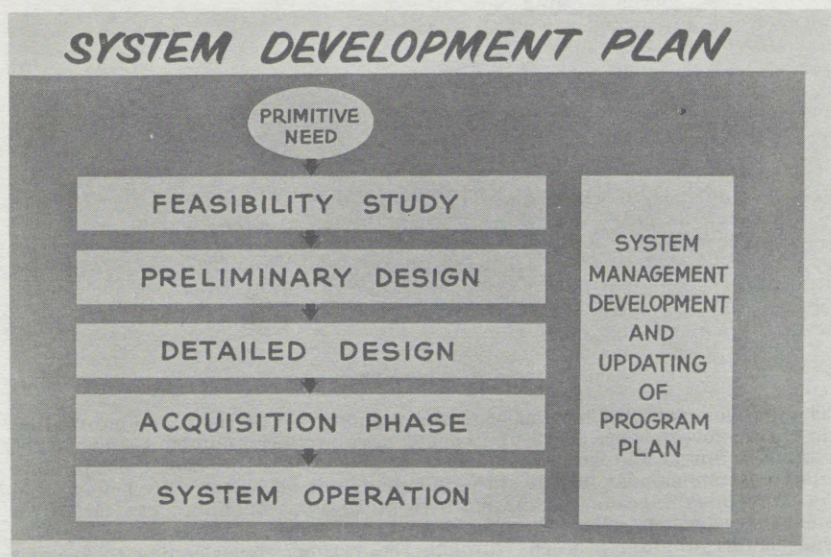


FIGURE 17

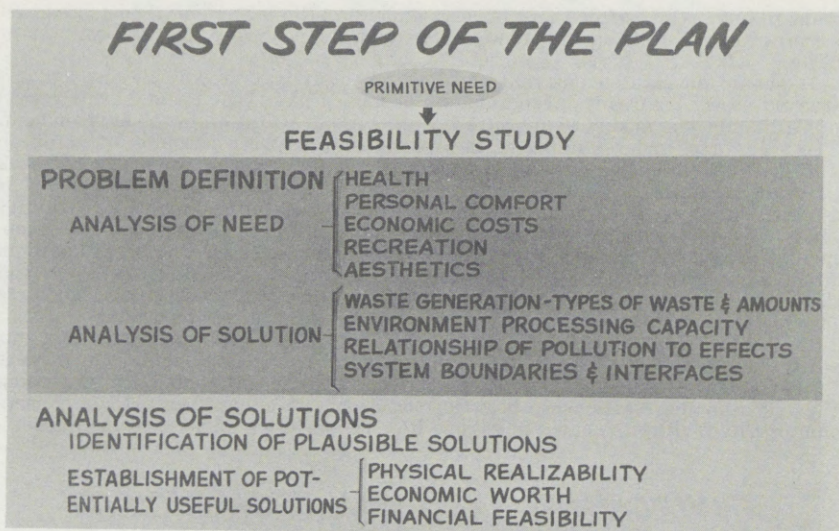


FIGURE 18

This is the first step toward the acquisition of an operating system. The feasibility study outlined here does not merely represent more information gathering, but serves as the working foundation for everything which is to come later. Let me discuss in a bit of detail the feasibility study. The primitive needs have been voiced by a large multitude in the Central Valley and San Francisco Bay area. There is unhappiness with the encroachment of bay waters into the delta region. There is unhappiness with the increasing salt content in the agricultural lands in the Central Valley. There is unhappiness in the San Francisco Bay area with pollution of the waters and with smog in the air. We need however to go from this statement of primitive need to a real definition of the problem.

We require an "analysis of needs" in terms of effects. What are the health effects? How does the pollution cause discomfort? What are the economic costs in terms of agricultural losses, in terms of cost to industry? What are the requirements in this region for recreation and for a beautiful and pleasing environment in which to live? When these needs have been defined in reasonably concrete terms, the feasibility study then turns to an analysis of what must be done in order to develop a solution. The amounts and types of waste being generated in this region must be measured and projections must be developed for the coming years during which the system will be in service. Data must be developed to provide a measurement of the capacity of the environment for receiving diluting and processing wastes. Quantitative relationships between pollution levels and the effects measured in the "analysis of need" step must be developed and then decisions must be made about the system boundaries and the interfaces which this system has with other activities of man of this region. When we have done this, then we have truly defined the problem and we are now in a position to initiate a search for plausible solutions.

A variety of plausible solutions must be identified and these can be sorted on the basis of which of these are potentially useful in terms of physical realizability, economical worth and financial feasibility.

The set of potentially useful solutions should have varying capability to reduce environmental pollution and will vary in their costs of implementation and operation. Their performance capability in terms of reducing pollution must be described in the same terms used during the "analysis of need" in order that the public or their representatives can make a selection of the type of system they

want to buy. Only after there is clear understanding of potential costs and cost savings can the decision be made to enter upon the next step, that of preliminary design.

It should be pointed out that the feasibility study is a difficult one and extremely costly. Already large amounts of money have been spent in this region of California just trying to measure the amounts of pollution in the environment. The study and understanding of the relationship between amounts of pollution and their effects in the terms used under the "needs analysis" is a major research program in itself. The measurement of environmental processing capacity is another major research program. We anticipate that for this region a feasibility study to a depth adequate to permit proceeding to the next step in the development program will consume three to five years and cost between \$8 to \$10 million. Final costs and time spent to this point will depend upon other research and development programs being conducted by the state and federal government to provide fundamental information on the two research areas identified.

In addition to the need for a number of models and computer programs, our study has identified the need for a national environmental simulation facility for the study of the complex problems associated with environmental processing capacity and the relationship between pollution and effect. An artist's conception of this facility is shown in Figure 19. The geodesic dome covering approxi-

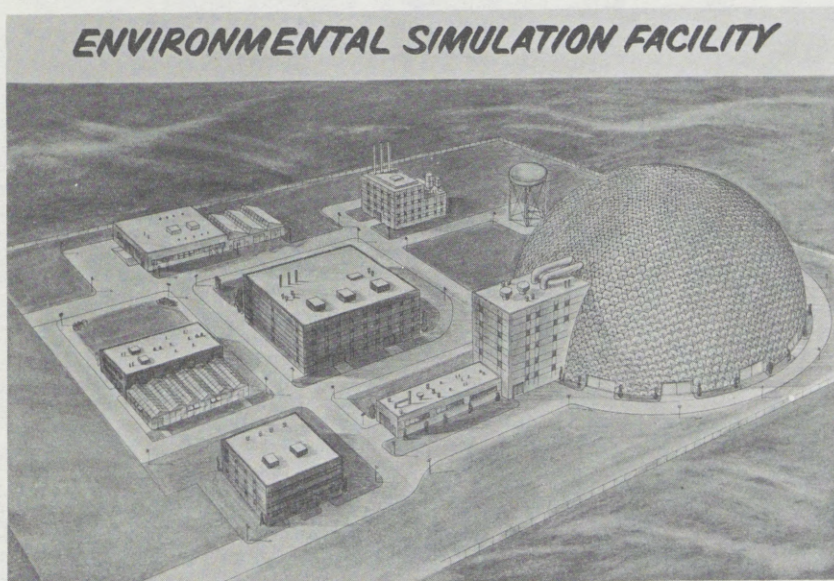


FIGURE 19

mately ten acres provides the capacity for experimentally determining the complex interactions of pollutants with environmental factors which can be controlled experimentally. This simulator would deal not only with gaseous pollutants but with liquid and solid pollutants and the interchange among all three states. Other simulators on a smaller scale are located in the attached building and are for the study of interactions of pollutants with environmental factors using only one or two variables. The central building is a supporting laboratory facility. A standby power plant is in the far corner, shops and maintenance facilities are to the left of the power plant and in the foreground, are the administration building and the animal and plant laboratories.

We feel that this facility will make significant demands upon a broad spectrum of aerospace sciences and because of this and the fact that California is a most suitable demonstration region for nationwide waste management problems, this facility should be located in California.

Senator NELSON. Our next witness is Mr. Jones, assistant to the president of North American Aviation. Mr. Jones, we are pleased to have you come here today. You don't have a prepared text?

**STATEMENT OF JACK JONES, ASSISTANT TO THE PRESIDENT,
NORTH AMERICAN AVIATION, INC., LOS ANGELES, CALIF.**

Mr. JONES. Yes; we do. The text and illustrations are before you now.

We also have submitted to the committee volume I, our summary volume on our California report, I understand that the complete volume of the other four technical volumes is in the hands of the committee.

Senator NELSON. Do you want to make this presentation extemporaneously?

Mr. JONES. Yes, if I might, using the illustrations to show the group.

Senator NELSON. Fine.

Mr. JONES. Senator Nelson, I appreciate the opportunity to talk to the subcommittee.

I am Jack Jones, assistant to the president of the Los Angeles Division of North American Aviation.

I would like to emphasize, since we will be using colored slides with partial illustrations, this is just the top of the iceberg,

To be consistent with your suggestion that we should hold the presentation to 20 minutes or less, we will go very quickly through the portion of our work. However, I do not want to leave the feeling that this is just Buck Rogers and glamorous, because there is quite a bit of hard-core work behind the presentation, and I would like your subcommittee to examine it.

The work that North American did was contracted with the California Division of Highways in cooperation with the U.S. Bureau of Public Roads.

I believe we may be somewhat unique in the four contract orders in that we did have a Federal sponsor connected with our work and a Federal monitor throughout the entire work.

I would also like to emphasize that the Department of Commerce has evaluated our report, and I believe this evaluation can be obtained by the subcommittee if it desires.

I would also like to emphasize that we were to do three things. We were to survey the total field of transportation and try to appreciate the size of the problem and to identify the problems in transportation. Then we were to see if a system analysis team of management, or whatever you want to call it, could be applied fruitfully, and if so how.

Well, obviously, we found out that it can be applied.

We have made a detailed recommendation to the State of California as to how to apply it. It is detailed in years, and manpower

scheduling is projected, but we were not to define transportation solutions. This was not specifically our job. Our job is to look at the entire picture.

The cover illustration has some meanings, because our task was to consider everything that moved within the State of California for the next 50 years—land, sea, and air movements.



SLIDE 1

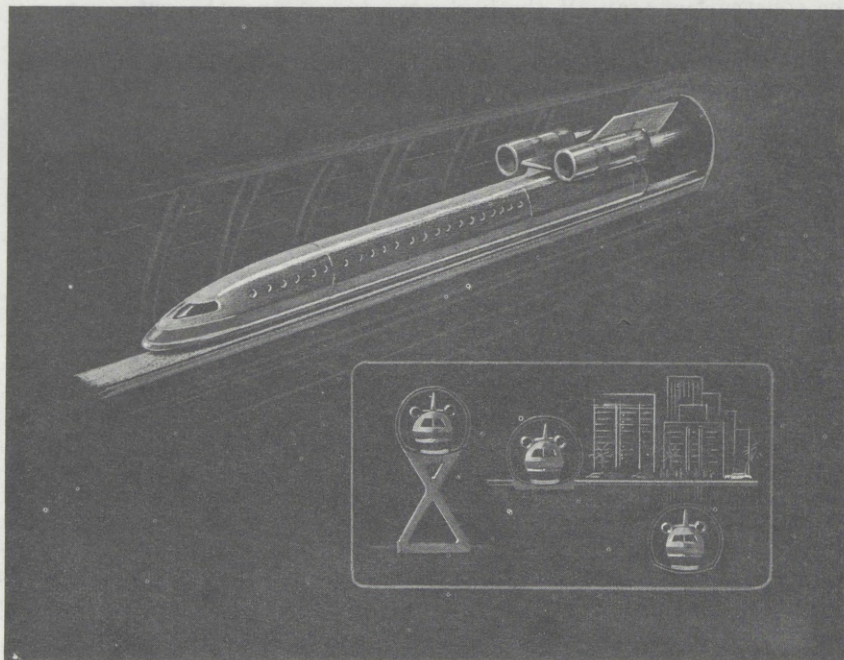
Of course, California has its urban areas and its recreational areas. The first task we had to do was to look at the transportation technology which might bring about changes in the future.

I am going to very briefly show a few examples of what we found we fully expect will be available in the next 50 years. Most of this equipment is expected to be available in the early part of this time.

First of all we have the tube trains. The recently passed high-speed ground transportation bill is evidence that this type of device will be developed in the very near future. When I say the near future, I am talking in the context of 50 years, so I believe Federal estimates of this sort of device can be developed and installed in the Northeast part of the Nation in about 12 to 15 years. That is the installation of the first major system.

There are several important characteristics of tube trains. First of all, those being considered seriously are in the jet airline speed class. They must be, because when you look at the economic justification of putting in a new type of installation like this, it has to be used

by the public, and today we have jet airplanes flying, you know, in the 500-mile-an-hour class. There are about a half-dozen types of tube trains being pursued today, either in the laboratory or on someone's piece of paper.



SLIDE 2

The one area of longest and possibly the most extensive type is that at Rensselaer Polytechnic Institute. Dr. Foa of the Department of Aeronautics and Astronautics has been experimenting with this type of device in a wind tunnel and with other experiments for over 15 years.

Just a few other remarks on what a tube train is.

The tube is provided to protect the train. It is not the usual pressure carrying device; although some tube trains require decreased pressure inside the tube.

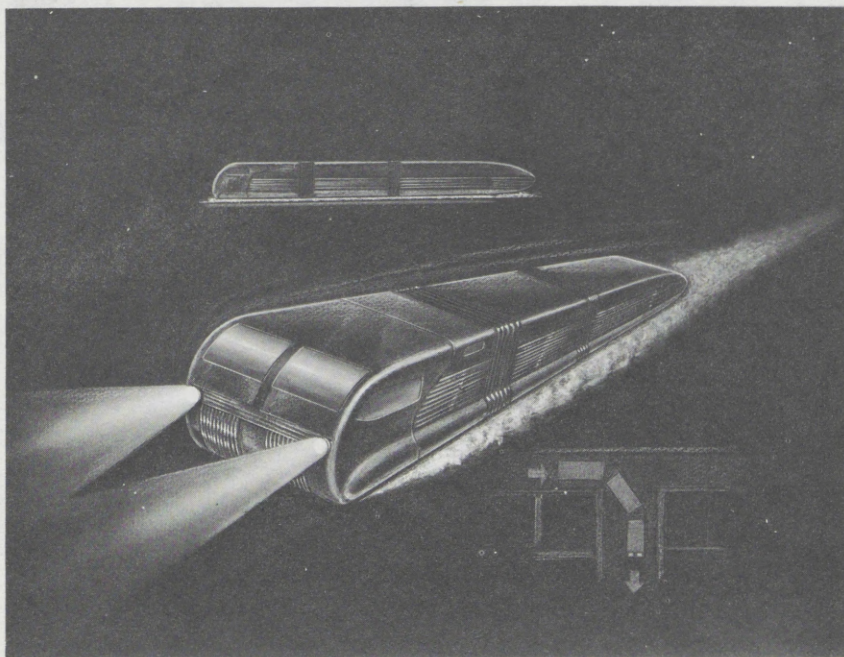
It is primarily for the protection of the train in such cases as children throwing rocks. If the train is traveling at 500 miles an hour and hits something, it will be damaged.

The tube also protects the public from the noise of the train. Most of these devices are conceived so they can be installed above the surface, on the surface, or below the surface.

Another area of considerable technology and one which is being pushed at this time is the ground-effects machine or air-cushion machine.

The British call it the Hovercraft. This particular illustration is of a truck two or three hundred feet long, traveling somewhere between 150 and 300 miles an hour. It would travel on a guideway. The guideway in this case is a smooth surface with a lip on either side to keep the machine from sliding off the guideline. It doesn't require the construction, say, of the highways today, and the guideway can be relatively cheap.

The insert at the bottom shows the truck articulated. They can be moved on wheels on a docking and undocking area.



SLIDE 3

There are a number of ground-effect machines being developed. There is an experiment that I am sure you are familiar with in San Francisco where the so-called skimmer devices are being used today in operation across the bay.

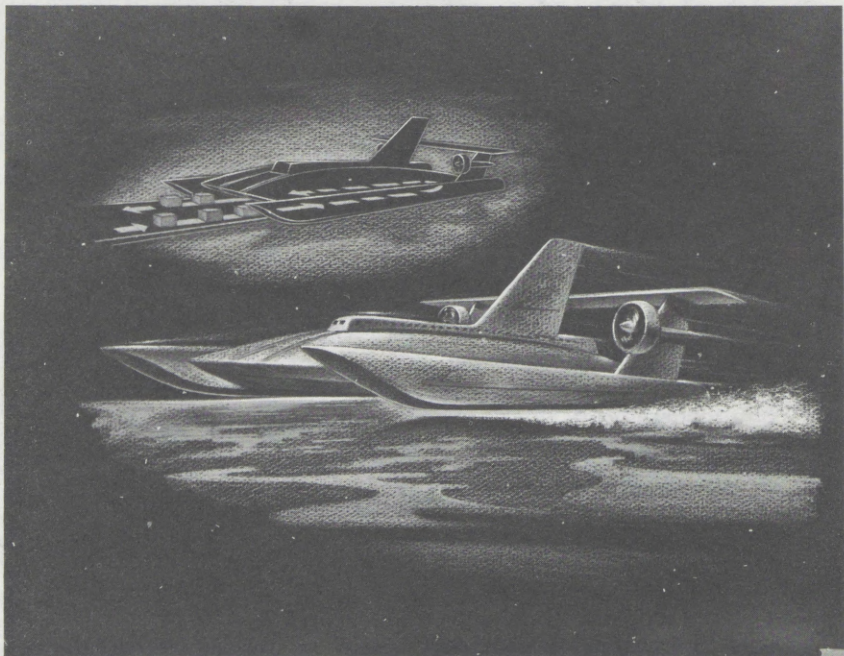
They have been used by the British Army to supply outposts in Malaya.

Our Defense Department plans to send a small number to Vietnam in the very near future—Marine skimmers—to see if they are effective in that type of operation.

The Navy just completed an extensive testing program this year, and we understand some requirements have grown out of this.

So, when you have that sort of a military background, and putting in that sort of effort in the development, you are bound to have this kind of vehicle available for civilian use.

The Maritime Administration, Department of Commerce, has been assigned the task of seeing if we can develop a new type of ship in order to help our merchant marine become economically stable and independent. I understand that some \$500 million a year goes presently toward supporting our merchant marine in tax dollars.



SLIDE 4

This is an illustration from a report of the Maritime Commission. We understand they are actively engaged now in considering major development programs of this type of a ship, and there are about a half-dozen concepts they have considered.

We selected this one as an illustration. This particular one is a 5,000 gross ton ship, with 2,000 tons of payload. It is an airplane; it flies. It floats on pontoons when at rest. As it accelerates it lifts off the water and flies in the surface effect.

I used the term "surface effect." What that means is if you are flying low enough over the surface, you get reflecting pressures. This gives you a greater lift and greater efficiency than you have when you are up in the air considerably above the surface.

Such a device is thought of as being automated with a crew of about five men to handle it.

I don't know if I mentioned the speed. It cruises between 150 to 300 miles an hour.

Further illustrations show an automated loading and unloading procedure, since the economy of this device depends on quick turn-around. It loads and unloads the containerized cargo on a rotating chain-pull principle. The ship is loaded and unloaded at the same time.

The Maritime Administration estimates this would all occur in less than 45 minutes. The ship can go back to sea and fly back to San Francisco or to Hawaii.

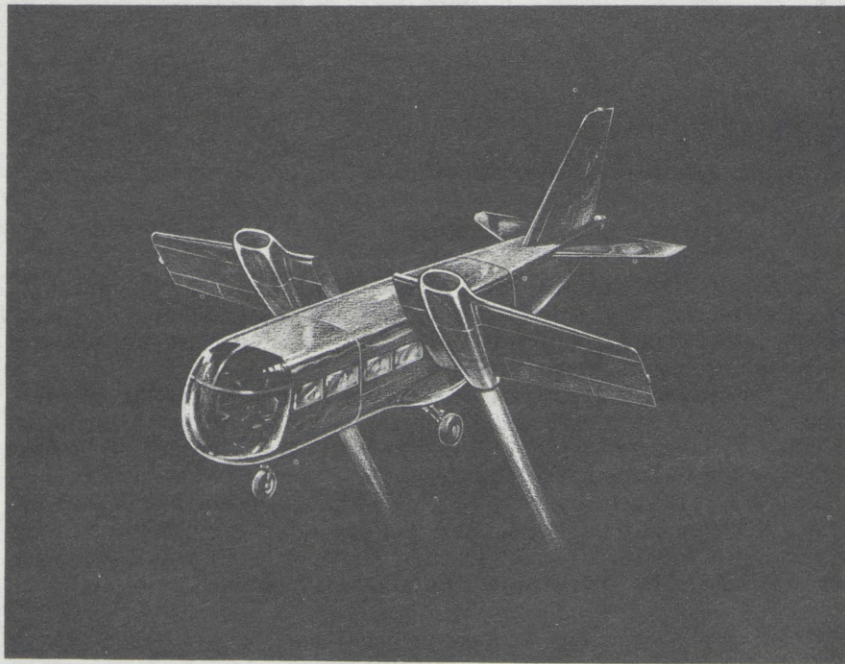
Such a device would be operated as a larger plane is today.

In one way or the other we believe that probably in 15 to 20 years our merchant marine will be using this type of ship.

The sky bus, or what the professionals call the V/STOL, airplane, for vertical and short takeoff and landing, is being actively pursued by the Defense Department and by some civilian concerns.

This is a cross between an airplane and a helicopter in its performance, and it rises very sharply, not necessarily vertically, but at a very steep angle and it also lands at a steep angle. Therefore, it uses very little runway. The standard runway for this type of aircraft is about 1,200 feet as compared to 12,000 feet for standard jet airplanes.

This makes it very attractive for suburban use; it is comparatively easy to find the land to put an airport for this type of aircraft.



SLIDE 5

The noise is not the major problem as it is around major airports because the aircraft rises so sharply. They wouldn't spread the noise over a large area of land at low altitude.

We in California find a particular use for this with our spreading suburban makeup and our desire to protect our natural beauty and recreational areas, and we see this type of aircraft being used to take people directly from the areas near their homes to the mountains or beaches.

These devices being designed for the military are required to land on soft ground, so you don't have to put a standard runway in the recreational areas, and it seems to be one use for this type of aircraft.

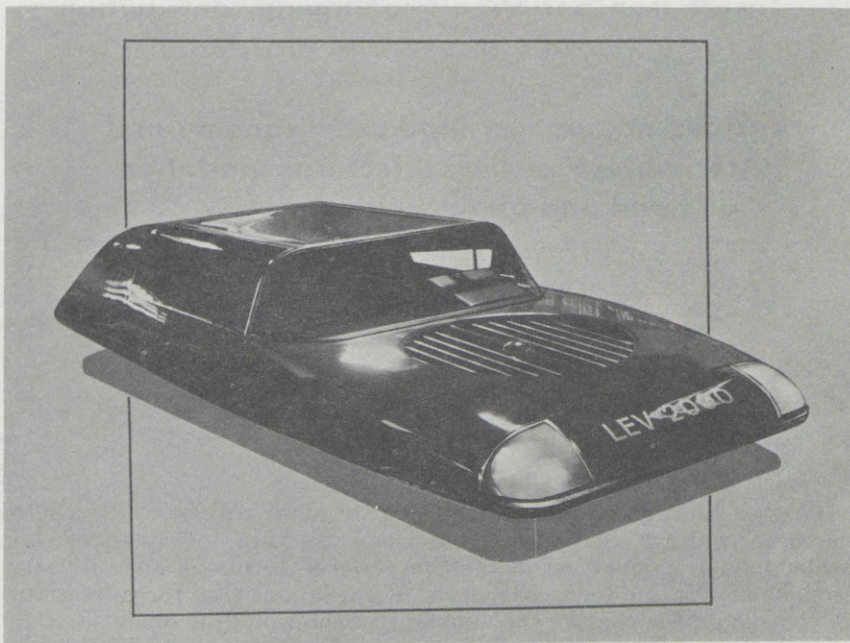
We see commercial versions of this being available economically very early in this time period, probably in about 5 years.

The subject of individual transportation is so diversified we had difficulty selecting an illustration.

This particular one is a full-scale, metal mockup on display this summer in Europe. The people who saw it on display said it is a flying vehicle with a ceiling of 5,000 to 7,000 feet. It is designed like an airplane, but appears more like an air-cushion machine.

The important thing is there are some types of individual vehicles being developed and, certainly in the next 50 years, we will have a new type of individual vehicle.

It may look like an automobile, but be propelled by a non-smog-producing engine such as an electric engine. It will probably be automated on our freeways, so we can achieve a space improvement of about 40 to 1 compared to today's cars.



SLIDE 6

It will probably be designed to have maximum speeds of something like 150 miles an hour on the freeways and about 50 miles an hour on our surface streets, and being properly designed structurally you can have a headon collision at 50 miles an hour and not kill people.

It is just illustrative of the fact there are in the laboratories a number of projects, and with the technology we have today, there are all of these possibilities.

In the study we have recommended—I am jumping ahead a little bit—we will encompass for the first time all transportation modes and propose that they have a single frame of reference. This has not been done. We have pinpointed the railroad and the bus and the airplanes and the automobile, but we have never put everything down compared on a single frame of reference.

We believe that if this study is undertaken this will insure transportation's continuing contribution to California's prosperity, but to do it we must include considerations of population, economy, and land use, and it will provide a forward look into the next century.

THE STUDY WILL

**Encompass all transportation modes in
a single frame of reference....**

**Insure transportation's continuing contribution
to California's growth and prosperity....**

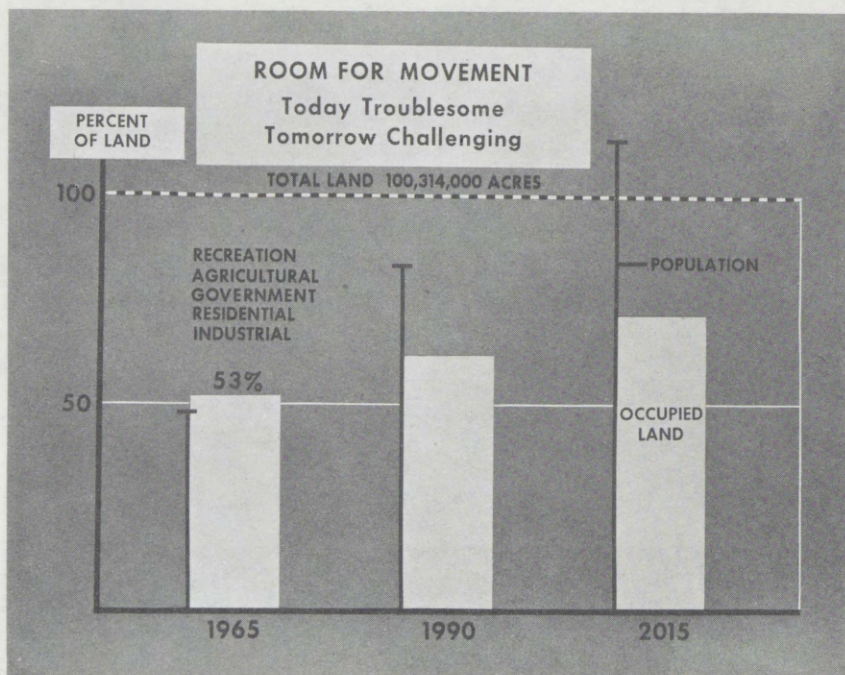
**Include population, land use, economy and
technology as they effect transportation
demand and opportunities....**

**Provide a forward look into the
21st century (2015 AD).**

SLIDE 7

To give you just an idea of what we are faced with as we look into the next century we plotted, and these are thin red lines, official projections of population in the State of California 25 and 50 years from now. We find today 53 percent of our land is used for recreation, as you see on the chart. We assume that we would be much smarter 25 and 50 years from now in the use of land. We can put more people

on less land for living and recreation and also for work. That results in the larger bars.



SLIDE 8

We can see that we will be using up our land and there will be less unused land in the State. One thing we are faced with in this State is we have only 100 million acres. We must face up to this fact.

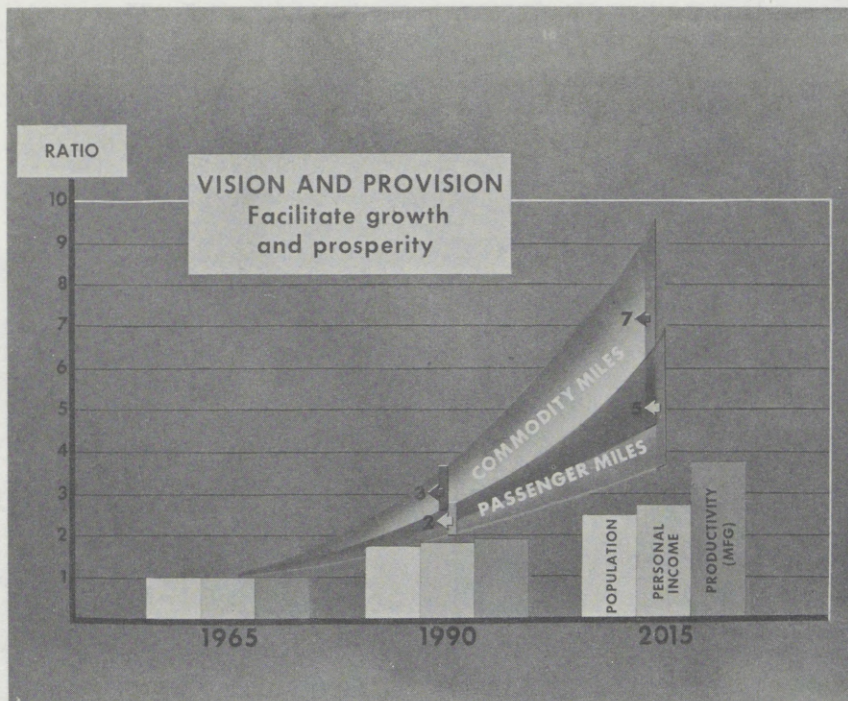
Probably the most significant indication of the future problem is shown on this chart; there are three prime driving factors influencing transportation. They are population, personal income, and productivity. When we combine them 25 years from now, we can expect twice the number of passenger miles and five times as much in 50 years.

The commodity miles will be three times as much in 25 years and then increase by as much as 7 and perhaps 10 times in the future.

This shows we are going to have a lot more movement in our State in the coming period. Things are also going to move a lot faster. This has a direct bearing on the way we design our terminals, our transfer points, how we get people on and off vehicles, how we move freight and commodities around.

Twenty-five years from now vehicles will be moving five times faster than they are today, and in 50 years about 10 times faster.

We as system analysts are always suspicious. Once a systems analyst is properly trained he will never take anything at somebody's word. He always questions it.



SLIDE 9

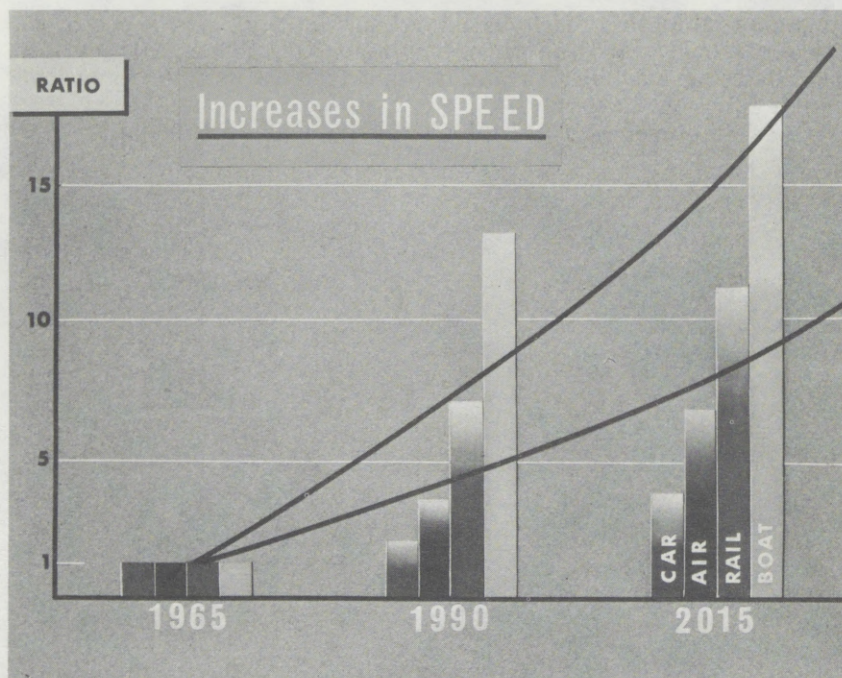
We found one area that concerned us was how much the population will be and where it will be. Everybody who projects population, and there are quite a few agencies, all agree on two things. In California we will have a lot more people and they will all be in the same place. We don't care to argue with their projections about a lot more people, because we have to believe that. We do argue with the assumption that they will all be in the same place.

We don't know. In order to properly plan for transportation we keep asking ourselves, will they? Because we look at the availability of water, power, communications, waste disposal and other items necessary for human life, and we find that through desalinization and reclamation water will be available almost throughout the State in this time, almost anywhere in the State.

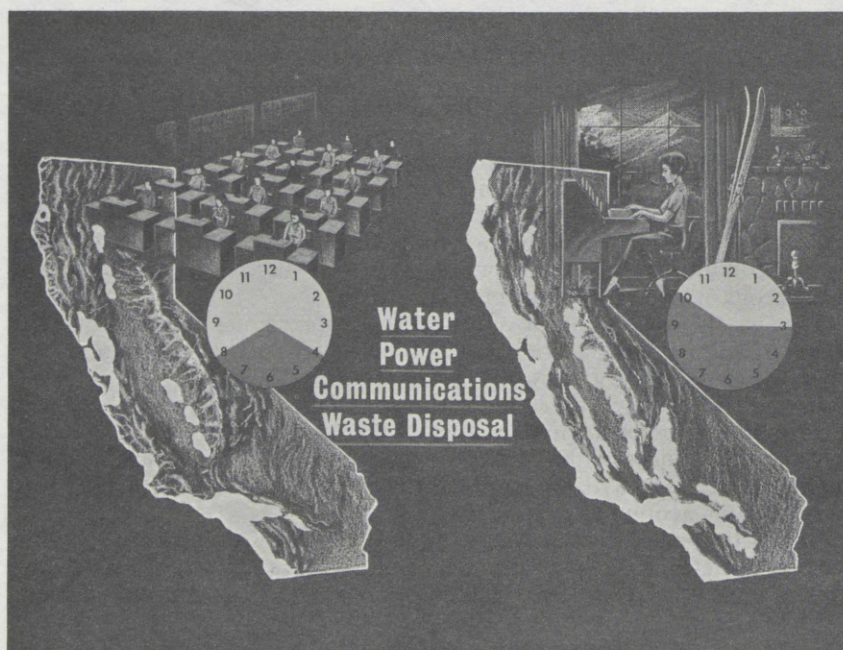
Power will be available either through small nuclear sources or through broadcast power.

Broadcast power is where you transmit your power like you do your TV signal, picking it up with an antenna at the house.

And then we looked at some of the reasons why people in our big cities travel to work. We chose San Francisco for an example, where there are quite a few insurance company headquarters, and we analyzed the personnel that work in those headquarters. Over half of the people travel about 45 minutes every morning, punch a card, and then sit



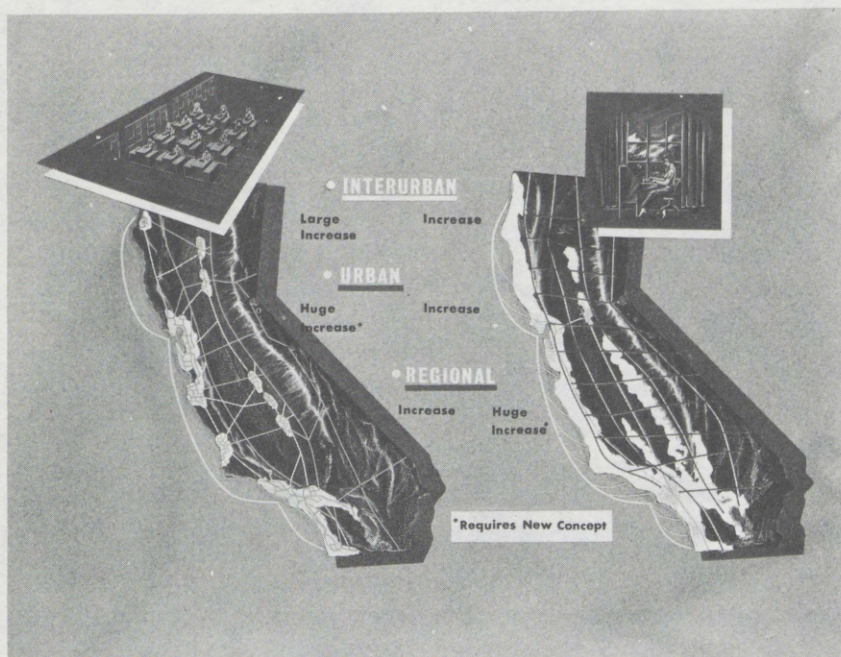
SLIDE 10



SLIDE 11

down at a tabulating machine throughout the day. At the end of the day they punch a card and travel 45 minutes back home. All they do at the tabulating machine is translate data from cards to tape, or some similar function.

We asked ourselves why couldn't this be done all at home?



SLIDE 12

The artists have chosen to show the high Sierra foothills, and a girl with skis. She got up in the morning and has taken her work out of the communication device, and puts her 5 hours in punching a tabulator. At night before she goes to bed she will put the results back in the communicator. Meanwhile, she will have freedom to ski or catch trout or whatever she would like to do.

This would have a major effect on transportation. The map on the left shows the standard prediction, all being where they are today.

The map on the right shows a spreadout population.

If the standard prediction occurs, we will have a large increase in inter-urban transportation because there are more people. We will have a huge increase in urban transportation, which would be of such magnitude it will require a new concept of movement, a new way to get people around the city.

On the other hand, if people were to live where they like to live and still be fruitful in their work, we would see that regional travel will have a huge increase. This means getting people in and out of areas

where they can't even get to today. Again, it will require a new concept of getting in and out of these recreational areas and doing it without destroying the natural beauty.

Systems engineering is an approach which we have evolved in the aerospace industry in order to examine problems that are very complex. We do use modern computing techniques for two reasons. A computer can store a tremendous amount of data that the human mind cannot, and it can perform calculations in a very short time.

SYSTEM ENGINEERING IS...

An evolved approach...

**for the examination of predicted,
complex problems...**

**utilizing modern computer technology....
and analytical techniques.**

NO OTHER METHOD CAN...

**Encompass the complete transportation task...
or... master its complexity.**

SLIDE 13

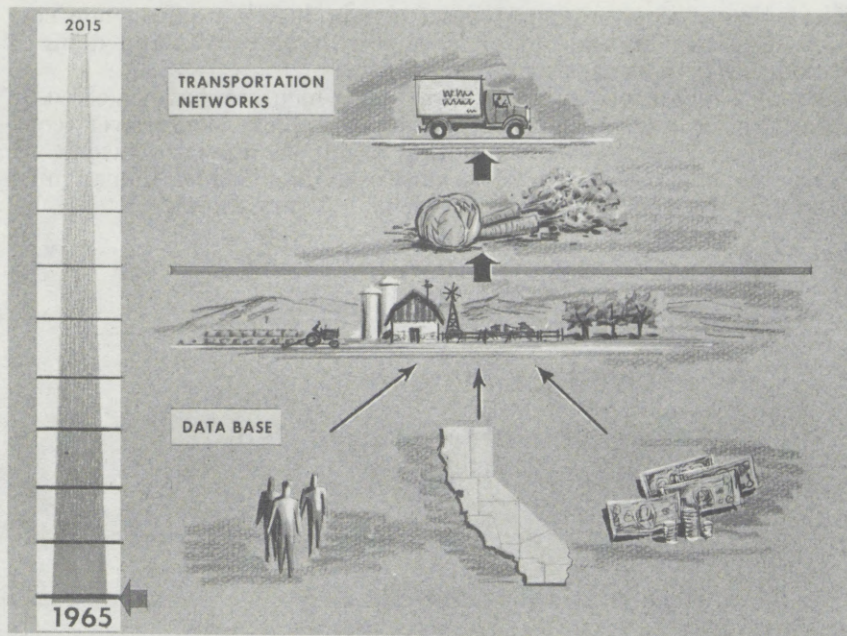
In order to properly operate the program, you must have trained people who know how to apply the analytical techniques necessary, how to identify the subsystems and the relationships between these, and therefore, model the problem for the computer. As far as we have seen, no other method can approach this complex transportation task.

Now our recommendation to the State for the next effort is rather small as far as dollars and time go, and it is represented by the next few charts.

We see California as we see any region, nation, or state in the world, consisting of three basic items:

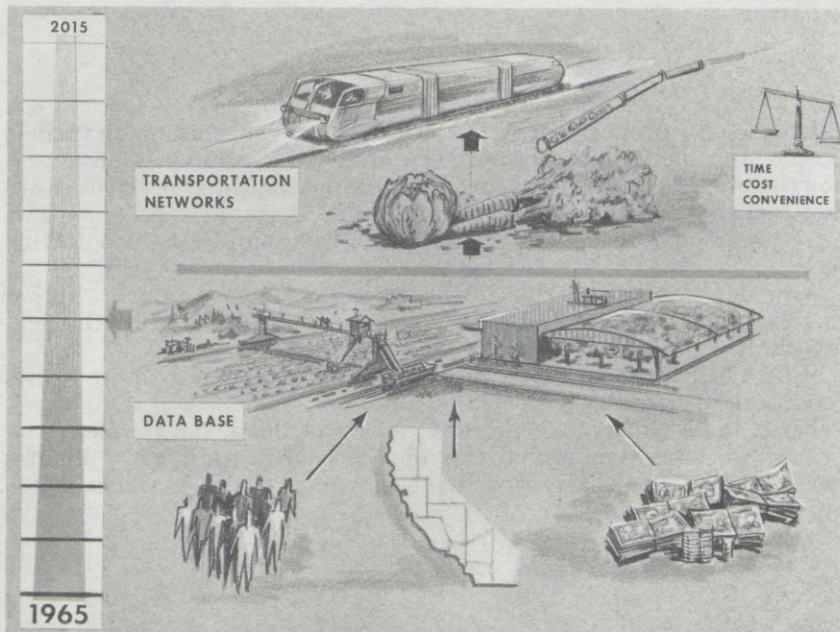
First, the economy; second, the land; and third, the people.

Now we have represented this on the chart as a farm. A farm has a product. In this case we have shown lettuce and carrots, which are moved by truck.



SLIDE 14

Now we look ahead a little bit and see according to the projections there will be a much greater and different economy in the State of California. We have the same land, but it will be used differently. We will put different industries and different people in certain portions.

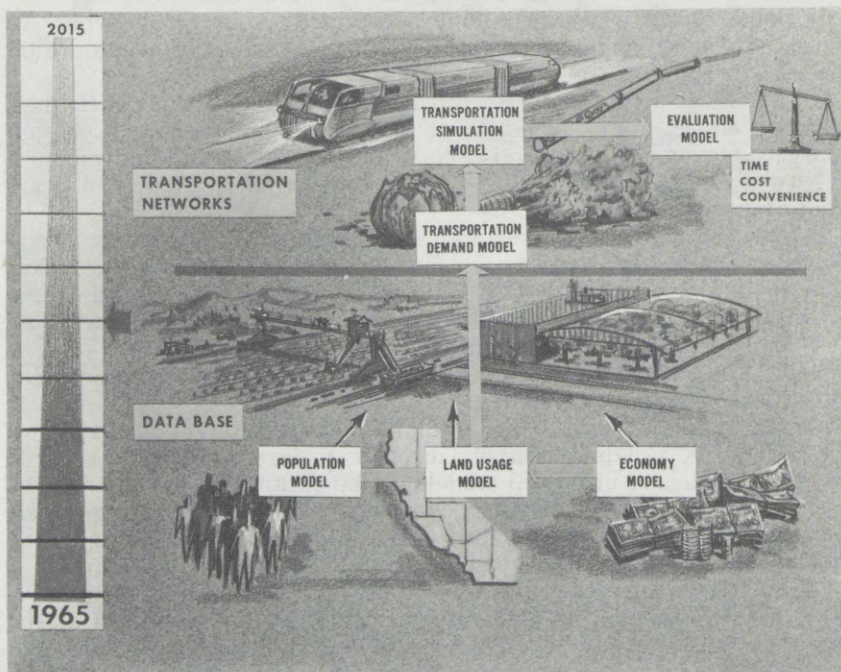


SLIDE 15

We will have a much larger population, but again it will be different. We will have different balances of important groupings, important as far as transportation goes.

Again we represent this as an automated farm. We found an interesting thing in the State, that today in agriculture 10 percent of the money goes for equipment and 90 percent to the people. The prediction in 25 years is that would be reversed. Ten percent of the money will go to the people and 90 percent to equipment.

This illustrates the changes you have to expect and plan for in the State; however, the product is the same. It is still lettuce and carrots.



SLIDE 16

Now we have a choice of how we are going to move this as we look ahead and do our planning.

We have shown illustrations of the ground effects machine, air cushion truck, and a pipeline. We found, incidentally, the movement of solids in pipelines is a very fast growing method of efficiently moving them. For instance, in Canada recently they established a 300-mile long pipeline to move wood in pipelines.

Now we must evaluate in time, cost, and convenience what is the best method for moving.

If we put this on a computer, we have the same illustration, but now we run into the word "model." Model means a set of equations that is in the computer. They represent what will happen.

We have an economy model, land use and population models. We assume to begin with a certain population. This is quite a complex

description of the population, not just a large number. From that we have an economy buildup. The economy which supports the population is created in the economy model.

Then we go back to the population model, and build up a population to support the economy. Then we reiterate it several times until the two models balance. This approach is unique to our knowledge in that it has not been done before. Once the two models balance you know you have got a population that matches the economy.

Then you load your land model. You know where the people are going to live and where the industries are going to be. Once you have done this you can feed the transportation demand model. At this point, you are talking about what has to move from where to where, and once you have that you feed your transportation simulation model.

This tells you how you can move them. You fill your rail lines, your pipelines, your trucks, airplanes, and so forth, and then you evaluate movement of various goods in time, costs, and convenience.

Now I am pausing on this chart because this is really the heart of our recommendation.

Above the red line you can place any number of models. You can have the power performance model, the requirement model, taxation requirement model. The point I am trying to make, the three lower models represent the State on a computer for whatever use the Government may have in mind.

This is necessary to do for transportation, but it has considerable additional benefits attached to it.

Another point I would like to make is, particularly since the Bureau of Public Roads was involved in this program, we were required to set up models as universal models. That means you can change the coefficients in the equations and can change the data which supports the equations and represent any State, any region of States in the Nation, or the Nation as a whole.

This is a universally constructed tool that the planners would use. Now we will also say in the transportation simulation model at the top that once we have such a tool in our hands the planners can say, "What if we install a certain system, what will happen?"

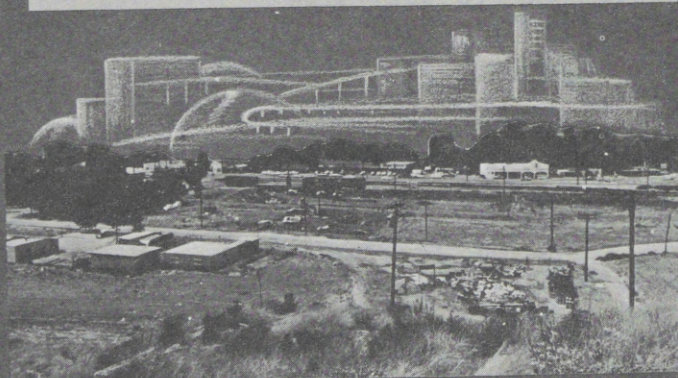
For instance, we assume that we install a tube train between Los Angeles and San Francisco, and they put the characteristics of the tube train in the simulation model. They have changed the real world of the future, and they can run through their problem and see what good that will do or what harm. They can change the characteristics of that train. They can make it go fast, slow, cost more or less, and see what balances out. When they get what appears to be the best answer, they then feed the whole thing back through the bottom and they start assigning land for that tube train, the effect on the economy, and so forth.

This plans the whole State out, and they can see what effect it has on the economy, land, and people. They may find it has a bad effect. It looked good for transportation but it was too expensive for other reasons.

Finally, we believe if this is done, it will allow for the first time for the communities within the State to fit easily into the total system

of transportation, and therefore it will give full opportunity to realize their full potential.

Allows regions and communities ease of integration into a total functioning system-realization of their full potentials.



SLIDE 17

An individual citizen should be released from a lot of wasted time from travel to enjoy the benefits of living in the State.

Permits citizens release from wasted time in travel and enjoyment of fuller lives through ease of access to recreation and social improvements

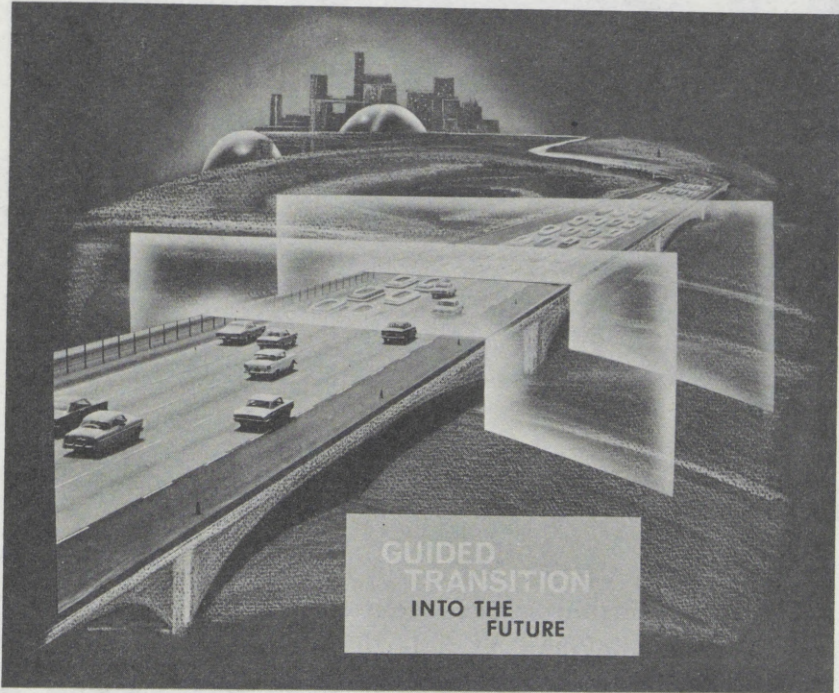


SLIDE 18

It should do one thing for the planners, which they have a lot of difficulty with today, and that is knowing how to change, knowing how to change from what they have to what they want to have in the future.

This illustration shows the freeways of today, and it is intended to show the automating of these freeways to smaller automatically controlled automobiles.

They can assume various methods of changing in time as they approach the computer and try various methods and select the one that is best.



SLIDE 19

So in summary, we recommend that we represent the State of California. Data is a very important part of our requirement. It is important for the State and the various other governmental entities and industries to be able to go to the computer and get some of these answers.

Some of these answers we can guarantee will be ridiculous. You cannot take a computer's word for anything. You have to use human judgment to screen those out and present attractive answers to the State.

Our recommendation as to the next step, and we have put in a glaring white chart—since that is dollars—is this plan. It is shown in a very simplified form. There are seven steps to be taken. We recommend starting immediately in putting these models together and gathering the proper data to support them. We think it will take a little over

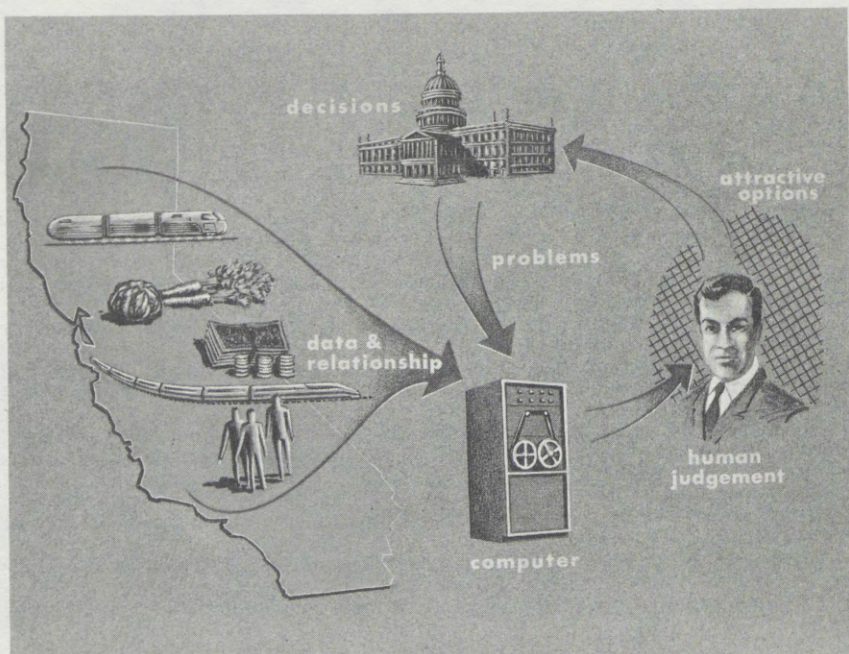
4 years to do that. However, the total cost of this effort should be less than \$10 million, about \$2 million a year.

Incidentally, that \$10 million is less than a mile of urban freeway. That is our message, sir.

Senator NELSON. I thank you very much for your presentation.

Do you have any questions?

Mr. MILLENSEN. Yes, sir.



SLIDE 20

Mr. Jones, you mentioned that this project which you just explained so well, was also done with the Bureau of Public Road funds.

Mr. JONES. No, sir; I didn't say that. I said in cooperation with the Bureau of Public Roads.

Mr. MILLENSEN. No Bureau of Public Roads funds were used?

Mr. JONES. I don't know. You will have to ask the State. I know the Sacramento office of the Bureau of Public Roads was involved in the writing of the requested proposals and selection of the contractor and monitoring this monthly as we moved ahead.

Gentlemen from the Bureau of Public Roads in Washington, very excellently qualified gentlemen, including a doctor of philosophy, came near the end of our study within the last month or two, and spent some time with us. They have told us that they received one of the first copies of our report and have evaluated the report and made their recommendations to the State and the Department of Commerce, but I do not know what source the \$100,000 was secured from.

Senator NELSON. If after going through your testimony we have some additional question, can we write you and have you submit any answers to the record?

Mr. JONES. Yes.

Senator NELSON. Any more questions? Thank you very much. Your prepared statement will be inserted in the record at this point along with your study.

(The prepared statement of Mr. Jones along with the study referred to follow:)

PREPARED STATEMENT OF JACK JONES, ASSISTANT TO THE PRESIDENT,
NORTH AMERICAN AVIATION, INC., LOS ANGELES, CALIF.

It is axiomatic that the future holds direct and indirect opportunities in the field of transportation and that they will appear at an increasing rate. To enable a wise selection from among these opportunities, many questions must be asked and answered. But before the right questions can be posed, some appreciation of the foreseeable opportunities and problems bearing on transportation is necessary.

Transportation technology is advancing rapidly. Unparalleled opportunity is unfolding for movement above, on and below the surface of land and sea. With proper planning California can realize timely benefits in an orderly fashion from transportation systems which are swift and convenient, economical and attractive, efficient while not marring:

Trains gliding through tubes at the speeds of today's jetliners, possibly far below surface streets and countryside;

Aircraft that rise vertically from small urban pads, woodland clearings and mountain meadows, and from the tops of buildings and then move forward at 400 mph for hundreds of miles;

Ships that "fly" a few feet over the waves at several hundred miles per hour, only to nestle gently to a dock where they will exchange hundreds of thousands of pounds of containerized cargo in short times comparable today's airplanes;

Trucks or buses that ride a cushion of air on guideways, moving between cities at several times today's cruising speeds and within cities on wheels at slow speeds;

Other vehicles, public and private, passenger and cargo, which can traverse water and virtually unprepared land with almost equal ease;

Pipelines which can deliver produce from farm to distant markets in a matter of hours;

Virtually accident-free electronic freeways, automatically guiding and spacing individual vehicles which do not emit noxious gases;

Urban transit systems offering door-to-door convenience, or subsurface transit systems with average speeds between stations far above those of the most modern systems today;

Tunneling methods which, by 1985, will lend economic justification to underground installation of transportation networks, parking and transfer sites, particularly in urban areas where surface acreage is now at a premium.

In analyzing future transportation requirements, technologies which affect where people might live, work and play must also be examined, since the desires and demands of people create the need for transportation.

While the supporting ingredients for modern living—water, power, communications, employment, and others—are not as yet available in vast regions of California, the ability to widely distribute these things will become technically and economically feasible in the next half-century:

Water desalinization plants, efficient, reliable, automatic and of long life, could be pumping water to California's desert regions in ten to twenty years. Low cost pipelines, suspended of their own weight in off-shore waters, could transport fresh water from as far away as Alaska without ditching, tunneling or extensive pumping. In the distant future, climate and weather control may be a reality.

Electrical power, broadcast in much the same fashion as a popular radio program, may be instantly available everywhere in the State in thirty years. Nuclear electric generators, portable, reliable, of long life and fully automatic, will provide the interim means of making electrical power widely available. Eventually, the electric power requirements of each household may be met by individual nuclear units.

New sanitation and waste disposal methods may break the shackles these necessities have historically imposed.

Advanced communication devices and systems will enable, for many kinds of employment, almost instantaneous transfer of data and information to a small work area in the employee's home, perhaps hundreds of miles distant from the central office. No longer will it be necessary to move, twice daily, thousands of people and conveyances into and out of a central area. The work will move instead. The employee need no longer live within twenty miles of the office; the hours once spent commuting can be used for recreation, child-care or other fulfilling pursuits.

Automation will bring higher productivity and a shorter working day. The office employee of tomorrow may well be able to schedule his five hours of work anytime during a twelve-hour period, perhaps within the confines of his own home in the foothills of the Sierras or on the coast of Northern California.

The oceanography laboratories of today may become mines and oilfields tomorrow, with a high level of activity on and under California's off-shore waters.

Therefore, we will have the ability to roll back and almost eliminate existing restraints on habitable space in the next twenty to fifty years. However, the full potential of this capability cannot be realized, nor all the benefits enjoyed, until the supporting technologies are packaged with timely transportation: there will be few people where there is no transportation, no convenient way to move about or to ship or receive the things produced or required by people.

Appreciating the possibilities for the future, consideration should be given to the ways in which these opportunities might be exploited and applied in California. Today's trends could be allowed to continue, with new technologies applied to the support of large, high-density super-cities. Alternately, the trend could be reversed and the population distributed in the Sierra foothills, irrigated deserts and along presently remote sections of wooded coastline. Other options lie between these two, and all have different transportation requirements: different objectives, different systems, different networks. Which is best for California, her communities and her citizens?

Analysis and judgment will provide the answers and decisions. Long-range planning will guide the transition and insure maximum benefit. The study described in this report will facilitate the decision making and uncover means of transition to these future systems.

The troubles of transportation today are symptoms of major problems tomorrow, if left untended. Shortcomings in the total transportation system of the State should not be tolerated, and obsolescence cannot be afforded, for transportation moves people and goods and in so doing moves the economy. If transportation fails to keep pace, the economy of California will slow, growth and prosperity will taper off, communities and regions will not realize their full potential, and individuals will be denied opportunities to enrich their personal lives.

In California today the single major transportation headache is that of urban congestion, mostly within but also out of and into the large metropolitan areas. The side effects of this problem are far reaching. For instance, by lack of low-priced convenient transportation, people of low economic standing are forced to work near home, and depressed regions within our cities are kept depressed. The affluence of other areas does not aid the residents of depressed regions.

Two primary factors have led to urban congestion: first, the increased number of trips within the metropolitan area, caused by many factors; and second, a lack of choice in urban transportation in that only one, the automobile, offers flexibility, convenience and seemingly some measure of economy of time and money to the individual. Congestion and competition for space will grow so long as these two primary considerations prevail. The automobile has an apparent economic advantage attractive to most of the population. To the economically depressed segment of the population, however, the automobile becomes a luxury which cannot be fitted into a daily work routine without undue hardship.

The lack of attractive options for intercity and intermediate range transportation is another problem evidenced today. Two passenger modes, private car and commercial air, and one cargo mode, truck, are heavily utilized in comparison to rail, bus, pipeline, ship, etc. Even the more attractive options have some well known disadvantages that cannot be taken lightly.

The San Diego family which would like to spend a week amidst the scenic splendor of Northern California has two basic options, drive or fly. Driving would be most economical and convenient, but would consume four of the

nine days available for the round trip, returning the family to San Diego late on a Sunday night, physically and emotionally exhausted. Flying would be expensive, particularly if car rental is included, and would limit the accessories to be carried and hence the activities to be pursued. This family will find it easier to stay at home, disappointed that it will not enjoy new experiences.

The Escondido avocado grower presently trucks his produce to the San Francisco area. His fruit cannot be fully tree-ripened, since he must allow for ripening while en route to the housewife's kitchen in Richmond. As a result, it lacks a fullness of flavor and commands a lesser price than it otherwise might; however, the housewife must pay an artificially high price inflated by yesterday's transportation and handling methods between orchard and market.

These are two typical examples of how a lack of attractive options in intercity or intermediate range transportation is today diminishing our opportunities to receive the maximum benefit of California living.

Already, California's recreation and transportation needs are clashing. Accessible recreation areas overflow with humanity while vast potential recreation areas remain inaccessible and virtually unused. Without exception, transportation systems in use today would require, individually or in combination, alteration of portions of natural landscape within potential recreation areas. Rights-of-way through already heavily utilized and scarred recreation areas would have to be expanded to handle through traffic, since, in some cases, these areas lie between the major urban centers and untouched potential recreation acreage. In short, transportation systems which served so well yesterday, and are relied upon today, show indications of being obsolete for tomorrow's requirements.

Among the other problems which directly affect the functioning and efficiency of transportation in California are: the limitations of coverage and accessibility of other than highway-based systems; the less than complete coordination and integration between the various modes of transport; and the bottlenecks created by outdated transfer and handling procedures. While these difficulties are not universal, they generally prevail.

Worthy of mention is the overall growth in transportation demand that can be expected in the future. Driven by a rising population, compounded by increasing disposable income, higher productivity and more leisure time, transportation demand for people may double within the next twenty-five years, increase five-fold within fifty years; commodity transportation may triple in twenty-five years and exceed seven times today's rate within fifty years. In addition, based on projections of population and improved efficiency of land use, the utilized surface area of California will grow from 51 per cent today to over 60 per cent within twenty-five years and to over 70 per cent within fifty years. In short, there will be a much greater demand for movement, but less available surface area on which to move.

Without sufficient insight, planning and action, the troubles of today could grow to be more costly, perplexing and far-reaching tomorrow. If the undesirable impact of these problems is to be reduced or eliminated, the initial effort must be undertaken now. The planning and provision of timely transportation systems and networks will be a vital element, greatly influencing our way of life, our economy and our total environment. The study described in this report is designed to contribute to the State's objectives through the transportation planning phase.

Although the transportation system of California may be plagued by troubles today, these need not grow unchecked for lack of preventive or corrective opportunity. As already pointed out, the rapid pace of technical advancement brings with it the ingredients to avoid pending dilemmas. However, the proper ingredients will not just come together in a timely and least costly manner unless made to do so by wise decisions reached, in part, through analytical long-range planning studies.

The importance of these studies and the subsequent decisions cannot be over-emphasized, for they will, in turn, commit the society of California to a course of action requiring large investments of time and resources, influence the vigor of California's economy, and bear upon the satisfaction each citizen experiences in his daily life.

Done properly, the task of analyzing and planning California's future transportation requirements is very complex. Just as transportation needs are influenced by many things, so does transportation influence many things. Transportation goes where the people and industry go, but the freeway system has shown the opposite is also true, that the direction of growth can be guided by transportation. But, people and industry require water, power, waste disposal,

education, communication and other public systems and services as well. These must also be provided.

How much industry and how many people will there be in 1990? in 2015? Where might they be distributed; how will the land be used? How much, for what purposes and between which points will people travel? How many goods will be produced and consumed in California, and from where and to where will they be transported? How much and what will be imported and exported by or through the State? How much land will recreation require, and how much should be devoted to transportation? What will be the likely characteristics, performance, costs, revenues and taxes of each of the possible future land, sea and air transportation systems and networks? How will these systems interface, and what will be the coordination and integration requirements? How will better communications influence transportation demand? What are the long-range budgeting and legislative implications?

These are significant questions requiring timely answers. Each case should be analyzed under several sets of assumptions and the sensitivity to these assumptions measured. Each case will necessarily draw upon quantities of data if it is to reflect all the essential factors.

At present, there is no operating device that can encompass this task in a single frame of reference or can master its complexity and handle the data and computations required. But such a device can be made available and can be practically applied.

The systems analysis approach was developed to master the predictable, complex problems of the Nation's aerospace and defense activities. As shown in this report, it can be applied to the total transportation problem. The systems analysis study described in these volumes includes building that planning device needed to provide the quantitative measurements that will support human judgments and decisions. This device would be constructed by specialists in many fields and would incorporate advance analytical techniques. It would be flexible, could accept a range of assumptions, and would display options.

The capacity and capabilities of modern computer and display equipment form a major element of this planning device. Many bits of data, together with the appropriate mathematical formulas and relationships, are inserted into the computer. After presentation of the problem to be analyzed with the assumptions to be used, the computer would perform the mechanics of the many computations required. Results would be printed out in words, numbers and graphs, supplemented by visual displays which could be copied and retained.

The other major element of this planning device would be the humans who compile the formulas, relationships and programs, who pose the problems and assumptions, and who must apply judgment to the results, make decisions and implement actions. The computer network simply makes the analysis practical. By handling large amounts of data and performing computations quickly, it provides the decision-maker a wider and more penetrating frame of reference upon which to base his decisions.

The study design described in this report calls for the application and development of appropriate mathematical "models", coupled with the use of computer simulation procedures. Aggregated, they can be viewed as a planning device. The "modeling" approach simply identifies and reduces the essential elements of an actual problem to a simplified representation, with the basic relationships between elements expressed by mathematical formulas.

This technique has a number of advantages: first, by testing prediction techniques and accuracy against specified historical fact, confidence is attained in the understanding of the problem; second, it serves as a laboratory enabling the investigator to rapidly build exhaustive experience with the problem by arbitrarily changing assumptions and conditions; third, by manipulating the controllable factors, computer solutions which "best" meet desired results can be obtained.

The first step in this process is to define the role which transportation plays in the overall picture of California activities. In the study design, this has been approached by examination of California as a functional "system."

When considering California as a system, one must first appreciate that it is only one of a number of similar systems interconnected to form a large network extending through the United States to encompass the entire world. This done, it becomes readily apparent that what occurs in California depends to some degree upon what transpires throughout the entire world. Therefore, any study of the California system and its future transportation requirements must of necessity investigate activities which might take place beyond the State's borders. This

is emphasized by the fact that California serves as a gateway to the Pacific and, as such, experiences a high import/export rate across the State.

Figure 1 illustrates California viewed as a system. The State's major internal activities, or subsystems, are represented, with the broad arrows depicting the general flow of people, commodities, energy and information into and out of these major subsystems. The transportation activity, or subsystem, has been defined as carrying energy and information, since these flows are becoming increasingly important alternatives to the flow of mass. Overall control of the California system is performed by the governmental control activity or subsystem.

THE CALIFORNIA SYSTEM

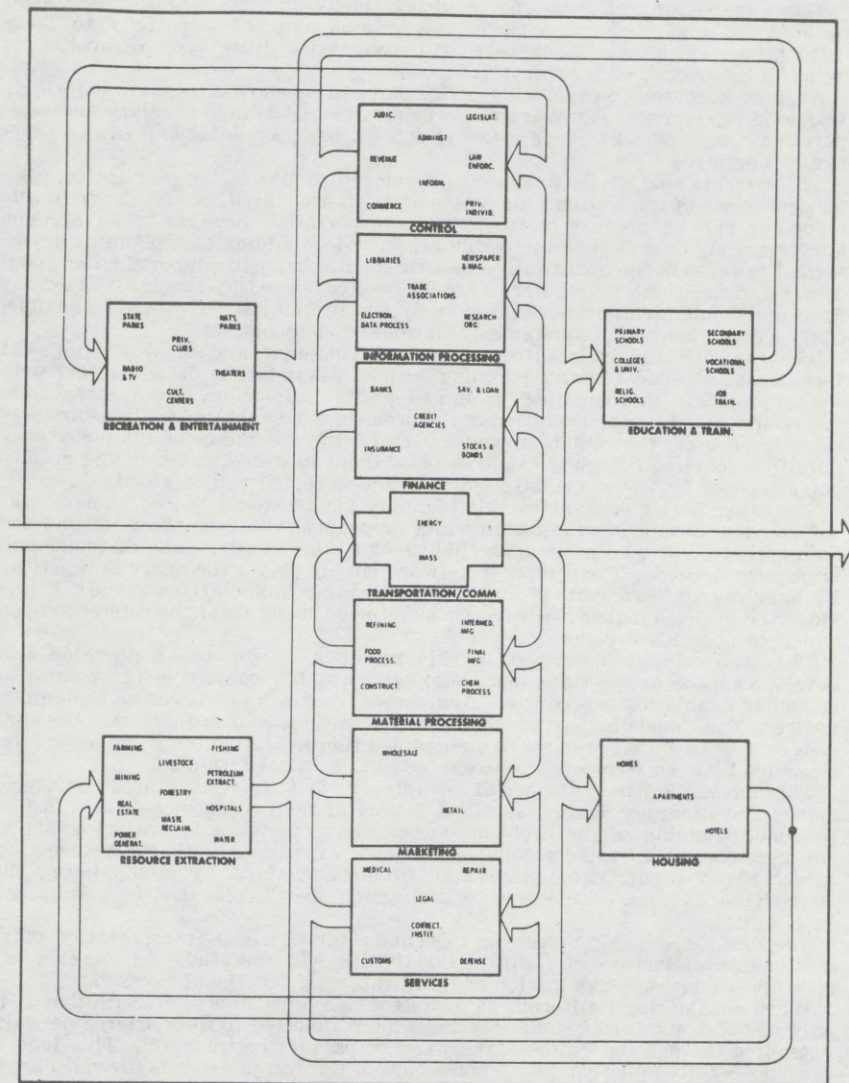


FIGURE 1

Examination of this type of representation of California readily indicates two primary implications. One, the transportation subsystem is a central, vital element of the overall activity of California. As such, the functioning of the other major subsystems or elements is dependent upon transportation. Therefore, effective use of this subsystem can influence all other aspects of the State's growth and activities. Two, any analysis of the transportation subsystem must involve consideration of most of the other major State activities. It is therefore essential that an integrated model of the State of California be developed.

Volume III of this report contains the design for the integrated California transportation system model which will mathematically simulate the factual environment and reflect the socio-economic and technical interactions creating transportation requirements. Figure 2 shows the major submodels which in the aggregate comprise the transportation model.

THE CALIFORNIA TRANSPORTATION MODEL

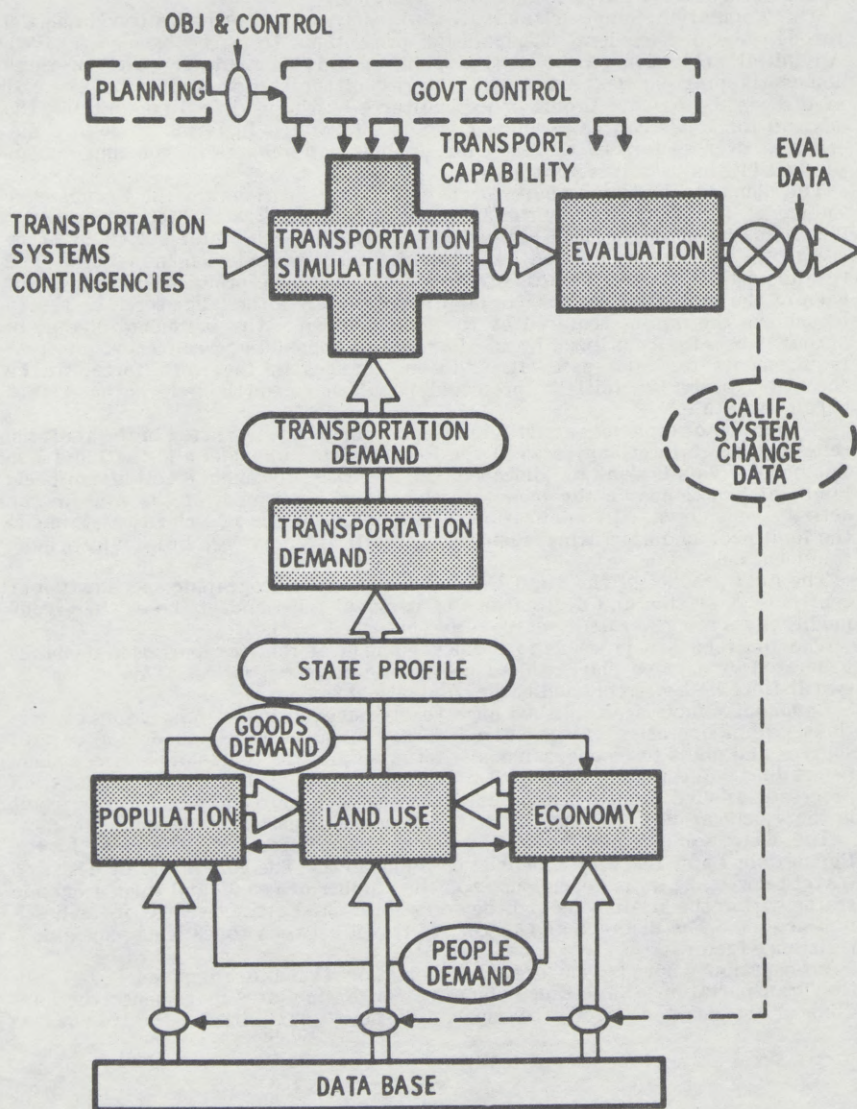


FIGURE 2

Three basic submodels, Population, Econometric and Land Use, develop possible future transportation demands. These feed a fourth which is used to allocate demand to transportation modes and define the flow patterns. This information passes into a fifth submodel used to simulate existing or possible transportation systems and networks. The results of this simulation are fed into a sixth submodel for evaluation.

A data base is shown at the bottom of Figure 2, the contents of which are addressable by a high-speed computer. The information within this data base is that which is necessary to describe California physically and functionally in quantitative terms.

It should be noted that, within the operation of the model, the analysis proceeds incrementally: a projection of conditions at some future point in time is not made in a single step, but rather is reached through a progression of incremental time periods, chosen at will but usually representing five to ten years. This procedure permits the resolution of many problems which plague planning activities by producing the sequence of occurrences, allowing the point of divergence from desired results to be identified.

The Population Submodel activates and drives the entire California model through the development of population projections from the base year, 1963. An initial projection to the desired point in time is made for each of three non-overlapping entities: California, the rest of the United States, and the rest of the world. From a profile of expenditures by the projected populations, the demand for goods can be developed and is interpreted in terms of dollars distributed over sectors of the economy, including purchases of consumer goods produced by industrial sectors.

The demands discussed above form the driving functions for the Econometric Submodel, the heart of which is a rather complex analysis which accounts for interindustry activity. The objective is to establish the total output of every sector of the economy as well as the final fund flows between industries. The results of this analysis have many uses. For instance, productivity trends for each of the industrial sectors can be utilized to derive the labor force necessary to achieve the output required by the final demand. Any increment change in output is eventually utilized by the Land Use Submodel and converted into new requirements for land use. In addition, changes in the work force can be checked against the initially projected population growth and characteristics within the State.

Conversion of economic activity into land usage is the next step in the analysis, representing an interplay between the Econometric Submodel and the Land Use Submodel. This is done by allocating the increase in economic activity to basic land units or zones on the basis of relative attractiveness of the zone to the activity considered. In application, a descending order of priorities segments the land use: manufacturing, residential, retail and services, and finally wholesale locations.

The final product of the Land Use Submodel is the geographic specification of centroids of origins and destinations of personal trips and of those where commodity flows are generated (sources) and absorbed (sinks).

The analysis then proceeds to the development of the transportation demands generated by a given placement of people and other activities. This is done in two distinct elements, commodity flow and people flow.

Commodity flow is established on a yearly basis, adjusted for seasonal variations. Joint operation of the Land Use and Econometric Submodels allows all sources and sinks to be geographically situated and the total flow between them determined. Within the Transportation Demand Submodel, a market allocation process is applied to measure the flow between each source and sink. The result is the specification by commodity of the strength of desire, or demand, for flow.

The desire for personal travel is developed from information provided by the Population, Land Use and Econometric Submodels. The generation of desire to travel between zones is dependent upon the number of people and their economic status within the origin zone and the accessibility and attractiveness of the destination zone. The distance and/or cost of travel between zones is employed as a resistance factor.

Information derived from the Transportation Demand Submodel is fed into the Transportation Simulation Submodel, which simulates movement (the handling of the demand) over a transportation network. Initially, the transporta-

tion demands for the year under study are applied to the transportation networks which exist or are firmly planned in the base year. This permits, for example, assessment of the growth potential of a given transportation link of an existing network, in terms of how long and well it will service future demands as influenced by several variable factors.

The Transportation Simulation Submodel furnishes information to the Evaluation Submodel describing the deficiencies, link overloads, revenues collected, etc., of alternative transportation networks. In turn, the Evaluation Submodel determines, through an iterative process, the network (mix of modes, routes) which should be applied to best serve the overall transportation demands and requirements of the periods under consideration. Technological changes related to new modes of transportation are reflected directly into network changes in the Transportation Simulation Submodel. In the iterative process, network changes are reflected back into the Population, Econometric and Land Use Submodels, with the principal effect being a change in attractiveness of the geographic zones with respect to their accessibility—one of the factors which determine the growth of a zone.

This then completes one major cycle through the submodels, resulting in a new description of the land use, population, economy and transportation networks which might exist at the time under consideration. The model can again be cycled in the same fashion to obtain other descriptions of the total California system for the same time period.

Other uses of the California Transportation Model are anticipated, one of which is to measure the impact of contingencies. For instance, changes in transportation demands induced by floods, earthquakes or fires are immediately reflected. In addition, technological advances likely to have a persuasive influence on the economy or on the distribution of the population would be incorporated in the Economic Submodel.

The development and use of the model(s) described will assist in finding solutions to the problems which transportation planners face, and will provide the means to assess and choose among several candidate networks and combinations of modes. Completely new modes of transportation, as well as improvements in existing modes, can be placed into competition with other projected services and their capabilities, convenience, feasibility, timeliness and cost compared. In addition, simulations which project ahead 50 years can be employed to provide a measure of the future value or growth potential of any given network link or mode. This would be accomplished by holding the network constant while the rest of the model is allowed to project ahead several time cycles.

One useful exercise, typical of transportation-related problems which could be analyzed, would be specifying the location of people and industries within the State in a manner which would minimize transportation needs. While there is no mechanism which presently permits this exercise, experience obtained by running many options on the model would determine the sensitive cause-and-effect relationships, thereby guiding the selection of sequences and criteria for producing such a condition. The incorporated display devices would facilitate this process.

Quite apart from the transportation problems, there is much good to be derived from the broad structure, inherent exibility, and computer orientation of the designed study and planning device. It can serve to produce estimates of long-term effects on the land and economy caused by policy decisions at an earlier time. Within this same framework, it is possible to employ the independent projections by planning activities of the county, city or private sectors to gauge consistency with State plans and projections.

It is estimated that to construct and initially exercise the planning device described above will require approximately fifty-two months. Of course, the discrete submodels would be completed and operative at various intervals throughout this period, and could be utilized to analyze specific types of problems. The estimated schedule for the completion of the six submodels is as follows:

Basic Submodels:

1. Land Use: Developed and checked-out at the end of the tenth month. Can be used independently to investigate land-use trends and their attendant effects upon industrial and population distributions.
2. Population: Developed and checked-out at the end of the eleventh month. Can be used independently to investigate population growth and demand trends.
3. Econometric: Developed and checked-out at the end of the fifteenth month.

Can be used independently to project interindustry flow, productivity and employment trends, and Gross State Product.

These basic submodels would be integrated with each other and with the data base at the end of the twenty-first month, and could be exercised to measure and project in a number of areas.

Transportation Submodels:

4. Transportation Simulation: Developed and checked-out at the end of the twenty-fifth month. Using independently generated inputs, can be used to assess adequacy of links by mode and to examine new or proposed transportation schemes.

5. Evaluation: Developed and checked-out at the end of the twenty-sixth month. Can be used to evaluate the outputs of the independently operated Transportation Simulation Submodel as well as the information generated by the simultaneous operation of the Population, Land Use and Econometric Submodels.

6. Transportation Demand: Developed and checked-out at the end of the twenty-ninth month. Serves as the bridge between the basic and transportation submodels.

All models would then need to be fully integrated and validated as a functional unit against an actual situation. This should be accomplished by the end of the forty-second month. Initial analyses on the validated model and final reporting are estimated to require an additional ten months.

More specific detail and explanation of the estimated schedule, manpower and management requirements and possible cost can be found in Volume V of this report.

CALIFORNIA TRANSPORTATION STUDY

BACKGROUND

On 17 November 1964, the State of California, Department of Public Works, Division of Highways, issued to the California aerospace industry a request for a proposal to design and develop specifications for an integrated study of transportation in California. Eighteen proposals were submitted on or before 30 December 1964. North American Aviation's Los Angeles Division was selected, and the six-month study design effort began 15 March 1965. North American Aviation's assignment was to develop a work program indicating the content for a systems study of California's future integrated transportation requirements, including manpower, cost, schedule, methodology, data requirements, agency involvement, technology implications and an exhaustive statement of the transportation problem. The results of this effort are contained in a five-volume, 640-page report submitted to the State on 15 September 1965.

CONDUCT OF THE DESIGN STUDY

The design study was conducted within the Los Angeles Division of North American Aviation. A cadre of specialists, drawn from North American Aviation's 30,000 degreed personnel from several of the divisions of the corporation, was assembled within the Los Angeles Division to conduct the effort. This basic team was supplemented and supported as required by additional personnel with unique qualifications. Fully fifty percent of these people hold advanced degrees in their disciplines, including five doctorates. Disciplines represented included: economics, mathematics, statistics, transportation, business administration, computer programming, operations analysis, systems analysis, data management, sociology, human factors, cost analysis, program planning and control, public administration, and various engineering disciplines.

No outside consultants were retained by the corporation. None were necessary: an ample inventory of qualified and willing professionals was found to exist within North American Aviation. Members of the study did consult with professional colleagues in universities, transportation and other public agencies, professional societies and private industry. Valuable assistance was obtained from these sources. Over 1500 documents, containing data and other information classified under 500 subject headings, were gathered from over 200 public and private groups.

A close working liaison with the State's Division of Highways and Advanced Planning Section, as well as with the U.S. Department of Commerce, Bureau of Public Roads (who cooperated with the State in this effort), was established and maintained throughout the study design effort. Direction and progress

were monitored through monthly progress reports and periodic oral briefings and discussions in Sacramento and Los Angeles. A preliminary report was submitted to the Division of Highways for review and comment at the end of August 1965.

The work itself was divided into eight tasks. While several of the tasks ran concurrently, all were programmed to feed together when required. Management controls were employed to assure cost and scheduling goals were maintained. The procedures and methodologies recommended were actually tested and verified against known historical fact in a sample problem.

THE SYSTEMS APPROACH

In a broad sense, the primary benefit from applying the systems approach stems from the inquisitiveness of the systems analyst. Rather than accepting the apparent problem and its cause, the systems analyst is trained to trace down all aspects of the problem, gauge the inter-relationships between elements of the problem, and study the sequential interactions and ramifications resulting from adjustments to any given element. Having identified the total problem and the attendant influencing considerations, the systems analyst is then in a position to define possible solutions which will allow specific objectives to be met in a timely and efficient manner without adversely affecting other goals. Optional solutions, as well as options within a given solution, are then analyzed and compared, leading to the selection of that approach which meets the requirements and best serves all objectives.

Systems management provides the environment enabling persons of widely diverse professional disciplines to work in concert in the comprehensive analysis of the overall problem. Having defined the problem and its solution, systems management employs techniques to cost, schedule, coordinate and control a development program, with the total job broken into discrete, manageable elements. Modern computer techniques are heavily utilized to handle large amounts of data and perform calculations, allowing broad and penetrating analyses to be made quickly. Computers also enable "real life" events and responses to be simulated economically in the laboratory.

RECOMMENDATIONS

In the specific case of the California transportation study design effort, the systems approach led to the recommendation for a transportation planning study based upon a comprehensive, integrated computer simulation program. The design for this computer program, as submitted to the State, enables both people and commodity transportation demands to be projected and vectored within the State, as well as the measurement of movements into, out of and across California. Within this framework, the computer program is sized to allow all conceivable networks and modes of transportation (land, sea, air, or novel) to be evaluated and compared for operating and economic performance in the handling of the transportation demand. The residual influence of optional transportation modes and networks upon the economy of the State, as well as upon the distribution and attendant requirements of the population and its supporting activities, can be projected. Further, the impact of technological change can be tested, as can that of possible catastrophes such as floods or earthquakes.

Apart from some widely accepted conclusions regarding the severe transportation problems to be faced in California, the study design effort uncovered many unfolding technical advances in transportation. While these add to the complexity of, and underscore the need for, transportation planning, they also represent major opportunities.

An equally important, but less obvious, impact on transportation may stem from technological advances in other fields. The ability to economically distribute water and power over large areas, coupled with greatly improved communications and life support systems, will allow people to live and work nearly everywhere. As the population grows, historic demographic patterns may change from high-density concentrations to a lower-density spread. While the difference in transportation requirements is obviously significant, nothing has been done to measure the real meaning; nor has anything been done to test the desirability of such a change. If found to be desirable, transportation could be used as one of the major levers of change. Transportation and economic development planning to date has been generally predicated on the high-density

pattern of demographic growth—more people in the same places they are today. The study recommended by North American Aviation includes testing such options or possibilities against the objectives of the State of California.

In order to facilitate these analyses, six major sub-routines were recommended: three (population, land use and econometric) which work in concert to define and project the possible environments in which transportation must function; one which extracts the transportation demands from these environments and vectors the flows between geographic sectors; one which simulates the operations (the handling of demand) by optional transportation modes and networks (or mixes thereof); and one which evaluates the results against many criteria, including cost/benefit, and provides feedback loops allowing changes to be reflected throughout the complete analysis.

Generally, transportation studies to date have been limited to either people or cargo demands and have presupposed the mode to be applied or have compared only the operating and economic performance of two alternative systems. Most project transportation demands by extending historical demand trends rather than projecting the total environment and factors which might influence trends in some fashion. None have attempted to measure the impact of the subject systems upon other types of activities or requirements in the total economic and social development of an area.

The recommended study calls for an analytical investigation to the year 2015 AD, with projections reached by a series of incremental time steps from the base year. This helps to identify the period of usefulness of a given transportation system or network and isolates the point at which any divergence from desired results begins. Long range planning studies to date rarely exceed analytical periods beyond 1980, reaching their terminal year in a single step.

Finally, the computer models have been universally structured for ease of application to areas other than California. With modifications, the specified techniques could be used to analyze and plan facets of economic development other than transportation.

Senator NELSON. Our next witness is Mr. Lehan of Space-General Corp. You may proceed as you wish, Mr. Lehan.

STATEMENT OF FRANK LEHAN, PRESIDENT, SPACE-GENERAL CORP., EL MONTE, CALIF.; ACCOMPANIED BY JOHN KUHN, PROJECT MANAGER

Mr. LEHAN. Senator, I would like to echo the sentiments previously expressed. It has been our privilege to take part in the State of California experiment, and I think perhaps we had one of the more difficult of the tasks, at least from an engineering standpoint.

Our task was to take a look at the crime and delinquency problem. The methods of reducing the costs of crime and delinquency to the State of California and the citizens of the State with the cost being defined very broadly to include, as far as we are able to, human costs as well as monetary costs.

I would like to insert a short summary at this point in the record.

Senator NELSON. Without objection that will be done.

(The summary referred to follows:)

SUMMARY OF STUDY ON PREVENTION AND CONTROL OF CRIME AND DELINQUENCY

PREPARED BY SPACE-GENERAL CORPORATION, EL MONTE, CALIF.

Under contract to the State of California through the Youth and Adult Corrections Agency, Space-General Corporation undertook a systems analysis and cost/effectiveness study of the California system of criminal justice. Of six-months duration, this study represented the initial attempt to apply the techniques of systems engineering to the problems of crime and delinquency. The study was defined to cover the broad spectrum of criminal justice, including

local law enforcement, the courts, probation, juvenile and adult institutions, and parole.

The objectives of this study were to:

Analyze the California system of criminal justice utilizing the techniques of systems engineering and operations analysis, and thereby explore the feasibility of application of these techniques to social problems.

Recommend a California program directed toward more effective prevention and control of crime and delinquency.

The study has resulted in an increased understanding of the interrelations existing between the functions of various jurisdictions. Examples of techniques used and the findings evolved will follow in the testimony text. Generally, however, there presently exists a lack of information which must be overcome if complete understanding of the objectives and operations of the system of criminal justice is to be achieved. This lack is in the understanding of relations existing between system expenditures and system performance. It is primarily because of this gap in our knowledge that certain programs are being proposed. In a sense, we do not accurately know how to allocate resources to reduce crime.

California now spends about \$600 million per year for the prevention and control of crime and delinquency, combining state and local costs. The program which is recommended here will require an estimated annual expenditure of less than three percent of that amount. Cost offsets expected to occur over the duration of the program will reduce the total cost to the state at the end of five years to less than that required for the continuation of present policy.

The study resulted in a program directed toward an improved system of criminal justice in California. The major elements of this proposed program are:

A continuing systems engineering analysis of the management and the effectiveness of the California system of criminal justice.

The development of an information system linking together various agencies of criminal justice and being capable of evaluating program and system effectiveness through collection, storage, and processing of appropriate data.

A systematic study of persons involved in criminal activity and identification of crime susceptible groups.

Carefully selected prevention programs directed towards the susceptible offender groups.

Technical assistance in the apprehension and processing of offenders.

Development of more effective methods in the management and treatment of offenders with attendant studies of subsequent behavior and costs.

The development and training of manpower to carry out the program.

The development of public support and understanding through information and community education programs.

A comprehensive master plan which projects over a five-year period the scheduling and costs of the program.

Associated with each group of related programs is a research effort which will continually examine new and novel approaches to each applicable area.

Mr. LEHAN. I would like to introduce John Kuhn, who headed our study, and will make our presentation.

I think we found, as a corporation, the study to be educational and beneficial, and I am completely convinced that the techniques that have been used by the other three contractors and ourselves are applicable even in the very difficult area of crime and delinquency.

John, perhaps you would like to take over.

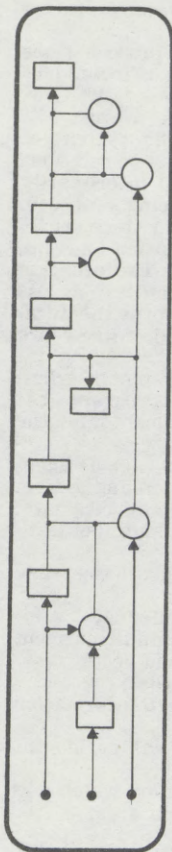
Mr. KUHN. Senator, as you know, we had a rather difficult problem of applying the systems engineering techniques to prevention and control of crime and delinquency.

See figure 1 for title of our study.

We elected in this study to approach the problem analytically and to demonstrate that the quantitative and numerical techniques, which are used in engineering, could indeed be valuable in the study of crime and delinquency.

We approached the systems study in the sense that you heard several people mention today. For example, we had an investigation

phase in which we reviewed the currently available data. We constructed a mathematical model, a very simple one, to be sure, because of the limited time period, and we proposed a future program, which we felt would help solve the problem of crime and delinquency.



FINAL REPORT

PREVENTION AND CONTROL OF CRIME AND DELINQUENCY

PREPARED FOR

YOUTH AND ADULT
CORRECTIONS AGENCY
STATE OF CALIFORNIA

BY

SPACE-GENERAL CORPORATION

FIGURE 1

In this case our objectives are quite clear. We want to reduce the cost of crime and the crime rate in our State.

We can go through the system analysis that we have performed now. It is quite analytical, but I will go through it, and you will be able to see the systems engineering approach to this difficult problem.

The first group of slides is part of the investigation phase. We were interested in the extent of the dimensions of crime in California, so we looked at the felon crime trend over the past few years. We did not go back in history to the thirties or the twenties, because our

culture changes rapidly. We went back 5 years, because we feel that in this short period the culture stays constant enough to give a true reflection of crime trends.

We calculated our crime statistics on a basis slightly different from what is usually reported. Usually crime is reported on the basis of total population. As you will see a little later, this is very misleading in California, because the population in California does not follow a classic mortality table distribution.

In this particular chart (fig. 2) felonies reported in the thousands over the 5-year period show that on a population age 10 to 64 basis,

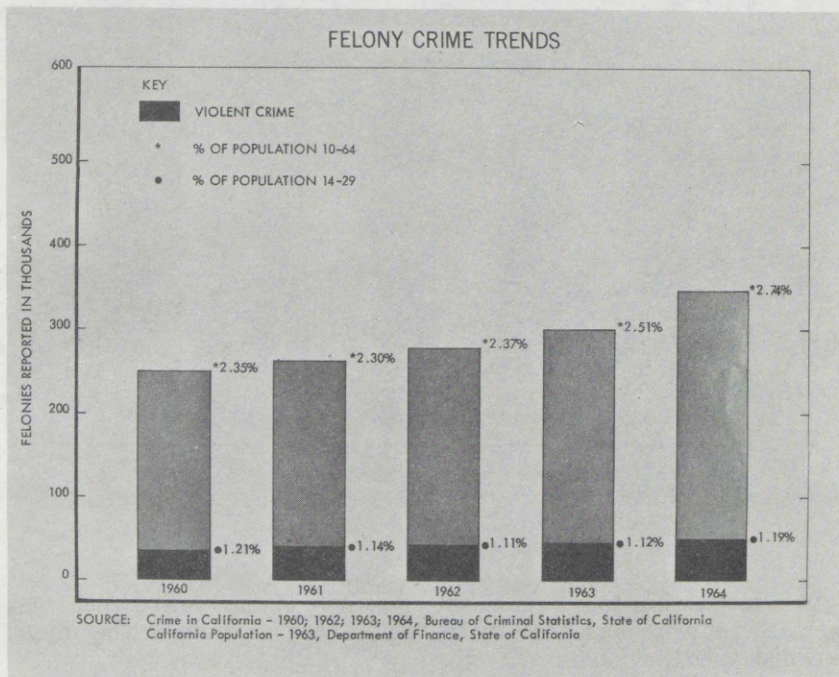


FIGURE 2

felonies reported do increase; the percentage going from a little bit over 2 percent, 2.35 percent, to 2.74 percent. This is for all reported crime.

When violent crime is considered, and this statistic is based on the age 14 to 29 population, which is the more violence-prone group, we see that the statistic does not increase over the 5-year period, but goes from 1.2 to 1.19 percent. These represent reports and are very much a function of the California reporting system. Our system is not completely adequate, but this is the best information we have available.

The next slide (fig. 3) shows the juvenile trend over the same period of time. Notice that delinquency arrests have increased from 175,000 to 275,000 over the past period. Again the basis of the comparison was chosen to more normally represent that segment of the population which is involved, since we are calculating rates.

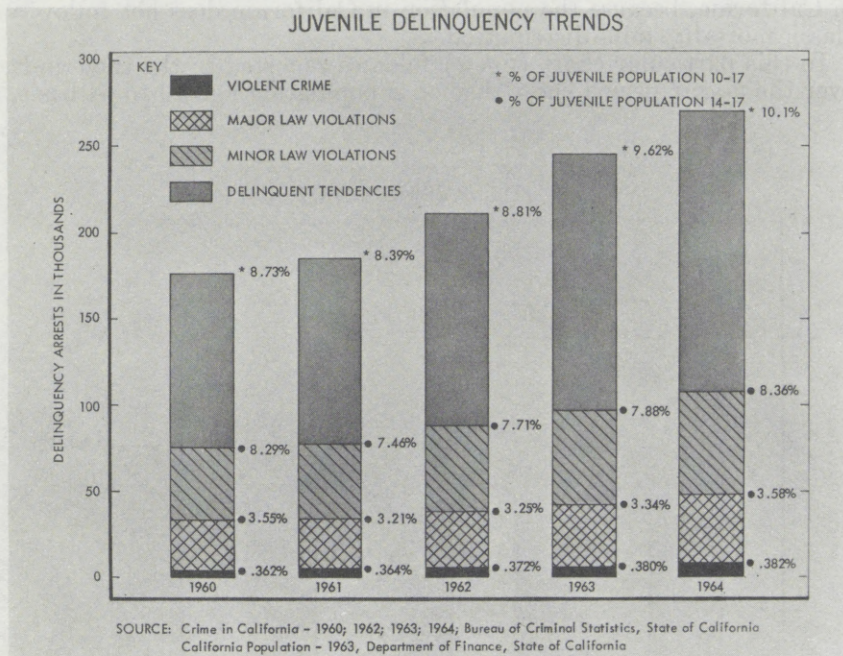


FIGURE 3

It is interesting to see that over the whole 5-year period the worst increase ratewise has been in the delinquency, which is the minor skirmish with the police.

The juvenile violent crime, which is shown at the bottom, has not increased substantially.

If one does an analytical least square calculation of these data, one finds that the annual delinquency rate has increased less than 4 percent. Violent crime has increased less than 2 percent per year.

The next slide (fig. 4) shows adult felony arrests over the same past 5-year period. This slide is also prepared on the basis of a more representative population, 18 to 64 for all arrests and 18 to 29 for the violent group.

Notice that the violent rate actually decreased over this period as did the total.

The next slide (fig. 5) describes one of the characteristics of the people that we commit to the institutions. We have talked about the dimensions of the crime. Now we can talk about the offenders' characteristics.

These are the characteristics of the individuals entering the institutions. These are the people already fairly far into the system.

In the adult category the educational distribution centers about the seventh grade. The juveniles is slightly higher, 9th or 10th.

The dotted line represents the California population statistic, the average statistic, for the total population.

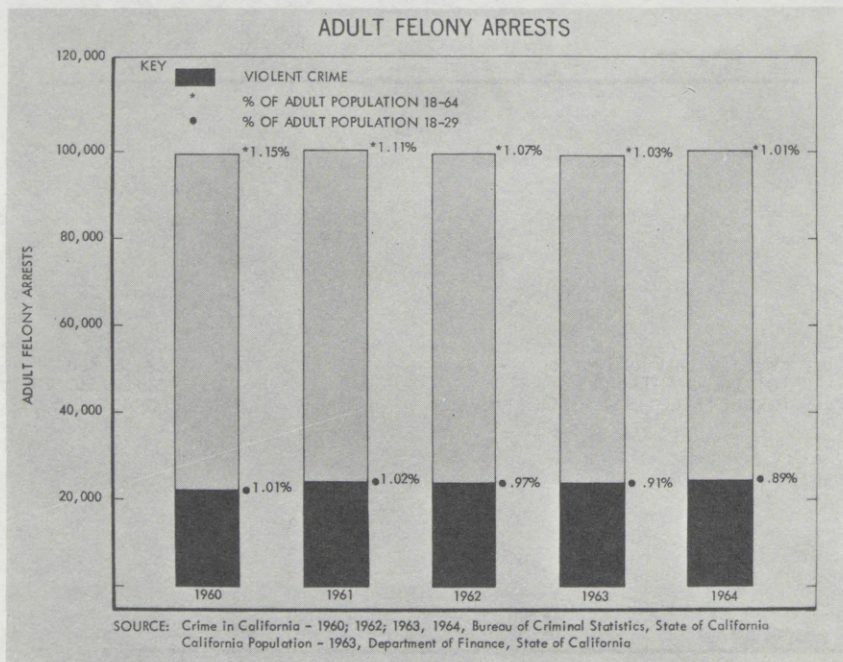


FIGURE 4

OFFENDER TYPOLOGY EDUCATION

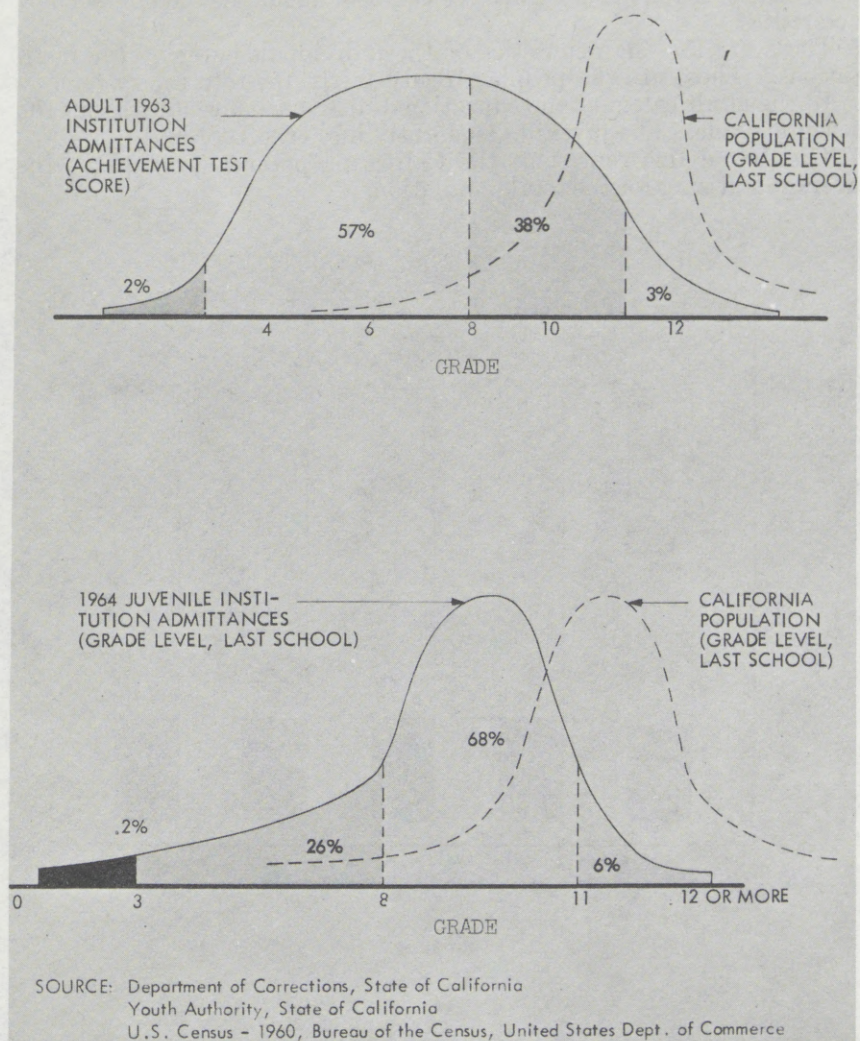


FIGURE 5

The next slide (fig. 6) describes the ethnic distribution that we are currently committing to our institutions.

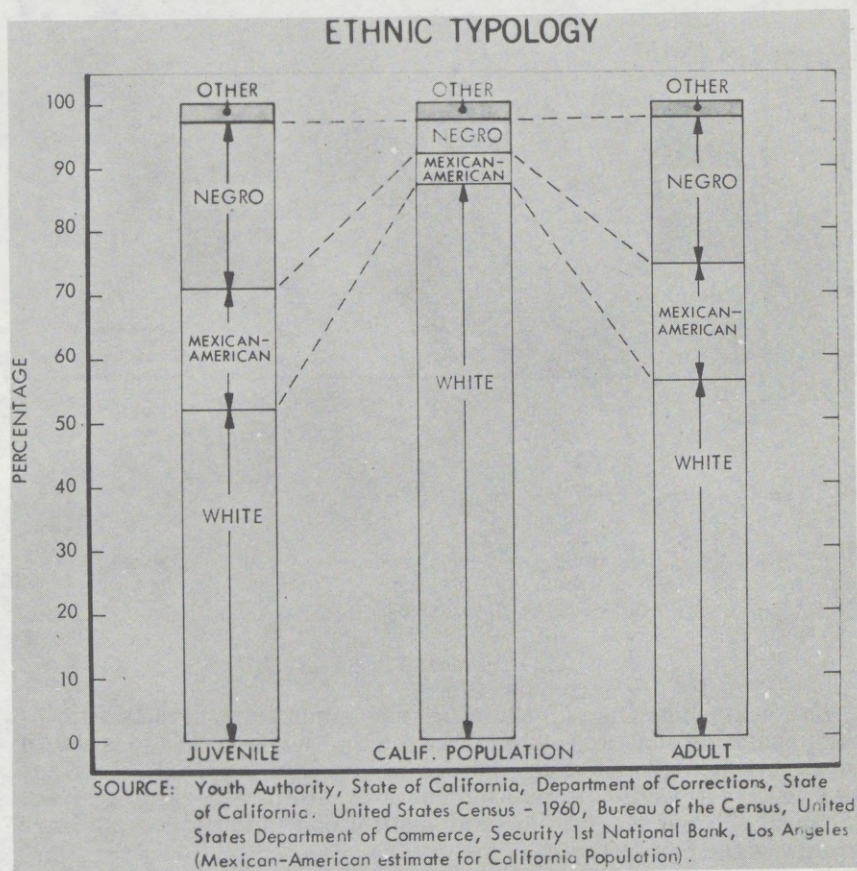


FIGURE 6

The center bar illustrates the California population as a whole. The two bars on the sides represent the juvenile and adult distribution. We can note easily that the Negro and the Mexican American populations are significantly overrepresented in commitments to the institutions.

From a geographical standpoint we find that our commitments are for a very large part from the districts in which these minority groups are represented.

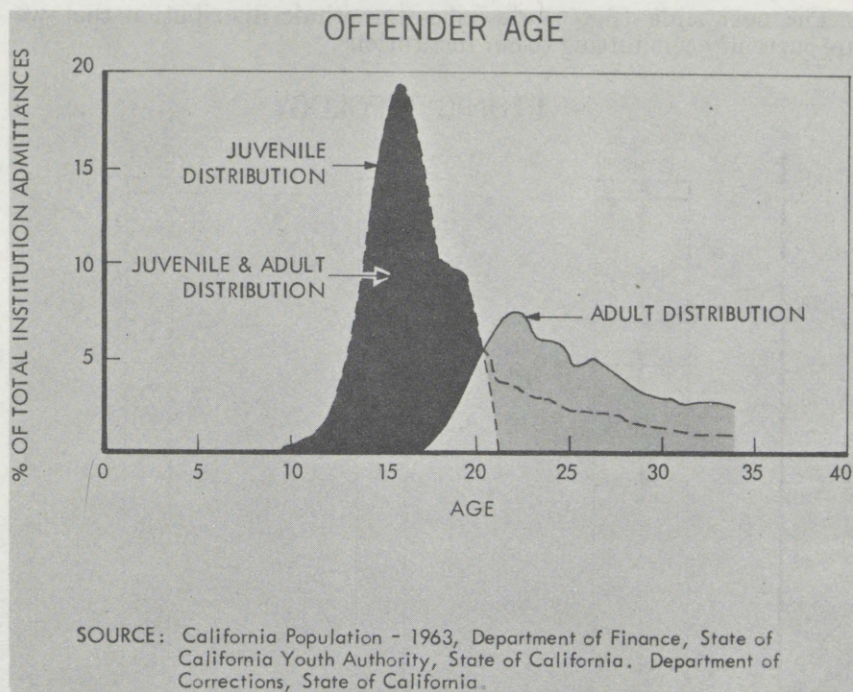


FIGURE 7

The next slide (fig. 7) shows a very important characteristic of the population that we commit. At the top the juvenile age is shown as a darkened distribution curve ranging from approximately age 10 to 21. The adult distribution curve is shown as beginning at age 17, with the percent of the total institutional admittances and age groups as the parameters.

If we combine these two distributions and put them on a percent-age basis, we end up with the dotted line. Now a very careful analysis of this dotted distribution of percentage versus age will reveal that 75 percent of the people we commit to the institutions are between 14 and 29.

This is important to us, because the next chart (fig. 8) shows the age histogram for California from 1960 through 1975.

Now this means that in 1960 there were a certain number of 14-year-olds, which is represented by the intersection of 14 with the population in thousands over at the left. The crime susceptible group the 14 to 29 group that we are interested in, is represented by the dark area.

Now you can see what is happening. As the people in California get older and as the immigration continues, as has been predicted, population in thousands over at the left. The crime susceptible group, is increasing faster than the population and will continue to do so between the years 1960 and 1975.

CALIFORNIA POPULATION HISTOGRAM

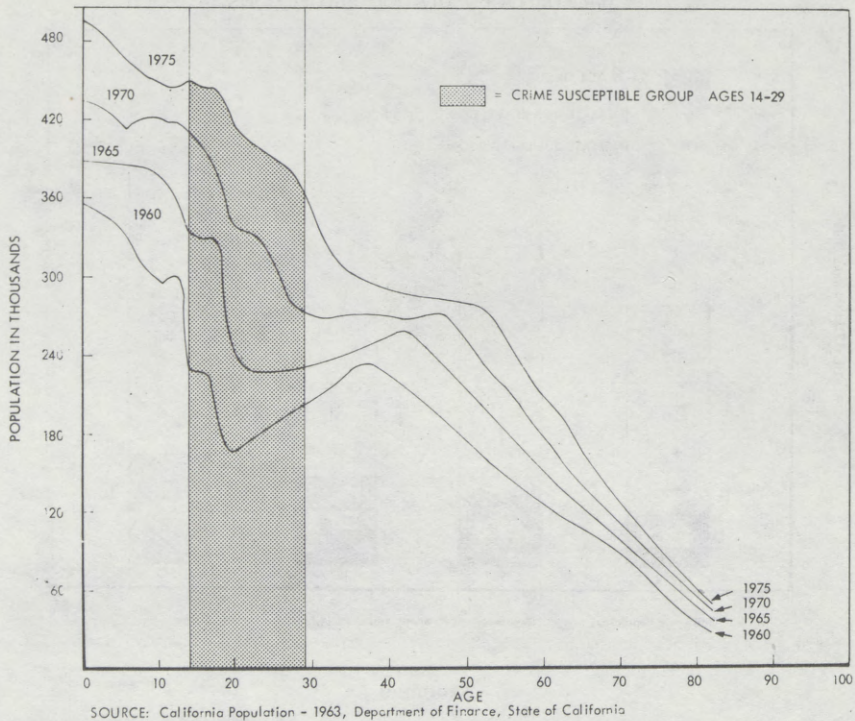


FIGURE 8

The next chart (fig. 9) illustrates the magnitude of this change in the distribution of the crime susceptible group. In 1960 about 20 percent of the people were 14 to 29. This percentage will grow until 1975 when this group will constitute 26.6 percent of the population.

By looking at the summary numbers on the left we can see that from 1960 to 1975 the total population will grow 59 percent; while the 14 to 29 age group will grow 110 percent.

It is clear then that the crime susceptible age group is growing twice as fast as the population.

Any extrapolation or predictions that we make regarding crime and delinquency should be related to this crime-prone age group.

We can see because of the skewed nature of the population histogram that California has had and will have significant crime problems.

This is the investigatory phase that the systems engineer looks at. This consists of looking around and observing what data are available and determining how it can be organized.

There is one other piece of data that we look at and that is the cost in California of the system that we use to prevent and control crime. Now the system we use in California is the system of police, sheriffs, probation, judges, district attorneys, public defenders, parole officers,

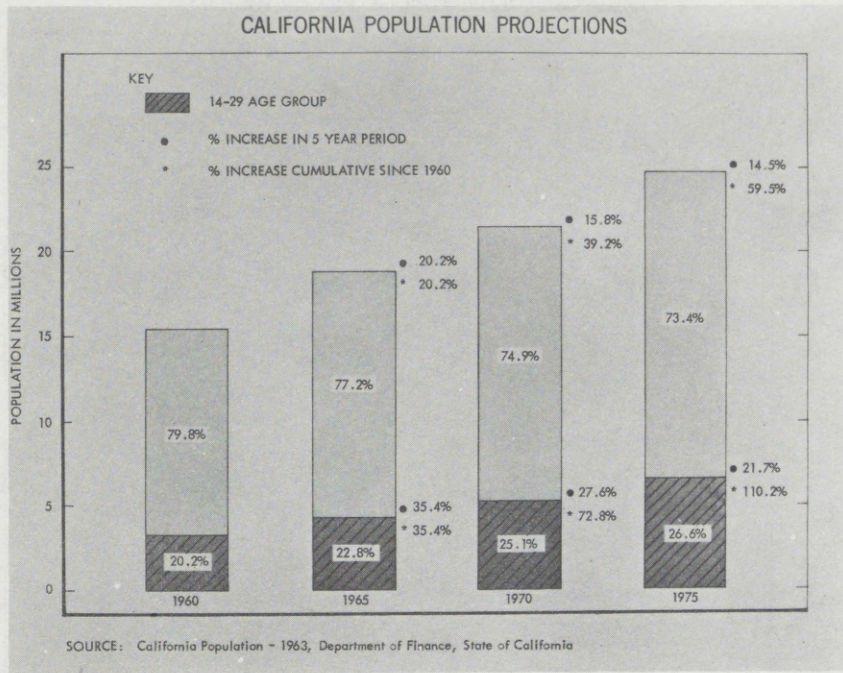


FIGURE 9

prisons, and other institutions. This is the mechanism that we use to prevent and control crime.

The bill for this system in California is \$600 million a year. We expect that in the next 5 years this system will cost us \$3½ billion, if we adhere to our present policy.

Senator NELSON. What period of time?

Mr. KUHN. The next 5 years.

The next slide (fig. 10) shows our approach to looking at this system of criminal justice, this system which we use to control and prevent crime. We constructed a decision network, and the one I have represented here is the juvenile summary decision network. The decision network totally is more complex than this, but this is the summary network, and each one of the balloons on this chart represents a decision that is made or could be made about an individual as he encounters our system of criminal justice.

On the far left you can see that an officer observes a delinquent act and does something about it.

On the right you can see that an individual is released from parole.

This net then encompasses all the possible paths that an individual may take through our system of criminal justice, from the time he commits a criminal act until he is again released to society through parole, probation, not guilty, dismissed at the arresting station, or whatever.

This is the engineer's worksheet for the construction of the model, which you have heard about today, and this is the model of the system of criminal justice.

This diagram shows all of the flow paths and all of the jurisdictions which we encounter or which a criminal encounters in moving through the system of criminal justice.

We, in a very short period of time, managed to make some simplifying assumptions and put this block diagram, this analytical mathematical model on an analog computer, in order to obtain some system type results.

There were certain simplifying assumptions made, but I will very quickly show you the engineer's analog computer model diagram (fig. 12), which was used in the study. This is the worksheet that the engineer uses to model the system of criminal justice. Each of the boxes represents the split and flow of individuals as they flow through this system.

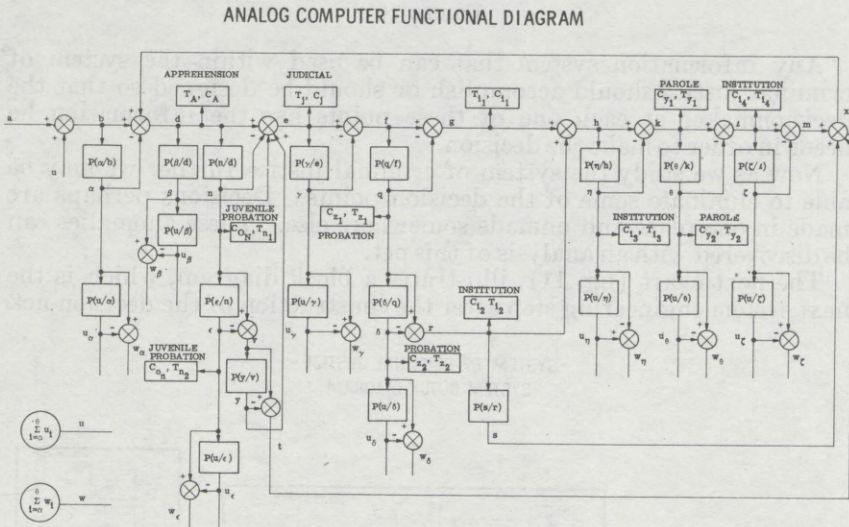


FIGURE 12

Each of the T's and C's represent times and costs, which occur within the present system of criminal justice, so as the machine is set up it makes it possible to calculate some things that are not easy to calculate with pencil and paper.

I will illustrate a few of the calculations that were made. The first one and perhaps the most interesting on the next slide, figure 13, is what we call career costs. These are costs that the taxpayers must pay on the average for each offender as he flows through the system. Our present system of criminal justice—police courts, prisons, parole, probation—presently cost us this much as a function of these offense groups.

PER CAPITA COST TABLE

OFFENSE	CAREER COST
ALL ADULT FELONS	\$ 4,000
ALL JUVENILES	800
ADULT HOMICIDE	5,800
ADULT ROBBERY	3,700
ADULT ASSAULT	2,700
ADULT BURGLARY AND THEFT	3,800
ADULT FORGERY AND CHECKS	16,900
ADULT NARCOTICS	10,900

FIGURE 13

Now there is something to be learned already, even from this simplified mathematical model, about our present system of criminal justice. There are rather some unexpected things we can learn. I think that we have known for some time that the forger check writer is a nuisance and is very much a repeater. He recidivates frequently, but perhaps what we didn't realize is that these individuals on the average in the State of California today with our present policies are costing us \$16,900 over their lifetime. This is the cost of processing each of these people.

Likewise with the adult narcotic offender, \$10,900, and perhaps down to adult homicide, in which we have murders second and manslaughter, to \$5,800 figure.

The questions the systems engineer can ask society is do you want to allocate your resources in this way. This is what society is doing today. Is this what we want to do?

The next slide, figure 14, illustrates another use to which we put this first system model. This illustrates the category of things that we discussed earlier today. What if we made some changes in our present system of criminal justice? What would the results be?

In this very simplified model we used per capita total cost as a measure, and we took the operating point for the average adult felon merely for illustrative purposes. We showed our present operating point and what would happen if we changed things that are perhaps open for us to change within the system.

For example, if we change the fraction of sentence in prison before parole, which is the line rising to the right, from its present value of

50 percent to say 60 percent, we will increase the per capita cost for each offender on the average of about \$200, from say \$4,000 to \$4,200.

Likewise if we managed to increase successful parole from its present value of about 50 percent to a new value of 60 percent, we would reduce the cost of processing this offender.

**-CALIFORNIA SYSTEM OF CRIMINAL JUSTICE-
PER CAPITA CAREER COST OF NEW ADULT FELONY OFFENDERS**

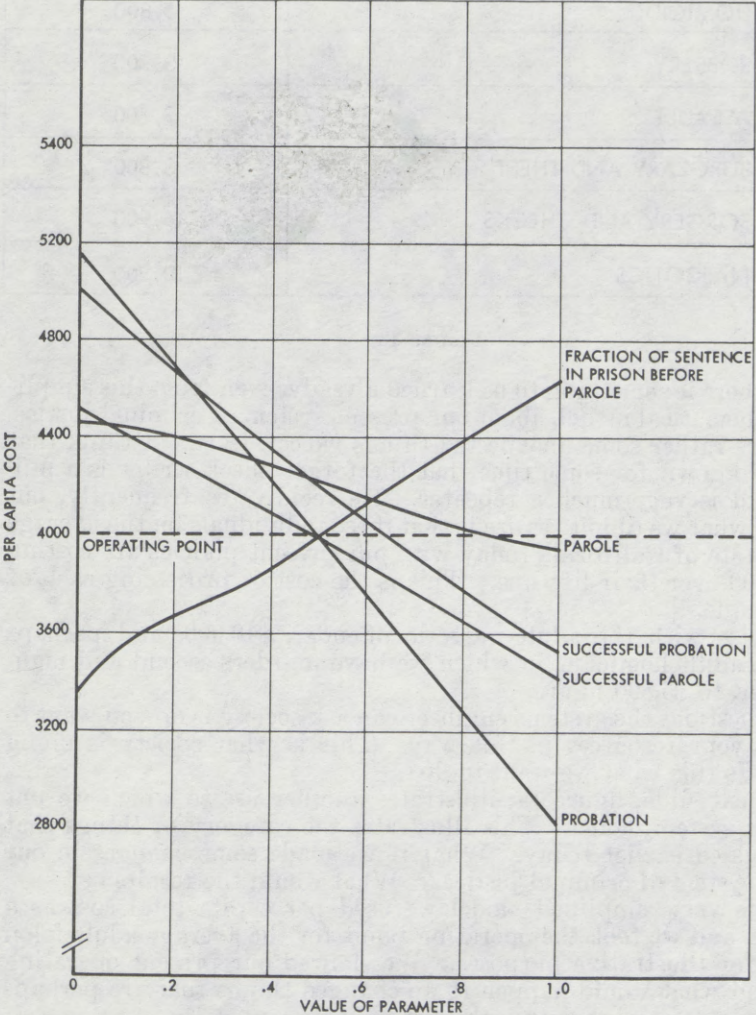


FIGURE 14

In the engineer's terms this is a sensitivity study. He evaluates the dollars which can be traded off for, let's say, rehabilitation programs in the prison in order to reduce the recidivism rate on parole.

The other parameters illustrate other points within the system. Obviously an increase in the number of individuals put on probation will decrease the average cost of the offender to the total system.

Now in this simplified model we have assumed linear relationships and we have assumed no interaction among the various parameters. We know both of these things aren't true, but the first model tells us what rewards can be reaped in the future.

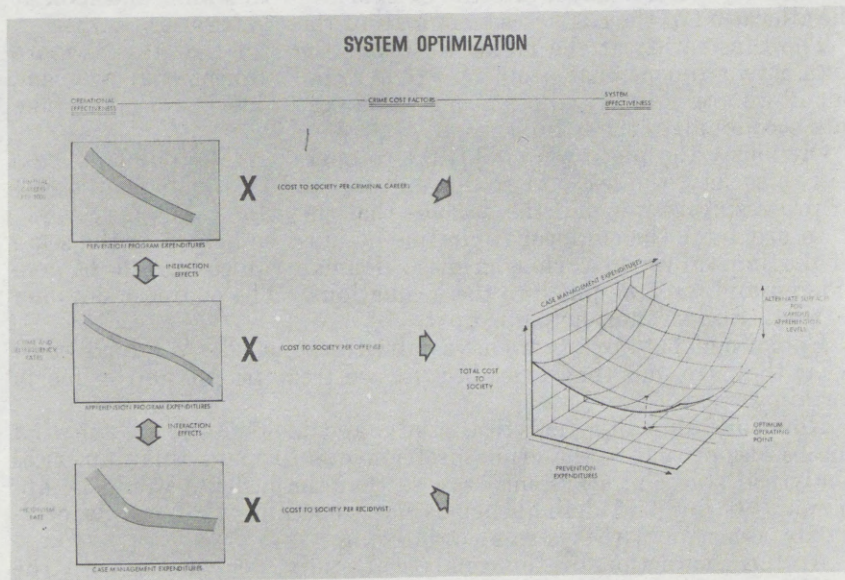


FIGURE 15

The next slide, figure 15, illustrates the synthesis, or the new system, part of the system engineer's approach to crime. This represents the way we would approach the optimization of criminal justice.

Now let's think back a minute. Our present system of criminal justice is largely concerned with apprehending individuals and rehabilitating individuals. Let's remember that our objective is to reduce crime, reduce the cost of crime to society and reduce the rate of crime.

There is a very large area which the present system of criminal justice does not have within its perview and that is the area which we have listed at the top as new careers. Crime might now be thought of as consisting of new criminal careers as part of the crime rate; the crime and delinquency rate by repeaters, people who are repeating crimes; and the recidivism rate, that is people who have already been

within the system and are now returned to the system because of crimes they have committed. These are the three areas in which are the three segments that make up crime.

Well, we are treating very heavily the second; that is, catching people. At the apprehension problem and the rehabilitation problem we are working very diligently in these areas, but what are we doing in the new criminal careers and prevention area? What sort of organized program do we have within the confines of the system for criminal justice which treats this problem?

If we are to allocate our resources properly, then we must take the crime rate, break it down into the categories of this kind and look at the allocation of the resources among all of these categories.

The illustration at the right illustrates the fact that this is more than a two-dimensional problem. It is a multidimensional problem, but if we are going to allocate our resources properly, we must take into account all of these things.

Obviously the place we would like to operate is the point at least cost to society, the less cost to our culture, and this includes the cost of processing people and the damage that they do.

In order for the engineer to do this he must be helped in the sense of putting values on various crimes. Human values have to be considered and must be put into these equations. The engineer does not do that. Society must help him do it.

I point out that already we have values established. We don't know what they are, but they exist because we treat people and crime in certain ways.

Now following this analytical study, and incidentally we felt that the best approach to the crime problem was to make this numerical analytical study in a systems way so that the benefits would be apparent. Crime and delinquency is not something that people ordinarily associate with systems engineering.

At the completion of this analytical study we worked with the professionals in the group, with the members of the multidisciplinary team, and we evolved with these people the best program for California that we could come up with. Because of the problems that I have described here earlier, that we had not been treating prevention as such in our system of criminal justice, and because we do not have the functional relations that I described on the previous chart, we need to run a program which is more complete and which will provide us these functional relations.

The program we evolved, working with the professionals in the field, is illustrated here, figure 16. A very large portion of a 5-year program is devoted toward prevention programs and the measurement of their effect; also apprehension, police work, case management, the problem of crime reporting; the problem of potential offender identification. Included in this is a system engineering program to tie all of these things together in an analytical way.

In our report this program is laid out in considerable detail. It contains some 34 separate program proposals, research techniques, so that the functional relations, which I described earlier, can be found; that the measurements can be made.

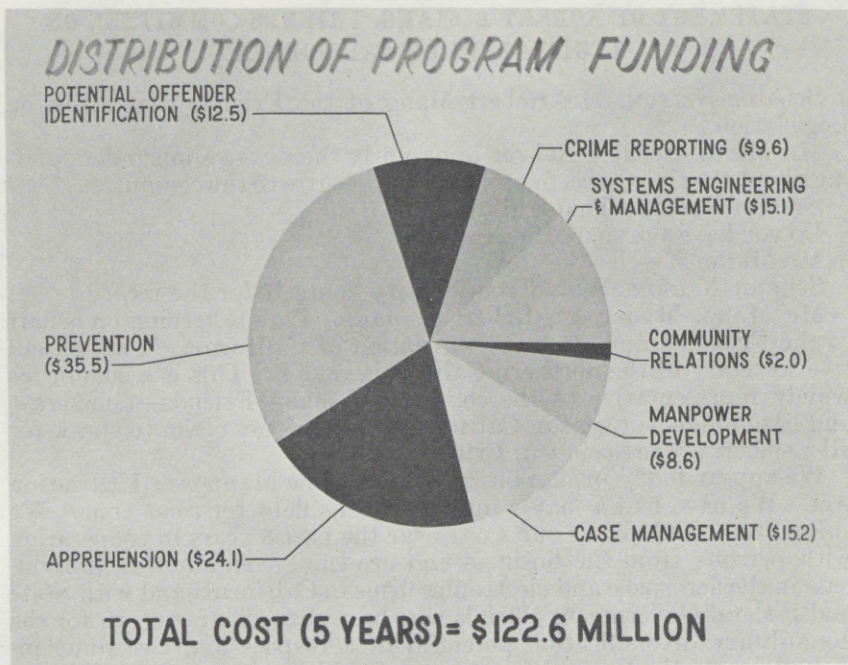


FIGURE 16

The program is to take 5 years and its costs a total of \$122 million.

I would like to point out that we are trying to obtain knowledge of how to run the system of criminal justice. Our present system of criminal justice, in the next 5 years, as I mentioned earlier, will cost \$3½ billion. If we do such things as double the police at a cost of \$1.8 billion, our bill will be \$5.3 billion. If we throw away the key on our convicted offenders and run a full sentence policy in California, our bill would be \$4.5 billion. If we did both of these things, it would be \$6.3 billion.

And yet we don't know just how much good these things would do in reducing the crime rate or the cost to society. What we are proposing then is that in the next 5-year period we make this effort to learn how to evolve our system of criminal justice in a rational, quantitative way.

Thank you, sir.

Senator NELSON. Thank you very much for your fine presentation.

Mr. MILLENSEN. Sir, concerning this study which you did for the State of California, do you know whether the State used any Federal funds, such as those under the Juvenile Delinquency Control Act, or some other program, as a method of paying for this?

Mr. KUHN. You would have to check with the department of finance, but I believe not. I believe these were State funds.

Mr. MILLENSEN. Thank you.

Senator NELSON. Thank you very much.

**STATEMENT OF ROBERT A. MANG, FRIENDS COMMITTEE ON
LEGISLATION OF CALIFORNIA**

Senator NELSON. Mr. Robert Mang of the Friends Committee on Legislation.

Mr. MANG. Senator Nelson, apparently there was a misunderstanding about the time I was to appear. I apologize to the committee.

Senator NELSON. That is all right.

Do you have a prepared statement?

Mr. MANG. Yes.

Senator NELSON. Would you identify yourself for the record.

Mr. MANG. My name is Robert A. Mang. I am testifying on behalf of the Friends Committee on Legislation of California. I am executive secretary of the northern California region. This is a committee widely representative of the concerns of many Friends—Quakers—and like-minded citizens in California, but does not claim to speak for all members of the Society of Friends.

We appear today in support of the Scientific Manpower Utilization Act. We have had a major interest in this field for some time. We speak from the basis of our work over the past 3 years in cooperation with persons from the business and academic communities, individuals in the aerospace and electronics firms in California and with State and Federal Government officials who have shared our concern for the nonmilitary diversification potential of aerospace and electronic industries in particular, and for the economic difficulties and possibilities of disarmament in general. In this context, I should just like to comment that we have been heartened by the increasing national and international interest in the subject of the economics of disarmament as evidenced in the United Nations study, "The Economic and Social Consequences of Disarmament," and the July 1965 report by the President's committee, "The Economic Impact of Defense and Disarmament."

As we became involved in studying the functions of aerospace firms, we learned of the potential these firms might offer to the civilian sector. In a sense, they had created a new resource for the Nation through an integration of technical competence.

We began to understand what the term "systems analysis" might possibly mean for the many other concerns on which our committee also works. We recognized the value of applying this kind of approach to some of the basic problems confronting our Nation; problems such as education, transportation, waste management, and others as mentioned in this bill.

We feel the approach of this bill is fundamentally sound in its perception of such possibilities and wish to commend Senator Nelson for his initiative in introducing it. We should also like to take this opportunity to commend Governor Brown for making available the \$400,000 for the four phase 1 contracts on the problems of transportation, crime, pollution, and information in California. It would seem that these have helped to show the feasibility of applying systems analysis to major social problems and should be expanded with Federal funds.

As you are well aware, California has a great interest in this matter, but there is also a nationwide responsibility for confronting many

such problems and we believe that here is an opportunity to confront them in depth. We feel this bill recognizes both the responsibility and the opportunity.

With regard to particular aspects of the bill, we wish to offer a few comments for your consideration.

First, the bill has defined the resources which might be utilized in solving our many social problems as "scientific, engineering, and technical." We merely wish here to emphasize the social nature of some of the problems which the bill goes on to list. We would hope, either through a different wording in the bill or through its legislative history, that there would be a clear understanding that these resources are construed to include social sciences as well.

Secondly, while we recognize that the bill does not limit the field of research and development to the problems it delineates—from education to waste disposal in section 2—we would like to mention several other areas of need in the public sector to which the systems approach might be applied:

Health and hospital systems; now with the Medicare Act, it is probable there will be even greater need for more hospitals. We have been told by scientists in the systems industry that modern technology might be applied to the development of hospital and medical systems which would offer greater efficiency to the patient as well as hospital staffs; and which in the long run would be more economical. Modern technology also offers new possibilities in the diagnosing of diseases and their remedies.

Rehabilitation systems are another area of public need. This might include a separate or comprehensive exploration of our mental and penal institutional and postinstitutional needs, with a view toward discovering new approaches toward rehabilitation. We wish to compliment Senator Nelson for describing some of these possibilities in his introduction of the bill last month. It seems that the systems approach could helpfully be applied to this problem to create a continuous and consistent method of approach to the aberrant from the time of his arrest or commitment hearing through his confinement and release, including his postrelease difficulties of adjustment. It is interesting to note here that presently sophisticated statistical data on the problems which have caused ex-prisoners to return to prison is virtually nonexistent. We know what percentage of prisoners return and what law they broke, but we know little or nothing, statistically, about what percentage were motivated by economic frustrations or social or family difficulties, and so on. There is great need for a comprehensive approach to the rehabilitative process.

Another area for attention is conservation and recreative utilization of resources. A part of this, which might well interest people on the east coast, might include the development of more efficient water and power systems including contingency reserve planning in case of shortage or breakdown.

Finally on this part of the bill, we would call your consideration to system operations possibilities in conjunction with international development problems and aspirations. We have been told by one very prominent scientist that such a company as this might undertake a regional, multisystems approach to a underdeveloped area. This would

include the development and integration of transportation, communications, industrial and agricultural systems within a entire region. While we realize there are many other problems which must be taken into account in the area of international development, we are attempting to indicate the wider range of possibilities and benefits these companies might offer if there were markets available to such civilian enterprise.

This leads me to my final comment. We are aware that the aerospace industry to a limited extent has on its own explored some of these possibilities. This bill should greatly encourage expansion of this competitive effort and in doing so might possibly open the way for these civilian markets to develop.

Thank you, Mr. Chairman.

Senator NELSON. Thank you very much, Mr. Mang, for your very thoughtful comments.

Do you have any questions?

Mr. MILLENSEN. I note, sir, in your testimony you say "Rehabilitation systems are another area of public need."

Are you familiar with the Correctional Rehabilitation Act of 1965, which the Congress had enacted into law this year?

Mr. MANG. Not in detail.

Mr. MILLENSEN. I was just wondering whether you feel putting an item of this sort in this bill might be a duplication of what Congress has done through the Correctional Rehabilitation Act.

Mr. MANG. I am not sure. This would take some exploration.

Mr. MILLENSEN. Perhaps you might want to add this to your testimony at a later time and submit it to us.

Mr. MANG. Well, that is possible.

Mr. MILLENSEN. And have a chance to look it over rather than answer off the top of your head.

Mr. MANG. I could just comment I think we have seen by the crime study here preceding us that there are some new areas and avenues of research we haven't, to my knowledge at least, explored heretofore, and my thought in this testimony was to bring together the possibility of looking at the prison and the mental institutional problems as possibly one or a related problem. I think that the comments here do relate closely to the crime study which has taken place. But my emphasis was to be on the rehabilitation process after prison.

Senator NELSON. Thank you very much, Mr. Mang. We appreciate your coming here to testify.

Is there anyone else who intends to appear?

Yes?

STATEMENT OF PATRICIA ARNOLD, ECONOMIC COMMITTEE OF WOMEN FOR PEACE

Senator NELSON. Will you identify yourself for the record?

Mrs. ARNOLD. My name is Patricia Arnold, and I am with the Economic Committee of Women for Peace. We support the Nelson bill.

I would just like to make a few remarks on the reasons for our support.

We feel or we believe in the peaceful settlement of world problems and we feel that a bill of this nature will make a commitment more possible for the peaceful solution of economic conversion. It becomes a reality and this does open the door for this type of possibility.

We are concerned with the public opinion and we are directly connected with trying to influence public opinion to support efforts like this bill, because we feel the American people, if they do not feel their jobs and our economy is dependent upon the predominance of the defense industry allocation, and we propose peaceful cooperation—excuse me, I didn't have this prepared fully.

Senator NELSON. That is all right.

Mrs. ARNOLD. I was not aware until last night of this meeting. I think these hearings should be more publicly known. I am sure mothers, as I have been, would be here to support you.

That is the end of my statement.

Senator NELSON. Thank you very much.

That will conclude the hearing.

I thank those who came here to make presentations with the charts. We will send the testimony to you, and we will have it so you can fit your own charts into the testimony and then we will ask you to add a summary, or rather an introduction that gives an explanation of what your aspect of the study meant followed by your explanation of the charts. We will send that to you.

Thank you very much.

(Whereupon, at 4:10 p.m., the hearing was recessed subject to call of the Chair.)

SCIENTIFIC MANPOWER UTILIZATION ACT

TUESDAY, MAY 17, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON THE
UTILIZATION OF SCIENTIFIC MANPOWER
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The subcommittee met at 9:30 a.m., pursuant to call, in room 4232, New Senate Office Building, Senator Gaylord Nelson, chairman of the special subcommittee, presiding.

Present: Senators Nelson (presiding), Pell, Javits, and Murphy.

Senator NELSON. We will open hearings on S. 2662, the Scientific Manpower Utilization Act.

We have two witnesses this morning. This is part of a series of hearings that we have been conducting on this bill. The first were conducted in California.

We have heard from witnesses from the aerospace industry. The two witnesses this morning are Alain C. Enthoven, Assistant Secretary for Systems Analysis, Department of Defense; and Mr. Henry S. Rowen, Assistant Director of the Bureau of the Budget.

This bill is designed to bring to bear on social and economic problems at the State, national and regional level new techniques developed over the last few years in defense and space efforts, and in budget efforts. These techniques, usually described as systems approaches or systems analysis, have played a very successful role both in aiding the engineering breakthrough into space and in military hardware development, and also by providing the management tools for informed decisionmaking.

The management application of systems analysis that has been so useful in the Defense Department is known as the planning, programming, and budgeting system (PPBS).

On October 12, 1965, the Budget Bureau issued its well-known bulletin 66-3, in which it informed the other agencies of the Federal Government that the President has directed the introduction of PPBS in the executive branch.

At today's hearings, we are pleased to have with us two gentlemen who have been instrumental in the development of PPBS. The problems faced by this Nation at the State, regional, and national level in the field of education, welfare, conservation, transportation, pollution, urban planning, and land use control, to name only a few of the staggering list, are certainly no less urgent or complex than the problems faced by the Defense Department.

It is therefore crucial, it seems to me, that we find ways to use the very best in advanced techniques to bear on this problem at the State,

national, and regional level. It seems to me that the system holds great promise for meeting the social and economic problems of the State, regional, and national level.

These hearings have two purposes: first, to explore systems analysis and systems approaches to find the best way to make them available; and, second, to develop a hearing record that will make clear to local officials and national officials, with administrative rather than technical responsibilities, what the systems approaches are all about.

I will call first on Mr. Enthoven. I would hope that both Mr. Enthoven and Mr. Rowen will feel free any time to raise questions about the other's testimony or to add to it during the course of the testimony.

Mr. Enthoven.

**STATEMENT OF ALAIN C. ENTHOVEN, ASSISTANT SECRETARY FOR
SYSTEMS ANALYSIS, U.S. DEPARTMENT OF DEFENSE**

Mr. ENTHOVEN. Thank you, Mr. Chairman.

Mr. Chairman, it is a great pleasure for me to appear before you this morning and to have the opportunity to make a contribution to the use of systems analysis on problems of State and local governments. I believe that this is a most worthwhile objective and that there are clear possibilities for making major contributions to the public welfare through the broader use of systems analysis at all levels of government.

What I have to say will be based on our experience in the Department of Defense. But, I want to emphasize at the outset my conviction that the problems of State and local government and the problems education, natural resources management, pollution of the environment, and public health and welfare are no more complex and no less amenable to systematic, rational analysis than are the problems of defense. I need only mention our current problems in NATO and in defeating aggression in southeast Asia to illustrate the point that we have our share of complex problems. While I would not want to suggest that system analysis has solved these problems, I think that it is fair to say that a systematic and integrated approach to the gathering and presentation of information on the alternatives available to our Government has made the work of our responsible decisionmakers easier and more productive than it might otherwise be.

I understand that you are interested in identifying and making available useful literature on the systems analysis approach. I am very happy to be able to call to your attention and to submit for the record a prepublication copy of "A Modern Design for Defense Decision," an anthology on Defense management, programing and systems analysis, including speeches and articles on these subjects by Secretary McNamara, former Assistant Secretary of Defense (Comptroller) Charles Hitch, and myself. This volume is being published by the Industrial College of the Armed Forces and the hard-bound printed version will be available late in June.

Senator NELSON. You are submitting a copy of this for use by the subcommittee?

Mr. ENTHOVEN. Yes.

Senator NELSON. That will be put in the subcommittee files.

Mr. ENTHOVEN. There is a great deal that might be said about the systems analysis approach. In this statement, I would like to pick out a few of the aspects that seem to me to be especially relevant and to make these points largely by the use of excerpts from "A Modern Design for Defense Decision."

In my statement, I would like to expand on the following points:

(1) Systems analysis is a reasoned approach to problems of decision, accurately described as "quantitative commonsense."

(2) Systems analysis is an application of scientific method, using that term in its broadest sense.

(3) There are limitations in the application of systems analysis, although these have often been overstated.

(4) In 1961, the Defense planning and budgeting system had to be changed to permit the application of systems analysis.

(5) Systems analysis is a regular working contributor to the annual Defense decisionmaking cycle.

(6) Two necessary conditions for the successful application of systems analysis as a working part of an operating organization are that it be used by decisionmakers, and that it be fed with ideas by a broadly based interdisciplinary research program.

(7) Systems analysis can be applied to the problems of State and local government, including programs for social welfare.

Senator NELSON. Will you elaborate a little bit on that? In what way do you use the interdisciplinary approach in the development of your systems analysis in the Defense Department? What disciplines are involved in the Defense Department development of a program?

Mr. ENTHOVEN. The main disciplines that we draw on in our weapons systems and strategy studies are the military profession; that is, officers experienced in military operations; physics, engineering, and other physical sciences, economics, political science, and other social sciences. The men from these professions work together in collaboration, oriented toward the solution of the problems at hand. The main focus has to be the problem itself, and not the prerogatives or the use of this or that particular discipline.

It is very important to make sure that the physics used in our weapons system analysis is good physics. So you want to have good physicists. But once the physicists are working on the problem, they have to be willing to transcend the traditional boundaries of their academic background.

Senator NELSON. In deciding on a particular weapon, for example, where it might be used or where it might be based, does the Defense Department use the counsel of political and foreign relations experts for some advice on what the effect might be? In other words, the development of a weapons system may require the use of a certain weapon, an airplane or something else, based on foreign soil; and as long as it is there, it may be most effective and the best weapon we have. But if something developed politically that required the withdrawal of the weapon and you could not use it at all, what effect would that have on the weapons system you have developed?

Are political experts used to raise these questions so that the decision maker or makers in the Defense Department can at least evaluate that problem in making a determination as to the weapons system?

Mr. ENTHOVEN. Yes, sir. We do that, both in our research program

and in our staffing of specific decisions that have to be made by the Secretary of Defense and with the help of the State Department. We go through a process very much along the lines of what you described. That is, a group working on the choice of weapons systems might well include a political scientist who would observe that the different basing concepts associated with different weapons would have substantial implications for our relations with foreign countries. He would raise and identify the issues and clarify what the implications are for the decisionmakers.

Senator NELSON. How is the system set up? You do have to have an analysis of the overall weapons system. It has a thousand parts. What are the mechanics for setting up the analysis of the weapons system?

Mr. ENTHOVEN. Let me take an example from the research program, one in which Mr. Rowen was a leading participant back in the early 1950's, when the Rand Corp. embarked on a major study of the basing and operation of the Strategic Air Command.

One of the main problems that study identified was the fact that our basing of strategic bombers on overseas bases close to the U.S.S.R. and outside our warning net left these bombers vulnerable to surprise nuclear attack. The study examined a number of alternatives for the solution of this problem, alternatives for guaranteeing the security of our strategic retaliatory power. The alternatives were described and evaluated primarily from the point of view of our strategic retaliatory capability, but also from the point of view of what implications and requirements they would have for overseas bases and therefore for our dependence on other countries.

Actually, this particular study, which is an example of the best of this kind of research, was done mainly by a group of four men within a larger organization from which they could draw for assistance on particular pieces of the work by aeronautical engineers, physicists, political scientists, and the like.

Senator NELSON. All part of the Rand Corp.?

Mr. ENTHOVEN. All part of the Rand Corp.; yes, sir.

Senator NELSON. Did they also use whatever they needed from the whole Military Establishment?

Mr. ENTHOVEN. Yes. In fact, we had very good assistance and cooperation from the Air Force; in this case, the Strategic Air Command. Air Force officers were present at the Rand Corp., participating in and contributing to the studies, and providing very necessary and most valuable advice on the practicability of the operations and the realistic aspects of the operational problems.

Senator NELSON. Senator Murphy, we have testifying presently Mr. Enthoven, of the Defense Department, and Mr. Rowen, of the Budget Bureau, with him.

Senator MURPHY. Thank you.

Senator NELSON. You may proceed.

I. SYSTEMS ANALYSIS APPROACH

Mr. ENTHOVEN. Systems analysis is nothing more than quantitative or enlightened commonsense aided by modern analytical methods.

What we seek to do in the systems analysis approach to problems is to examine an objective in its broadest sense, including its reasonableness or appropriateness from a national policy point of view, and then develop for the responsible decisionmaker information that will best help him to select the preferred way of achieving it. This process of selection requires that we first identify alternative ways of achieving the objective and then estimate, in quantitative terms, the benefits (effectiveness) to be derived from, and the cost of, each alternative. These aspects of the problem that cannot easily be quantified are explicitly stated. Of course, this would include the foreign policy aspects. In principle, we strive to identify the alternative that yields a specified degree of effectiveness for the least cost or, what is the same thing, the greatest effectiveness for a given cost. In essence, it is a way of dealing with the basic economic problem—how best to use our limited national resources. So much for what systems analysis is. A few words on what it is not.

Systems analysis is not synonymous with the application of computers. There is no essential connection between the two. Certainly the development of the former in no way depends on computers. Some researchers, working within the limits of the systems analysis approach, try to do their analyses by means of large-scale computer simulations. Actually, the computer simulation approach so far has not been particularly fruitful as a method of weapon systems analysis. However, the potential advantages offered by high-speed electronic computers are very great. One of the primary advantages of the computer to the systems analysis function is to permit us to examine a much larger number of alternatives in a shorter period of time than would be otherwise possible. This is especially important in the case of very complex and interrelated systems where hand calculations would limit the time available for the more important work of analysis. I intend to try to exploit more fully the potential of high-speed computers. But I would like to make it clear that I view the computer as a mechanical aid in my work and not as the substance of my work.

Moreover, systems analysis is not mysterious or occult. It is not performed with the help of a mysterious black box. A good system analyst should be able to give a clear nontechnical explanation of his methods and results to the responsible decisionmakers.

II. APPLICATION OF THE SCIENTIFIC METHOD

I would like now to turn to what I believe are some of the basic characteristics of the systems analysis method. Systems analysis is at once electric and unique. It is not physics, engineering, mathematics, economics, political science or military operations, and yet it involves elements of all of the above disciplines. But regardless of its makeup, the art of systems analysis—and it is an art—like the art of medicine, must be based on the scientific method, using this term in its broadest sense.

What are the relevant characteristics of scientific method as applied to the problem of choosing strategies and selecting weapon systems, or, for that matter, to the analysis of any problem of public policy involving allocation of the Nation's scarce resources? I would like

to answer this by quoting a passage from an address I gave before the Naval War College in 1963.

First, the method of science is an open, explicit, verifiable, self-correcting process. It combines logic and empirical evidence. The method and tradition of science require that scientific results be openly arrived at in such a way that any other scientist can retrace the same steps and get the same results. Applying this to weapon systems and to strategy would require that all calculations, assumptions, empirical data, and judgments be described in the analysis in such a way that they can be subjected to checking, testing, criticism, debate, discussion, and possible refutation. Of course, neither science nor systems analysis is infallible. But, infallibility is not being claimed; it would be worse than unscientific to do so. However, scientific method does have a self-correcting character that helps to guard science from persistence in error in the long run.

I might add, Mr. Chairman, that it was a possible misconception when we brought systems analysis into the Pentagon that this somehow was going to be a substitute for and an end to debate. In fact, it has not turned out that way at all. Rather, I think it might be better described as a sophisticated, logical set of ground rules for conducting a debate, ground rules which help the debate to converge on some useful conclusions and to eliminate the unsupportable arguments as you go along.

Second, scientific method is objective. Although personalities doubtless play an important part in the life of the physics profession, the science itself does not depend upon personalities of vested interest. The truth of a scientific proposition is established by logical and empirical methods common to the profession as a whole. The young and inexperienced scientist can challenge the results of an older and more experienced one, or an obscure scientist can challenge the findings of a Nobel Prize winner; and the profession will evaluate the results on the basis of methods quite independent of the authority of the contenders, and will establish what is the correct conclusion. In other words, the result is established on the objective quality of the physics and not on the reputations of the persons involved

Third, in scientific method in the broadest sense, each hypothesis is tested and verified by methods appropriate to the hypothesis in question. Some are tested and verified logically, some experimentally, some historically, etc. Some sciences, of course, can reproduce experiments cheaply and they tend to emphasize experiment. This is notably the case with the physical sciences. In others, particularly some branches of medicine and the social sciences, one cannot experiment readily, if at all, and the detailed analysis of available historical data is most appropriate. In this respect, they resemble military science very closely. In choosing weapon systems some experimentation is possible, but a great deal of analysis is also required. In fact, in the development of weapon system analysis, one is more handicapped than in most of the sciences, for fully realistic tests come only at infrequent intervals in war, while the development of new weapon systems also takes place in peacetime. But this argues for better analysis and more heavy reliance on analysis where fully relevant experience is not generally available.

Fourth, quantitative aspects are treated quantitatively. This is not to say that all matters can be reduced to numbers, or even that most can be, or that the most important aspects can be. It is merely to say that the appropriate method for dealing with some aspects of problems of choice of weapon systems and strategies requires numbers. Non-quantitative judgment is simply not enough. What is at issue here really is not numbers or computers versus words or judgment. The real issue is one of clarity of understanding and expression. . . .

Numbers are a part of our language. Where a quantitative matter is being discussed, the greatest clarity of thought is achieved by using numbers instead of by avoiding them, even when uncertainties are present. This is not to rule out judgment and insight. Rather, it is to say, that judgments and insights need, like everything else, to be expressed with clarity if they are to be useful.

Let me emphasize the point about uncertainties. Many people seem to feel that quantitative analysis is not possible if there are any uncertainties. But this view is incorrect. In fact, there is substantial literature on the logic of decisionmaking under uncertainty going back at least as far as Pascal, Bernoulli, and Bayes in the Seventeenth and Eighteenth Centuries. Moreover, there are simple practical techniques for dealing with uncertainty which make it possible to do analyses that point up the certainties for the decision-maker and indicate their significance. In fact, rather than conceal uncertainties, a good analysis will bring them out and clarify them. If it is a question of uncertainties about quantitative matters such as operational factors, it is generally useful to examine the available evidence and determine the bounds of the uncertainty. In many of our analyses for the Secretary of Defense, we carry three estimates through the calculations: an "optimistic", a "pessimistic", and a "best" or single most likely estimate. If there are uncertainties about context, at least one can run the calculations on the basis of several alternative assumptions so that the decision-maker can see how the outcome varies with the assumptions.

III. THE LIMITATIONS OF SYSTEMS ANALYSIS

I have frequently been asked about the shortcomings and limitations of the systems analysis approach. Let me refer to an article I wrote for the *Naval Review*, 1965, reprinted in "A Modern Design for Defense Decision."

What's wrong with systems analysis? What are its particular limitations and biases? One criticism I have heard is that emphasis on quantitative analysis risks ignoring those factors that cannot be reduced to numbers, or at least over-emphasizing those that can.

Suppose, for example, that the problem is to choose between two alternative ways of destroying a certain set of targets. The less costly way is to base short-range missiles on the territory of an ally; the more costly way is to cover the targets with long-range missiles based in the United States. But suppose basing the missiles on the ally's territory would lead to political difficulties, to the embarrassment and possible fall of a friendly government. How does one take account of such political aspects in a quantitative analysis? The answer is that one doesn't. There is no way of "grinding in" the potential political difficulties of an ally. The most the analysis can do is make clear to the decision-maker the differences in cost and effectiveness between the two approaches so that he can make an informed judgment about their weight in relation to the political problems.

I would not want to deny that there is potential danger here, even though there is nothing about the systems analysis approach that prevents an assessment of the political or other non-quantitative factors from being included in the staff work. I am confident that the top-level leaders of the Department of Defense who use systems analyses as one of their sources of information are careful to give balanced consideration to all factors, whether quantitative or not.

Another criticism sometimes made is that application of the "flat of the curve" argument—

that the extra effectiveness is small in relation to the extra cost—

to force or performance requirements may lead people to ignore the decisiveness of a narrow edge in superior performance. There is a danger here if an unwary analyst confuses performance and effectiveness. There is no question but that, in some cases, a narrow edge in performance may have a very great impact on effectiveness. The performance advantage of the Japanese Zero fighter over American aircraft at the beginning of World War II is a good case in point. But there are other cases in which even a substantial increase in performance, purchased at a high price, may have a small impact on effectiveness. For example, many Navy aviators believe that under today's conditions, a substantial speed advantage in attack aircraft may mean rather little in terms of increased effectiveness. It is easy to confuse performance and effectiveness. But this mistake is clearly not peculiar to the systems analysis approach. The only way to avoid it, and to relate performance to effectiveness properly, is with the help of good analysis.

Next, it is argued that the system analysis approach may be biased against the new and in favor of the old. I am sometimes concerned that our analyses may be subject to such bias, but I think that the method of open explicit analysis is much less likely to be so biased than is reliance on judgment or intuition or experience unsupported by analysis. The reason for the bias is that we all tend to compare the old and the new in the current mission that happens to have been optimized for the old * * *.

Finally, sometimes it is said that systems analyses oversimplify complex problems. Of course, we have to simplify the complex problems we face; no one could possibly understand most problems of modern weapon systems and strategy in all their complexity. And it is a natural human failing to oversimplify. But I believe the facts are that the systems analysis approach is much less prone to oversimplification than any alternative approach. For it is part of systems analysis to bring to bear all of the best of modern analytical techniques for organizing data and summarizing clearly its most relevant aspects. Moreover, reliance on the method of open, explicit analysis is our best guarantee against persistence in harmful oversimplification. For if I must lay out clearly all of my assumptions, objectives, factors, and calculations, my critics can see what I have done and point out where I have oversimplified, if indeed I have done so. But if I am allowed to keep it all in my head and appeal to experience or judgment, others have no way of knowing whether or not I have oversimplified the problem.

IV. INTRODUCTION OF SYSTEMS ANALYSIS IN THE DEFENSE DEPARTMENT

Although systems analysis is a reasonable and straightforward concept, it was not an easy one to implement in the Department of Defense. In conducting a sound cost effectiveness study you must be able to associate both the benefits and costs with the alternatives to be examined. The Defense management system as it existed 5 years ago did not permit this. Assistant Secretary Hitch described the problems he encountered as follows:

In 1961, the chief, in fact the Secretary's only systematic and comprehensive vehicle for the allocation of resources in the Defense Department, was the annual budget. For the task which it was being asked to perform, it was deficient in several respects. The budget focused on the financial problems of a single upcoming fiscal year, thereby discouraging adequate consideration of decisions whose near term dollar impact was slight but whose impact in later years was very large, to the point of becoming an important constraint on Defense managers. The structure of the budget, which portrays the Defense program in terms of broad functional purposes (e.g., personnel, procurement and construction) and organizational components—

That is, Army, Navy, Air Force, and so forth—

also limited its usefulness as a management tool. Rational military strategies and force requirements have to be planned and expressed in terms of the final products of the military program such as numbers of combat-ready divisions and deployed missiles, rather than in terms of the basic resource ingredients of the budget. Moreover, in the Department of Defense at that time there was an almost complete dichotomy between military planning, which was long range, expressed in terms of outputs, and performed by military planners in the Joint Staff and the Military Departments; and budgeting, which was short range, expressed in terms of inputs, and performed by the Comptroller organization.

It was to bridge the gap between these two functions that we designed and installed the "programing" system. By linking military planning and budgeting in a unified planning programing-budgeting decision-making process we are able to produce a single Department-wide blueprint for the future known as the "Five Year Force Structure and Financial Program". The program projects not only the military forces needed to meet the requirements of our long-range military plans, but also the personnel, equipment, supplies and installations required to support them. In addition, the Program projects the full costs of these resources, thereby permitting responsible decision-makers to assure themselves that the program they are planning is financially feasible and is providing a sound basis for the development of our annual budget requests to Congress.

The Five Year Program is organized by forces and weapon systems grouped by mission. At the broadest level of aggregation, there are ten major military programs—the Strategic Retaliator Forces, the Continental Air and Missile Defense Forces, the General Purpose Forces, Airlift and Sealift Forces, the Research and Development Program, etc. These major military programs are made up of sub-aggregations. These, in turn, are made up of “program elements” which we consider the basic building blocks as well as the decision-making level of the programming process. A “program element” is an integrated force or activity—a combination of men, equipment and facilities whose effectiveness can be directly related to national security objectives. The B-52 bomber force, together with all of the supplies, bases, weapons, and manpower needed to make it militarily effective is such a program element. Other examples would be attack carriers or infantry divisions. There are in all about 1,000 program elements. Groupings of program elements are based on a common mission or set of purposes, with elements either complementing each other or being close substitutes which should be considered together when making major program decisions.

The programing system thus allows the reader to see at a glance how much of the Department of Defense budget is going to strategic retaliatory forces and how much of that is going to each of the major weapon systems included in that category. This is clearly a far more meaningful way of subdividing the Defense budget from the point of view of determining its overall shape. But even more importantly, the programing system permits us to relate both benefits and costs to the forces and activities that must be compared and planned. This feature is essential to any agency that hopes to apply the systems analysis approach to its problems.

Senator NELSON. Does your budgeting system project, then, 5 years in advance, so that you do have a prediction of what each program will cost, 1, 2, 3, 4, 5 years from now?

Mr. ENTHOVEN. Yes, sir. In fact, we call it the 5-year force structure and financial program. It projects at least 5 years into the future. But in order to project the costs 5 years into the future, we have to project the forces about 8 years into the future. For example, to have a C-5A aircraft delivered in fiscal year 1973, we would have to include appropriations for it in the fiscal 1971 budget. So that would bring it into the 5-year period.

Senator NELSON. Each year then you just project ahead another year in addition to the 5 or 8 that you had projected previously.

Mr. ENTHOVEN. That is right. It is what we refer to sometimes as a “rolling 5-year plan,” because we add a year at the end of the 5-year period each year. Of course, in some of our studies we have to project considerably further than 5 years into the future. Whenever it is a question of introducing a major new weapon system, we are likely to have to look approximately 10 years into the future.

Let me give you a couple of examples. We are now developing the C-5A, a large transport aircraft. A couple of years ago, when the analyses were being done leading to the major decisions on development, we had to look about 10 years into the future to make sense out of the whole thing, because it would have been about 10 years before the whole posture would be completely developed and delivered.

Similarly, now in our own studies on the antimissile missile, we have to look out to about 1974 or 1975, or even a little beyond. Of course, our ability to predict that far into the future is extremely limited. There is no doubt about that. The fog gets pretty thick when you try to look several years into the future. But nonetheless the decision

we make today have important implications that far into the future. So it is important at least to be clear about the assumptions on which we base our projections and decisions.

Senator NELSON. Of course, the system itself then has a built-in factor that compels you to utilize all the information you have gained this year in revising your predictions for the 5th year away or the 10th year away?

Mr. ENTHOVEN. Yes. That is very true, and it is a very good point, a very significant point, Mr. Chairman.

One of the very important problems in any large organization is to get the people in it to think about the problems of the future, out far enough in the future that there is time to do something about them, rather than dwelling on the problems of the past or trying to solve the problems of yesterday or today.

By having a rolling 5-year plan that has to be kept up to date all the time, we keep forcing ourselves to think systematically about 1970 and 1971 now at a time when we still have some time to do something about it.

I think that is a very important benefit of having a 5-year planning system.

Shall I go on?

Senator MURPHY. Is this a completely new idea?

Mr. ENTHOVEN. A 5-year plan as such is not a new idea. For example, we know that the Russians have had 5-year plans for a long time.

Senator MURPHY. I hope ours works better than theirs.

Mr. ENTHOVEN. We have reduced to a system and put into practical application ideas on defense planning that were developed by the Appropriations Committees of the Congress, by Gen. Maxwell Taylor in his writings, by our research program at the Rand Corp., by scholars at universities studying defense management, et cetera.

Senator MURPHY. Are we to assume that the idea of a rolling 5-year plan is an innovation that came in with systems planning, or was this in use in the Department of Defense previous to this time?

Mr. ENTHOVEN. Yes, sir; this was an innovation in the Department of Defense. The rolling 5-year plan for the Department of Defense, integrating or tying together the forces and personnel, dollars and supporting programs, was an innovation that was introduced in 1961. To my knowledge, at that time no government in the United States, Federal, State, or local—no government agency had such a plan. In fact, I am not aware of any government having had such a system at that time. But the idea had been suggested during the 1950's as something that ought to be done.

Mr. ROWEN. If I may comment on that. The notion of having long-range plans is not new. The military have had long-range plans for many years. Nonmilitary parts of the Government, the Forest Service, for example, have had a long-range plan for a long time. What is different is that these earlier plans have lacked something very important. They lacked tying the specific accomplishments which were spelled out in those plans to the finances required to accomplish them in a very specific, precise, and detailed way. They weren't really operational, they were sort of dreams for the most part, things that would be nice to have.

That does not mean that they are without value, but it is not quite the same thing as the type of plan that Dr. Enthoven has been describing.

Senator NELSON. I think you mentioned the Forestry Service. One of the factors that has been absent, say, in the long-range forestry planning is that each of these plans, whether forestry or reclamation or any other plan, is a kind of vertical plan that concerns itself precisely with the discipline involved.

For example, in the Forest Service, they have millions of acres, they have a timber stand improvement plan, narrowly confined to the use of the national forest. And until the last few years they have given no consideration to using the national forest on a broad basis for other purposes, multiple use such as conservation. The Congress passed some enlightened legislation a few years ago, which established the 701 grants that could be used by States and cities and regions within States for the development of a comprehensive long-range plan which involves the same concept of systems analysis as the Defense Department is now using, and in Senator Murphy's State, the State government tackled this issue—as I am sure you are well aware—by letting contracts to the aerospace industry to do a system analysis of a whole problem. One of the studies was on waste management.

We have always tackled the question of pollution as a problem that involves municipality polluting the water. We have never taken an overall look of the whole question of pollution. If you put an industry on the river you have done something to the economy. But, as you probably mention in your testimony, you have done something to the water. We have never taken a look at the whole waste management plan involving pesticides, industrial pollutants, and air pollutants and tried to develop a program which deals with the whole problem of waste management.

In California they have made a preliminary start with some contracts to use this system and taking a total look at the whole picture. The field of crime is one. So the governments at least have not made very good use thus far of the concept of systems analysis in taking a total look at all the factors involved in a particular social situation.

V. THE WORK OF SYSTEMS ANALYSIS

Mr. ENTHOVEN. The primary function of systems analysis in the Pentagon is to assist the Secretary of Defense by developing information that will be useful to him in making key decisions on force levels and resource requirements. For this reason the work of the staff is tied very closely to the annual defense decisionmaking cycle which is based on detailed continuing requirements studies. Carefully formulated, detailed analytical studies are basic to sound decisions on force and resource requirements. We develop each year a program of studies that we believe should be conducted during the coming year. These proposed studies are submitted to the Secretary, who reviews them, decides which ones he feels are required, and requests the Joint Chiefs of Staff and the Service Secretaries to have their staffs conduct them. My staff works closely with the groups that are actually conducting the studies to advise them on methodology, selecting assumptions, and to insure that the study is focused on the questions the Secretary feels

need answering. When the studies are completed and submitted to the Secretary, we assist him by reviewing them, indicating weaknesses, summarizing them for his use, and so forth.

The completed studies normally serve as the basis for proposed changes to the 5-year defense program. These changes may be submitted by one of the military departments or by the Joint Chiefs of Staff. Proposed changes to the force structure are then reviewed in depth by the staff of the Office of the Secretary of Defense.

We in systems analysis emphasize cost/effectiveness studies of the proposals, comparing each with the previously approved force and other alternative ways to accomplish the mission. The Secretary then makes tentative decisions on the force structure. These tentative decisions are reviewed by the Joint Chiefs of Staff and the military departments, who have the opportunity to make further recommendations. After further discussions with his principal military and civilian advisers, the Secretary of Defense makes his final decisions, and these decisions serve as the basis for the annual budget. The budget is reviewed by the Secretary in the fall of each year and, of course, submitted to Congress in January. By this point we are well into the next cycle and new requirements studies are being initiated.

Throughout the decisionmaking cycle, systems analysis emphasizes integration of the various elements of the defense program and focuses on the broad national security objectives. This should be a primary objective of any systems analysis staff, at the Federal, State, or local governmental level, as integration is an area in which most government organizations are weak. This was particularly true in Defense 5 years ago.

A 1961 organization chart of the Department of Defense would show the advisers to the Secretary of Defense on forces and military strategy, the Joint Chiefs of Staff; the adviser on research and engineering matters, the Director of Research and Engineering; the adviser on financial matters, the Comptroller; the adviser on production matters, the Assistant Secretary for Supply and Logistics; the adviser on international matters, the Assistant Secretary for International Security Affairs; et cetera. Each adviser was concerned primarily with his own specialty rather than the Defense program in its entirety. The Secretary of Defense, virtually alone, was expected to integrate all of these diverse facets personally and to do so without systematic assistance.

The programing system was developed to provide one mechanism for integrating the diverse parts of the defense program, especially to integrate force planning with budgeting and support programs. The Systems Analysis Office was established to gather and display information associated with these different areas in a manner that would show the Secretary of Defense how the pieces fit together. Its work cuts across these various specialties. Of course, the information that we provide the Secretary of Defense is only one of many inputs available to him, and the integrating functions that we perform in no way reduce the very great importance the Secretary attaches to the advice and information provided by the Joint Chiefs of Staff and his other civilian advisers.

VI. SOME IMPORTANT PRECONDITIONS FOR SUCCESS

Two conditions seem to me to be necessary to the successful development and functioning of a systems analysis group within a policy-making organization. The first is that the responsible decisionmakers make use of systems analysis and take it seriously. Without this, the professional personnel will recognize in time that their work is not influencing the course of events and their motivation is likely to be destroyed. By using systems analysis and taking it seriously, I do not mean that the decisionmakers must accept the results of the analyses uncritically or that they must rely exclusively on the systems analysis input. Far from it.

Every analysis must be based on many assumptions, and a responsible decisionmaker may not choose to accept the assumptions that his analysts have made. What is important is that the analyses be given a fair hearing and be acted upon if they successfully stand up under reasonable debate and criticism; or, if they are not acted upon, that the analysts are told why so that they can correct their work in the future. The analysts must have this "feedback" from the decisionmakers, if they are to know which issues are considered relevant or significant, which objectives the decisionmakers wish to pursue, and which assumptions appear to them to be plausible. A systems analysis capability installed as "window dressing" is not likely to develop into a good one.

The second necessary condition is that the systems analysis operation be fed with ideas growing out of a broadly based interdisciplinary research program. A research program is necessary in order to develop analytical tools, to define criteria and objectives for programs, and to invent new alternatives for achieving the objectives. Certainly, in defense, the research program must be interdisciplinary, because the scope and complexity of defense problems is too great to be encompassed with any single discipline. I am sure that this would also be true of systems analysis applied to major social problems outside of defense.

One practical implication of this is that, generally speaking, research funds in these fields are likely to be better spent supporting research institutes containing groups of scholars from a variety of relevant disciplines oriented toward the problems, rather than on individual scholars who are more likely to be oriented toward the exercise of their academic specialties.

I might add a third necessary condition for success in this kind of work is that the studies be conducted with continuity and depth. In almost every area that I have seen studies by systems analysis, the studies in the first year or two that the particular group was working, tended to be very superficial and weak. It is usually only after a good group has worked continuously for a period of several years that they begin to develop the true continuity and the depth required to understand the problem adequately.

VII. SYSTEMS ANALYSIS NONDEFENSE APPLICATIONS

Finally, let me repeat my conviction that systems analysis can be applied fruitfully to social problems. I feel certain that good

analysis can assist in the design, development, and consideration of alternative approaches to education, health, urban transportation, justice and crime prevention, natural resources, environmental pollution, and numerous other problems. In fact, there is already a great deal of useful research going on in these areas, some of which you pointed out, Mr. Chairman.

It is often suggested that these problem areas will be resistant to systematic analysis because they do not lend themselves to quantification. In commenting on that, I would like to point out that we, in the Defense Department, also have our own imponderables to deal with. We try to measure those things that are measurable, and, insofar as possible, to define those things which are not, leaving to the responsible decisionmakers the job of making the difficult judgments about the imponderables. It has been our experience that in those areas most difficult to quantify, years of research and the application of a good deal of ingenuity will often yield ways of measuring and making comparisons that were not available at the outset.

Ultimately, policy decisions will be based on judgments about relative values, the likelihood of uncertain future events, which risks we should and should not run, et cetera. But, in defense, and in these other areas as well, good analysis can do a good deal to sharpen the issues, clarify the alternatives available to the decisionmakers, and narrow substantially the range of uncertainty, thus freeing the responsible officials to concentrate their attention on the crucial judgments.

Mr. Chairman, that completes my presentation. I would be happy to attempt to answer any questions you may have.

Senator NELSON. One of the purposes of conducting these hearings on this bill is to explore, as you know, the possibility of using the systems analysis approach in terms of evaluating social problems that confront all levels of government with the ultimate objective of seeking an adequate or best possible solution to the problem.

You raised the question a moment ago about the difficulty of quantifying the statistics in the social problem field. I am wondering if it is really any more difficult in meeting social problems than it is Defense Department problems.

For example, if you were going to tackle the various problems that confront a State government; welfare problems, transportation problems, education problems, recreation problems—isn't there a substantial amount of this that can be quantified in the same way that you do in your analysis of the defense problem? For example, in any system analysis approach to these problems you would need to start out and locate certain statistics. You would have to start out with a comprehensive State evaluation, comprehensive population plan; because all of the rest of the problems you are concerned with also involve the population.

So you would have to do an analysis of how many people you are going to have in your States in the year 1980, and how many in the year 2000. You can come up with pretty good predictions by starting with the year 1930 and going to 1940, 1950, 1960. Then you see the population shift within your State after making this analysis. You then make a qualitative analysis of the population. That is, what are the age groupings? Where are they going to be located in the State?

How many are going to be mentally retarded? How many are you going to have in primary and secondary schools? How many are going to be elderly citizens and need some type of care?

Then when we get all through with this basic study of the population, which again you would, if completed in 1966, you would continue to project in 1967 for another 40 years and in 1968 for another 40 years. Then you need to tackle the question of what is the long-range problem in terms of building adequate institutions for, say, the mentally retarded. We know now that a certain fraction of 1 percent of all the children born will be mentally retarded. If that factor did not change, you can predict in the year 2000 how much personnel you need, how much institutional space you need.

Of course, the factor you raise about needing interdisciplinary advice here comes into play, because you would need the experts in the field of mental retardation to qualify your statistics by pointing out that maybe we are making some headway in reducing retardation on births, which we are.

Then you project how many are going to be age 18 and then how many are going to go to college. So you can predict for the year 1980 and the year 2000 how many institutions you have to have, how many students you have, and then where the institutions should be located to best service the State.

You move with your statistics over to the transportation problem, making analysis and projection of what air transportation you need, what bus transportation you need, what railroad transportation you need, what mass transportation you need, based again on the predictions of your location of the population, location of industry, the necessity for moving products and people.

So, it seems to me that you can certainly quantify a tremendous amount of information which then you begin to analyze, and give the decisionmakers; that is, your city council, county boards, legislatures, and the Congress—good information for making determinations and predictions as to how you meet that problem.

You apply it, then, not only to your college institutions, your welfare institutions, your transportation, but you move over into the field of recreation. And then you have to get into the land use field. You make a prediction on how many people are going to be water skiers, fishermen, and so forth. What demands are going to be made for parks.

I just want to emphasize at this point, it does seem to me that a tremendous amount of information can be quantified in the social field which would be creatively useful to the administrators and legislative bodies that have to face up to these problems.

Mr. ENTHOVEN. Mr. Chairman, I am very much in agreement with you on that. It seems to me that a great deal of considerable value can be done. Many people seem to look at this problem of quantification in an all or nothing way. That is, they reason that if you can't completely reduce the problem to numbers and calculations, then it must not be useful at all to develop numbers and do calculations. I think this kind of intellectual extremism, if you like, is a mistake. The fact that you can't quantify everything does not mean that it is not useful to do some. Most of the problems that we analyze involve interpenetration between measurable calculable things and unmeasurable things.

A good systems analysis will organize and calculate the calculable, and then leave it to the responsible public officials to judge the other parts.

Senator NELSON. Doesn't exactly the same theory and the same scientific method and the same approach apply in the case of systems analysis with equal force to social problems as they apply to the development of a defense system?

Mr. ENTHOVEN. Yes, sir. I might give a couple of examples. My mentor in this business, former Assistant Secretary of Defense Charles Hitch, from whom I learned a great deal about systems analysis, is now the financial vice president of the University of California. He is starting to develop similar methods of long-range planning and analysis for application to the problems of the University of California system.

There, it is very necessary, as you pointed out, Senator, to project pretty far into the future. If I recall correctly, Mr. Hitch told me a few weeks ago that the leadtime on a new campus in the University of California system is 12 years.

Senator MURPHY. Even then, they are behind schedule. At a new campus down at Irvine, they found that they are 20 percent off now in their prognostications. They have to upgrade it continuously, as you say, from the action which is really taking place.

Senator NELSON. If I could comment on that, I think the fact of the matter is that in all States the failure has been that they really haven't used this type of systems analysis in order to make accurate predictions on how many young folks are going to show up in college. So we have ended up with a shortage of space on the campuses and a shortage of personnel.

It would have been pretty easily predictable. But every prediction they have made has been kind of an ad hoc one which ended up with them under predicting the number of students that wanted to come in.

Senator MURPHY. This is one of the outputs of bigness. Whenever you get into an industry, Government, State, or local problem, you have to have an accumulation of all the skill, all the knowledge, all the statistics, and put them together and then evaluate them quantitatively and come out with the right answer, which is exactly what we are talking about.

There is no question in my mind that this is the right approach if properly applied, not only the right approach, but it must be applied in the future.

May I be excused, Mr. Chairman? I have another committee meeting.

Senator NELSON. Certainly.

Senator JAVITS. I have one question.

Senator NELSON. Yes, Senator Javits.

Senator JAVITS. Would it be feasible, Mr. Enthoven, for you or your colleague Mr. Rowen, to ask you to submit an outline for how you would go about applying systems analysis to a specific subject?

For example, I would give you a choice of three. One, would be the medical care facilities of the United States which are under very great debate right now, especially in view of the imminence of the impact of the medicare legislation. Second, concerning this very discussion on education, what are the demands on elementary or secondary education? We have higher education legislation and we have more

coming. Third, unemployment. We have a bill going through this very committee which deals with new techniques for the Department of Labor in dealing with unemployment, consolidating the various functions which are intended to serve the unemployed in the State employment offices.

It seems to me it would strengthen enormously the case for Senator Nelson's bill if we could have some outline of the applicability of the systems analysis technique to a specific social subject. Naturally, you would not make a systems analysis of it, but you would tell us how you go about doing it.

I remember reading a book which impressed me enormously, possibly the most important book I ever read, which was called "An Introduction to the History of Civilization in England," written by Thomas Buckle in the middle 19th Century. He outlined how you would go about taking a scientific approach to the writing of history. That is what I had in mind with you.

In other words, would it be feasible to apply this technique to a subject by outlining how you would go about making a systems analysis that would be applicable to that subject?

I make that as a suggestion, Mr. Chairman. I think it might strengthen your case enormously.

Senator NELSON. I think it is a good question. I will be happy to have Mr. Rowen or Mr. Enthoven handle that. We have asked the aerospace industry to do exactly that. They will be testifying later on. We have had some preliminary testimony from them in California last fall.

As I mentioned, I think before you came, the State of California made four contracts with the aerospace industry. One of them deals with waste management, for example; one with the field of crime. We have asked them to testify, to explain how to use the systems analysis technique as applied to social problems. So that will be in the testimony.

But I will be very happy, if the gentlemen have the time, to have them add examples of their own, because I think it is a necessary part of the testimony.

Mr. ROWEN. We will be very happy to prepare, to take one of these and prepare an outline of how to tackle the problem, how to structure it, recognizing as you have said that we can't do it very quickly, because these are very complex matters.

Senator NELSON. If I may add one that may or may not be similar. I would just add this one. The question of pesticides. This is not the whole question of pollution, but is a very narrow and significant part of pollution.

I think it would be relatively simple to apply the systems analysis approach to the use of pesticides; that is, we could even just take one pesticide, or DDT. We know how much DDT we are putting into the atmosphere each year. We discover it is showing up in the Antarctic, in the fatty tissue of the penguin. We find it is showing up in the egg of the eagle. We find it is showing up in the fatty tissue of the muskie. We find it is having some effects on insects and worms in soil.

Now we are using it in this country in great quantity, but we have no notion of what the social and economic cost of using this particular

pesticide is in terms of the damage it is doing to marine life and to birds and animals, and so forth.

I think it would be fairly simple to set up a systems analysis approach to weigh the value of this versus the damage it is doing. If that one turns out to be a simple one to apply—

Mr. ROWEN. Let me look into it to see if it is possible.

Senator JAVITS. Thank you so much.

Senator NELSON. Mr. Rowen, did you want to make some comments on the testimony in general or the issues raised by Mr. Enthoven?

**STATEMENT OF HENRY S. ROWEN, ASSISTANT DIRECTOR, U.S.
BUREAU OF THE BUDGET**

Mr. ROWEN. I think my testimony will in large part accomplish that purpose.

Senator NELSON. You go ahead then.

Mr. ROWEN. Mr. Chairman and members of the committee, I welcome this opportunity to join in your discussions of the ways in which some of the new management techniques and particularly the techniques of systems analysis may be used to improve the effectiveness of Government operations. I would like to discuss three things with you this morning. The first will be the planning, programing, and budgeting system which is now coming into operation throughout the Federal Government. The second will be the kinds of analysis that underlie this planning, programing, and budgeting system and are crucial to it. The third will be my sense of the problems and the opportunities for the future in the broadening application of systematic approaches to Government operations.

I. PPBS

PPBS is a management system, internal to the executive branch, whose purpose is to produce better plans, more effective programs, and budgets designed to support those plans and programs throughout the executive branch. It is modeled on a system which Dr. Enthoven has described now in operation in the Department of Defense and it is intended to have two important effects on the governmental decision process. The first is that it attempts to improve the planning process, producing comprehensive, realistic, and effective plans for the use of agency resources. The second is that it ties such plans through a programing system to the actual operations of Government agencies and to their budget.

Senator NELSON. May I ask a question at this point, Mr. Rowen? You say PPBS is a management system internal to the executive branch. One of our concerns, of course, is that there is a decisionmaking problem in the executive branch but I assume you also agree that the system can be used for purposes of decisionmaking that has to be done by the legislative branch.

Mr. ROWEN. I have no doubt about it. In fact we actually encourage each of the departments that is installing this system to make available in testimony, presentations to the Congress, the results, the fruits of the analysis that they are now undertaking.

Senator NELSON. Proceed.

Mr. ROWEN. Why is PPBS needed? It is needed because the resources of the Federal Government, great as they are, are finite. They are not sufficient to meet all of the claims which are made upon them. Choices must therefore be made. Choices as to the objectives to be attained, choices as to the programs to reach these objectives, and choices as to level at which to support these programs.

The budget process is the mechanism by which those choices are normally made. However, budget requests submitted to the President and to the Congress too often have not contained adequate data and analyses necessary if the best possible choices are to be made, not only by the President but by agency top managements and by Congress. This, of course, is the situation that Dr. Enthoven described as existing in the Defense Department in 1961. It has been generally true throughout the Government.

The format of the budget has itself tended to obscure those choices. It has stressed organization rather than program. It also has focused on inputs, that is, the money and men and buildings and supplies going into our programs, and not the concrete accomplishments which those resources are being used to try to achieve. It also has been focused on the immediately following fiscal year and has thus made difficult the examination of long-term implications of current decisions. Analytic backup material, moreover, has rarely been available in the scope and comprehensiveness required for sensible decision; such materials that have usually been available have been produced under severe time pressure in the fall of the year. These conditions have made systematic study and comparison of the various competing requests extremely difficult.

PPBS is an attempt to improve that situation. It does this by requiring the preparation in each of the major departments and agencies of two kinds of documents. I would like to add here that also, of course, it involves more than just the preparation of some documents. It involves the introduction of the analytical competency of the sort that Dr. Enthoven has described in each of the departments where this does not now exist, or where it does exist, to strengthen this competency. In general this means creating new staffs made up of people capable of conducting and carrying out this kind of analysis, the staffs to have in them, in many cases, people drawn from within the agency where they have some competency. For example, in the Department of Agriculture there is a long tradition of not only having competent technical people but having competent economists on the staff. The systems analysis activity in the Department of Agriculture is staffed largely, perhaps entirely, by people drawn from within the Department. But, in general, it has been necessary to get quite a few people from outside, from universities, from nonprofit research organizations, from industry, to provide the expertise in these staffs.

Senator NELSON. Let me ask you a question there. With the Federal executive agencies moving into the field of systems analysis and thus making a demand for the various disciplines that are required to perform the function and hopefully with State governments and regional agencies moving into the field, will we have a problem of a shortage of available personnel to perform the functions we are talking about, that is, the interdisciplinary force?

Mr. ROWEN. We do indeed have a problem. We are taking some steps, which I will describe a little bit later in my testimony, to ease this problem. It is a problem that the country as a whole does not contain very many people who can do good analysis of this sort, and of course many of those that do exist in this country are in universities and in private firms. Part of our difficulty is attracting them, interesting them in working on public policy problems.

Senator NELSON. Are there two types of problems here, that is, the problem of finding the technical discipline, whether it be in physics or chemistry or economics—that being one manpower problem—the other being finding the really key man who is in fact from none of these disciplines but is, himself, a systems analyst?

Mr. ROWEN. It is a little bit more the latter than the former. Of course, there are many economists, many physicists, many mathematicians in this country, but the great proportion of these are interested in what I guess can best be described as classical problems, doing economics as it has been defined, as it has developed over the years, or doing physics and doing mathematics. This is not quite the same thing as working on problems of health, education, and the comprehensive systems in the problem-oriented sense that is needed. Dr. Enthoven described, for example, his illustration of the work at Rand years ago. The sort of person who has a good academic foundation and who is interested in these broader social problems and who is an organizer, which also helps, this sort of person is quite hard to find.

Senator NELSON. The systems analyst himself is a kind of generalist. He may not be from any discipline at all.

My experience as Governor was that we had one superb systems analyst who was trained as a budget analyst but somehow had the feel for administration, the understanding of the concept, the only really first-rate one that I ran across all the 4 years I was Governor.

So I am wondering, where do you get this fellow and are there programs for training people in the concept of systems analysis or is it just something that people learn in industry or in government just because at some stage they are compelled to start looking at the broader problem and happen to be broad-gage people who understand the broad concept and have a capacity for leadership and understanding what discipline is necessary to meet this total problem?

Mr. ROWEN. I think training is important. I think training really is of two kinds. Training in certain academic disciplines is really quite relevant. Training in quantitative methods is really very helpful. Training in economics is quite helpful. Engineering training is certainly relevant. But beyond that—and I think this is not sufficient—it may not even be necessary in some cases but it certainly is not sufficient, the best places to be trained today in this country are the comparatively small number of organizations that are doing systems analysis. On-the-job training is probably the best kind.

I would say today that these places are Dr. Enthoven's office; perhaps beginning about now in the Budget Bureau, where a small systems analysis staff is being created; the Rand Corp.; not a very large number but certain of the defense and space contractors; and defense, non-profit organizations, the Center for Naval Analysis, for example. The total number of such places that are good at doing this training in this country is not large, probably two dozen at the most.

Senator NELSON. Are any of our universities attempting to train this kind of person?

Mr. ROWAN. They are, within the limits of academic structure and traditions. Most of the people are being trained in physical sciences, in mathematics, in economics, although these disciplinary barriers are beginning to break down. There are places where people can get training in operations research techniques and in a range of quantitative studies; the Case Institute, for example. Also some of the business schools, good business schools in the country are teaching the students methods of the sort that are really quite useful, quite helpful in doing systems analysis. These are quantitative methods, operations research, economics. But universities are still not turning out well-rounded systems analysts. It is not possible to get a really decent degree in systems analysis today although there are approximations to it that are coming along.

Mr. ENTHOVEN. I might just add, Mr. Chairman, as one of the approaches that we have taken in the Defense Department to increase our homegrown supply of systems analysts, we have established a course that is run cooperatively by the University of Maryland and the Institute for Defense Analyses, the latter being a nonprofit organization which is a consortium of a dozen major universities. This is a 1-year, 12-month postgraduate course at the masters degree level.

Senator NELSON. For the specific purpose?

Mr. ENTHOVEN. Yes, for the specific purpose of giving military officers the training that they need to become good systems analysts.

In this program they are taught economics, mathematical statistics, mathematical operations research, and a course on defense analysis that goes into the politics of defense, international relations, the technology, and then in which the students review and analyze a number of the actual studies that have been done in the Defense Department. They take them apart and see what is good and bad about them and try to learn that way. Hopefully we will be able to tie this in with tours of duty right afterward in which these men will go to the various offices doing system analysis and thereby cement their learning with some practical experience on the job. However, I think this is only one of a number of approaches that need to be taken. We are a long way from being able to define what is exactly the best way to go about doing it.

Mr. ROWEN. I might add, following up on this Defense Department initiative, we are now in the process of arranging with 6 or 7 universities to have approximately 90 Federal employees spend a year in a similar program beginning this coming September.

Senator NELSON. To have 90 Federal employees—

Mr. ROWEN. Go to six or seven universities throughout the country to study these methods. Not defense, however. This is a nondefense program which will have a common core at each university of quantitative methods, statistics, economics, but with applications varying a good deal from place to place. Some will concentrate more, I believe, on water resources and transportation; some on human resources problems. The University of Wisconsin, for example, will concentrate on human resources. Education will also be emphasized.

Senator NELSON. The university as a matter of fact is underway now in establishing an interdisciplinary department.

Mr. ROWEN. So, with the six or seven universities beginning in September we will have the beginnings of what I hope will be a very useful program in training people—in this instance people who are selected from the Federal Government, civil service, who will spend an academic year doing this. But I hope also and expect that at these universities, students, both graduate students and undergraduates will become interested in these problems, will be exposed to some of the courses, and to the interest that will be generated—hopefully—on the part of the faculty in problems of this sort.

Senator NELSON. Isn't the concept of systems analysis fairly closely related to the whole theory of public administration?

Mr. ROWEN. Yes, indeed. The problems that are worked on can be public problems or private problems. Last night I was reading an account of how United Airlines decided to spend \$700 million on buying a new fleet of aircraft. There was no question about it that the techniques used were system analytic techniques. When applied to public problems this is an aspect of public administration.

Senator NELSON. We have schools of public administration. It does seem to me that in general the theories taught to an administrator encompass the whole idea of systems analysis, and that their training, and background, this kind of training and background would fairly well prepare them to be a systems analyst.

Mr. ROWEN. Yes. In fact, I hope and expect that schools of public administration will over time be doing much more to train their people in these techniques because they have not been in the forefront up to now in developing systems analysis.

Senator NELSON. You may proceed.

Where are you now?

Mr. ROWEN. I was speaking of the requirement of two types of documents. The first is essentially a rough and tentative multiyear budget—but in a revised format. This revision will group together, in categories representing the main objectives of the agency, all the various operations and activities intended to meet those objectives. In short, it is organized by program rather than by bureaucratic structure. Or I might add appropriation account.

Next, this document—which we call the program and financial plan—will attempt systematically to associate the sums requested with the specific accomplishments expected from each program; the number of children to receive preschool training and the number of hours of Spanish language broadcast of USIA, for example. And thirdly, the programs proposed by the agencies for the next budget year will be presented in the perspective of the tentatively outlined expenditures of the agency—similarly organized by program—over a number of future years. This will provide a useful long-term perspective against which to assess requests for the immediate future.

The second type of document required under PPB are studies which we are calling program memorandums, and which are similarly focused on major objectives or programs. These will describe expected accomplishments in concrete terms, show priorities among objectives and programs, present analyses of the probable costs and benefits of the recommended programs and compare them with alternative programs. These studies are to be the product of a continuous process of analysis and review within the agencies.

Senator NELSON. This is the kind of a proposal that is made by the executive branch to Congress or by the Congress which involves doing something and the cost of it for this year is X dollars. The program budget would require that you also give a prediction for some years in advance, that whereas, it is going to cost \$1 million this year, the program will cost \$50 million a year 5 years from now, so that the decisionmakers can decide whether or not what looks like a good program for \$1 million is in fact worth \$50 million.

Mr. ROWEN. This is one aspect, Mr. Chairman. In some cases when we make the decision now we are locked in for the future. For example, when the decision is made to build the 200-billion-electron-volt particle accelerator which has a capital cost of the order of \$300 million, it is quite clear we are committing ourselves to a stream of operating costs in the indefinite future amounting to \$60, \$70, \$80 million a year.

Now, we all generally know that but it is not really built into the system in a way that makes it possible for us to record that future commitment, that stream of operating costs that we know we are committed to make in the future along with other future commitments that we are also making. So that we for one thing, for example, can see how much flexibility we have in the future, what new areas we can expand into, given the extent of our commitments. We cannot do that very well today. We have not had a system.

Now, in other areas, of course, we are not tied into the future. For example, in title I of the Elementary and Secondary School Act we are not committed to any given amount 5 years from now. It is possible, however, and desirable for the Department of Health, Education, and Welfare to produce a specific proposal, to produce a theory, a theory supported by evidence, data, analysis, which would suggest what should be the level at which we should support elementary and secondary school education and health and other programs. Here it is somewhat different. It is not a matter that we are committed in the future. It is that we need to know what theory we are operating under, what we are trying to accomplish, and how much money it looks today it is going to take 5 years from now in order to meet certain objectives.

Senator NELSON. Will the end result of the development of a program budget not only be that each agency will be required to state the given cost of any particular project within the agency of which HEW may have a thousand, and predict what the cost will be 5 years from now, but that also the net product of this whole evaluation will project all budget commitments as of today, showing what costs are involved 5 and 10 years from now? Is that one of the objectives?

Mr. ROWEN. Yes. It certainly is important that we have a clearer sense of future commitments. And I mean commitments. This is the first category, the building of a 200-billion-electron-volt particle accelerator that does involve important future commitments. We need to know; we need to rack up all future commitments made year by year, made by past decisions, and made by current decisions.

We need to do more than that. We need to explore various sorts of options, alternatives, ways in which we can move, to see what looks attractive, to see what objectives look feasible, look interesting, are likely to be achievable with any reasonable budgetary levels. So, it is

not just a matter of recording future commitments that we make, it is also a matter of really exploring to see what the choices are that the President and the Congress should focus on, and do so in a better informed way than we have so far.

Senator NELSON. So that if budgetary requirements really do demand that an election be made between one program and another, at least you have enough information before you to say that though both programs are fine we cannot afford them and we can make a decision as to which one will be frozen or eliminated, at least we would have enough information to make the election.

Mr. ROWEN. Well, more information. The millennium is not about to arrive, but we shall have better information, better analyses on which to make decisions.

This system was ordered into effect by the President last August and it is clear that it will take a good deal of time to get the system operating as we want it to. But this should not be surprising. Good analysis of complex public problems understandably will take time. It calls for a process of successive approximation and refinement which will have to go on indefinitely.

II. ANALYSIS

Next, I would like to say something about the kinds of analysis which should be performed. The PPB system provides a setting in which a better basis for decisionmaking can be worked out and implemented. But it provides no automatic guarantee that agency plans or proposals will be better based. That depends on the quality of the analytic work which underlies those plans. Good analysis is crucial.

Systematic analysis is the subject of a good many misunderstandings. Probably the most dramatic and misconceived is what might be called the black box syndrome. The analysis of alternative methods dealing with broad social problems cannot be produced from machines; not just from machines. PPB is not a computer operation, though computers may be helpful from time to time. Nor can the thinking that must underlie well-worked-out agency plans be produced by machine-like analysts. Most problems of importance are simply not susceptible of solution merely by highly abstract mathematical or economic techniques, though some capability for dealing with numbers is important. A point that Dr. Enthoven mentioned.

The real nature of the analysis which major social problems require is a good deal more commonsensical. First, it requires a precise statement of objectives; not, for example, "the development of a safer civil aviation system," but rather, for example, "the reduction of the civil aviation accident rate by 10 percent annually over the next 5 years." That has some bite to it. That can mean something. That leads one directly into programs to see if this can be done. This is just one example. I don't mean to attach too much importance to it.

Second, it involves the better measurement of costs. Costs in this context means not just the costs of a particular program to a particular agency but the whole cost of accomplishing an objective; that is, the full system costs. This is particularly important in the nondefense field. The Defense Department is not quite the whole owner of our national security. We do have allies that we depend on, but in the

nondefense field the Federal Government quite often finds itself very much a minority stockholder.

In education, for example, the Federal Government is putting up 10 percent approximately, I suppose—less than 10 percent—of the total national bill for education. In health, similarly. The Federal Government's stake is rather small in proportion to the total effort, both public and private, in the country. In crime, the Federal role is rather limited. The local role is very important; it is dominant in fact. So that when we analyze health and education and crime, we have to do it, and when we look at our programs from the point of view that we cannot look at the Federal effort in isolation, we have to look at what is being done, what is the situation in the country as a whole. This is true not just of costs but measuring benefits as well.

This kind of cost estimation is hard and unglamorous work but it is essential. Next, we need better estimates of the benefits of proposed programs. Benefits are hard to measure well, especially in the case of new and untried programs. Moreover, benefits are often not truly expressed by simple mechanical measures of output, like the number of acres reclaimed or number of cases brought to trial. Many important benefits can't be qualified easily, or at all. But numbers can tell us a great deal. Mortality rates, school dropout rates, real income levels, unemployment figures—all these can be used to attempt to estimate and state with some precision what a proposed program is going to attempt to accomplish.

The next requirement of good analysis is that it develop and examine alternative methods of reaching program objectives. This is an effort which requires inventiveness and imagination. But there can be no assurance that a proposed program makes sense unless a variety of other methods for attempting to reach the same objective have been exploited. And the final step in this cycle of analysis is the review of the original objectives in the light of the costs and of the probable effectiveness of the programs which can be designed to attain them. It is only when one knows what it will take—in money, in men, in time—to reach a given objective that one knows whether it was a sensible objective to establish in the first place. And even then, the process isn't over. It's a continuous process. You can't pick objectives first and say this is what we are going to accomplish, and then go through a deductive process at the end of which drops out the money required to do it, and expect this will be a really good optimum program. Instead, one has to work through this process many times to get a feeling for what other resources are available, what will it cost; it is not one objective but a variety of objectives, different kinds of things, different levels, and to go through this process quite a number of times before one can get a feeling for anything like a good solution.

Mr. ENTHOVEN. Another way of putting that is that one has to recognize that ends and means interact. What is worth attempting to do depends on how much it costs to do it. After you have found out how much it costs to try to achieve an objective then you should go back and reconsider the objective. If the costs turn out to be low you consider more ambitious objectives, or if the costs turn out to be high, you consider less ambitious objectives.

Mr. ROWAN. I might add that there appears to be a widespread belief that this kind of analysis, though feasible for programs of

defense, is not applicable to other concerns of Government. I think we have discussed that point at length. I don't share that belief. Though the analysis of social questions is necessarily difficult, there are some domestic, social problems which are easier than some problems of defense and of foreign policy. For one thing, objectives in health and welfare and education may be somewhat easier to define than those of defense. To be very specific, in the case of health we have mortality figures which mean a lot. These are numbers that have some compulsion. We know something about the incidence of various kinds of diseases, tuberculosis, more concrete to get a grip on than deterrence, for example.

For another, better data are often available on civil problems—and where necessary more data can be produced by testing and experiment. This is not always possible or desirable in defense problems.

The qualities which are required for good analysis are principally these: A dedication to the idea that objective standards of cost and performance ought to be applied to governmental programs; this is simply a willingness to follow the logic wherever it leads. Secondly, the instinct to see the problem whole—and to see it systematically. Thirdly, the possession of simple, quantitative skills, and a sensitivity to quantitative differences.

This kind of analysis produces no certainty. It cannot, because some of the relevant factors are unknown and indeed unknowable; for example, the unemployment rate during 1968—and because much that can be known is known only imperfectly—an example of this is our data on crime rates. Lastly, there can be no certainty because even where the data are wholly adequate, the techniques of analysis are not perfect. No matter how well performed, therefore, analysis produces answers which are in many cases only partial and in all cases subject to uncertainty.

But partial and uncertain answers are helpful. They can suggest the reduction or elimination of some programs or activities which are clearly ineffective and indicate that we concentrate on others which look better. Further, they can identify the key variables which may deserve more study, or require testing or which may simply be watched as the passage of time improves our understanding.

Finally, the kind of partial and uncertain answers that systematic analysis produces may suggest whether a subject is ripe for current decision at all and, if so, how much should be decided now and which decisions might better be deferred until our understanding is improved.

This leaves the decisionmaker essentially where he has always been and where he always will be: Forced to use his own judgment, intuitions, and faith in determining what to do and what not to do. But that judgment and faith can be far better informed than they now typically are, better aware of costs, more sensitive to alternatives, equipped with estimates of likely benefits, and conscious of the relevant criteria.

III. OPPORTUNITIES AND PROBLEMS FOR THE FUTURE

Finally, I'd like to discuss with you some of the opportunities which I believe this system, or others like it, may hold for the im-

provement of the effectiveness of State and local programs and some of the problems which may tend to retard that effort.

Plainly, a management system which stimulates better analysis and then applies the results of that analysis to governmental decision-making can be useful at any level of government at which resource allocation decisions are made—in State government, city government, county governments. All of these levels of government deal with problems comparable to those of the nondefense Federal agencies: Health, education, poverty, justice, housing, employment, natural resources. The usefulness of such a system at the State and local level should have at least two aspects:

First, it should make possible a better and more effective utilization of State and local resources in the same way we expect it will stimulate better utilization of Federal resources; by improving our understanding of the problems to be solved, and our ability to estimate the probable costs and effectiveness of the various measures which can be taken to solve them. In addition, however, State and local systems comparable to PPBS will have the important ability to help us better relate local efforts to Federal efforts; in all of the areas that I just mentioned, Federal, State, and local efforts are involved. It is important that we learn more than we now know at each level of government about the plans and programs of the other levels. Ideally, indeed, for each State and local function which parallels that of a Federal agency, all the State and Federal agencies would eventually work out comparable planning, programing and data systems. I would emphasize that while systems should be comparable, they need not be identical. All that is necessary is that each level of government understand what the other level intends to do.

Some efforts along this line have in a very preliminary and tentative way already begun. The Bureau of the Budget, for example, is taking a lead in organizing a cooperative pilot project to develop programing systems for several program areas which involve substantial Federal financing. For these programs, multiyear PFP's will probably be developed by five States, five counties, and five cities in a joint effort.

Additionally, several States—New York and Michigan among them—have expressed interest in the operation of the Federal program and financial plans. The city of Portland, Maine, is also interested in exploring the possibility of devising such a system for its own use. And the city of Detroit and the Department of Housing and Urban Development are now attempting to work out jointly a system for the planning and programing housing efforts for that city. It is still far too early to report any accomplishments, however, and there are many problems to be solved before we can expect the maximum benefit from governmental management systems based on intensive analytic work. One problem you alluded to, Mr. Chairman, and that is the problem of finding people.

One of the problems associated with the wider use of systems like PPBS at other levels of government is clearly the need for a wider understanding of the value of serious analytic work and of its nature—there are still probably too many citizens and local officials who are uninformed as to systems analysis or whose hopes or fears

for it foresee machines operating inexorably in some automated decisionmaking process.

But there are two much larger problems: The first is that of using better than we do now the analytic talent we currently have. The second is that of developing additional analytic capability and of deploying it more intensively on problems of public policy. The subcommittee will understand, I hope, that my purpose here is not to propose specific plans of action but only to stimulate thought.

Under the heading of better utilization of existing analytic capability, a number of things might be said. First, much of present systems analytic ability is associated with the so-called hardware industries and especially those involved in defense and space activities. The four Aerospace Industries studies which were done for the State of California demonstrate, however, that the analytic techniques developed in those industries are relevant to problems of State and local governments, and those studies demonstrate also that a number of such firms may be interested in working on broader social problems and have something to contribute to their solution. The current work now being done by computer manufacturers on analysis of the learning process and the design of machines to accelerate learning is another case in point. The analytic capabilities already well developed in private industry should be encouraged and utilized by government at all levels wherever they appropriately can.

Secondly, there are a number of existing nonprofit organizations for research and analysis. These, too, have tended to focus on problems of defense but these, too, might be interested in problems of State and local governments. Indeed, they are being drawn into consideration of Federal nondefense problems through the increased research and analytic requirements of Federal agencies. Here again, existing pools of talent can be used to produce analyses of nondefense activities.

Thirdly, State and local governments, like the Federal Government, may find the universities, and especially the schools of business and departments of economics to be good sources of analysis and of analysts.

Over the longer run, however, it is my belief that additional analytical capability will have to be developed and that new organizational forms might well be appropriate to insure that those capabilities are effectively used.

One way of producing additional capability is obviously to have training and familiarization courses, of various lengths and intensity, for governmental employees. The Federal Government has found this useful in connection with the establishment of PPBS. State and local governments may wish to use similar programs. In addition, State and local governments, like Federal agencies, may well want to recruit trained analysts directly for work on analytic staffs at all levels. Such a recruiting effort would soon run into the fact that the number of trained and capable analysts is extremely limited. It may be, therefore, that over the longer run we are going to have to look to the universities to produce a greater number of such people. I really should not have expressed that so weakly. It is clear we shall have to look to the universities to do this.

Finally it is probable that there will develop specialized centers at which our major domestic problems—transportation, housing, crime, health—will be continuously under study. I noted earlier that the analysis of some civil problems was easier than the analysis of some problems of defense. Defense studies now have one great advantage however. Good analysis of hard problems takes time—the persistent application of intellectual effort to a limited range of related issues over a period of years. These conditions are met in a number of defense-oriented organizations—RAND, RAC, IDA, CNA, among them, and the contribution of these organizations to our understanding of the problems of defense has been very great indeed. But very few similar institutions exist which are devoted to nondefense issues. We come closest in the area of medicine and health. But what is needed are centers for the study and analysis of all major social problems. These would serve many purposes. They could bring together and focus the work of analysts now working separately. They could stimulate interest in social problems in analysts not now working on them. And finally they could provide a training ground for analysts who might later work directly in the Government.

You will recognize, I think, that these ideas are preliminary and tentative. Much needs to be done before we will know how we can most effectively aid State and local efforts to better utilize the analytic skills which are proving helpful at the Federal level. But I believe that these hearings can be helpful in that effort, and I am pleased to have been able to take part in them.

Senator NELSON. Thank you. Would there be a value in Congress, itself, or any legislative body having an independent systems analysis capability.

Mr. ROWEN. That is a very large question indeed.

Senator NELSON. Let me put it this way. Can the executive branch, at least in terms of all of the agency functions, effectively perform that function and furnish the Congress the information or does Congress need some independent systems analysis agency of its own?

Mr. ROWEN. I really am uncertain on this. I think the executive branch can do an awful lot better job of supplying the Congress with data and analyses than it has done in the past. I am quite clear on that.

Now, given the improved effort, the improved performance on the part of the executive branch which we are trying to undertake, how much more the Congress would want to have by way of analysis which could not be, for whatever reason, provided by the executive branch, I don't know. In a way we are trying out that experiment in introducing this system and with the expectation that the Congress will receive much better data and analyses than it has in the past.

Senator NELSON. Or if not an independent systems analysis agency of its own, qualified analysts on each committee who are able to evaluate with some independence the work of the executive agency.

Mr. ROWEN. Yes. I think one problem here would be a critical mass problem. It is very hard for an individual or a very small group of people operating more or less by themselves to really have the sufficient skills, to have the breadth of experience, the breadth of technical skills available to them which really is important. This, of

course, has been a problem in congressional staffs, the question of size, and getting built into these staffs the appropriate skills. It would be a hard thing, I suspect, to have each committee supplied with the relevant expertise in systems analytic terms, especially in the short run, because of the shortage problem that we have discussed.

Senator NELSON. I would assume that all analyses done by the executive agencies with the various alternatives would be submitted to the Congress in any event. In other words, after analysis and a projection of the budget by any department or agency, the executive branch is going to make some recommendation between competing claims. I assume that the Appropriations Committee and the appropriate committees of the Congress would have received all the benefit of all the background and the reasons for the decisions made in their recommendations by the executive branch.

Mr. ROWEN. We intend that the Congress receive the substance of the analyses that have been done. The specific documents, however, that I have referred to are budgetary documents, the program and financial plans. On the other hand, we hope and expect that agencies will draw on these and make the materials available to the Congress. In fact, a good deal of value of the system will be lost if this is not done.

Senator NELSON. One of the main objectives of the bill is to provide appropriations to industries and to State governments for the purposes of systems analyses. The State government may make contracts with private industry under this bill for analysis. What value do you see in the Congress, the Federal Government, and the State governments for using the Rand Corp. type of agency to evaluate social problems?

Mr. ROWEN. I think the value, over time, is going to be enormous. I have no doubt about this. I think the immediate problem for State and local governments as of right now is building up some internal competency in this area. It is very difficult, I think, right now for most State, city, and county governments to do this. If they had money, for example, to do this right now they would find it very difficult in most areas to know how to frame the issues and how to use the results. I think that Dr. Enthoven could speak to this in connection with the Defense Department. I have no doubt at all that the effectiveness of outside organizations such as the Rand Corp. or the aerospace companies has been very much increased, enormously increased, by the existence inside the Defense Department of a competent group of people who can take the results and assess them and do some independent analyses of their own. This is what worries me right now about the state of affairs in most State or local governments. There is no place to plug in the results in many cases.

If I may just add, we are working on this very actively in this pilot program we are doing, carrying out with five States, five cities, five counties.

Senator NELSON. Have you selected those yet?

Mr. ROWEN. Yes. We are working with the Council of State and Local Governments, League of Cities and comparable county organizations. Those cities, States, and counties which have expressed interest and decided they want to join in this cooperative venture have all been selected. We are now into the process and I hope within

the next few weeks a contract will be signed which will permit the work to get started. Now this is potentially a very important move. This will be the first time a systematic, sizable effort has been made to get State, city, county governments into the program budget and systems analysis business, certainly on the part of the Federal Government.

Senator NELSON. I think this is a very fruitful and creative idea.

As you are aware, this is one of the problems. Problems do cross county lines, village and town lines and so forth. For example, the metropolitan area of New York has the incredible situation of some 1,400 various units of government. I think the State is no doubt the best regional government in America. It is a regional government in a sense.

My question is: Have you made a contract with any regional planning commissions for this particular program which encompass a number of counties?

Mr. ROWEN. I am not aware that any such contract has been let. The 701 money that you mentioned earlier is of course relevant in this connection. It is my understanding that this money on the whole has been used much more for traditional land use planning, to some extent transportation planning, and not the full-blown systems analysis approach that we have been discussing today.

Although I do not mean to depreciate the value of this other work, I think it has been moving in the right direction, it just has not gone far enough.

Senator NELSON. The reason I raise that is that there are very few regional planning commissions in the United States and as of 1959 when I was in State government there was almost none or only a few that weren't doing much.

Since then some regional planning commissions have been developed which do cover a number of counties and which with 701 grants are doing a comprehensive analysis of the whole spectrum of problems that confronts them, including transportation, education, recreation, welfare, sewage disposal, and so forth.

I would think that it would be valuable. I think the best one there is in the State of Wisconsin, the Southeast Regional Planning Commission. They have received national recognition now because they are taking on a large metropolitan area which would include Ozaukee County, Milwaukee County, all of Waukesha County, Kenosha County, Racine County, all the way down the Illinois line. It must involve a million and a half people I should guess.

Regional planning commissions are going to become of increasing importance simply because you can't settle your institutional transportation and municipal sewage problems within the particular unit of any particular municipality or county.

I would hope that you would consider using at least one regional planning commission in this program. This kind of concept of regional planning commissions and regional approach to the problems is going to become of increasing importance.

As a matter of fact, I don't see how any metropolitan area can solve its problems without using the concept of the regional planning commission and regional programs.

Mr. ROWEN. We are very much interested in doing just what you are suggesting. The Department of Housing and Urban Development and Economic Development Administration, just to mention two agencies, are particularly interested in exploring and doing just this, finding ways of building up and improving the quality of the work of the relevant governmental jurisdictions, which in the case of metropolitan areas will be primarily these regional ones rather than the fragmented ones.

Senator NELSON. I think those are all the questions.

Do you have anything you would like to say, Dr. Enthoven?

Dr. ENTHOVEN. No, sir.

Senator NELSON. I assume after we have looked over the testimony and the questions, some other questions are going to occur to us based upon subsequent testimony. If we submit those in writing to you, you will be willing to respond to them?

Dr. ENTHOVEN. Yes.

Mr. ROWEN. Yes.

Senator NELSON. In response to Senator Javit's question, I do think it would be very valuable if you could give us an example of how you would apply the systems analysis technique to a social problem.

Mr. ROWEN. We will be very happy to do so.

Senator NELSON. I find what is most difficult in talking to people is that the concept is not understood at all. This is what we are attempting to do, to get the aerospace industry in simple testimony, as to the contracts they handle in California, to give us a simple explanation of how it is done and what its value is and how it can be used by decisionmakers. If you can give us an example or two, I think it would be very valuable in our testimony.

Mr. ROWEN. Yes, indeed.

Senator NELSON. Thank you very much.

(The material referred to had not been supplied when this hearing went to press.)

(Whereupon, at 11:45 a.m., the subcommittee recessed, to reconvene at 9:30 a.m., Wednesday, May 18, 1966.)

SCIENTIFIC MANPOWER UTILIZATION ACT

WEDNESDAY, MAY 18, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON THE
UTILIZATION OF SCIENTIFIC MANPOWER
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The subcommittee met at 9:30 a.m., pursuant to recess, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the subcommittee) presiding.

Present: Senators Nelson and Murphy, members of the full committee.

Senator NELSON. This morning we will resume hearings on S. 2662, a bill to mobilize and utilize scientific manpower of the Nation and to employ systems analysis and systems engineering to help the employed manpower resources, the Scientific Manpower Utilization Act.

The first witness this morning is Mr. William Gorham, Assistant Secretary for Program Coordination of the Department of Health, Education, and Welfare, formerly Deputy Assistant Secretary for the Department of Defense.

Mr. Gorham, will you proceed?

STATEMENT OF WILLIAM GORHAM, ASSISTANT SECRETARY FOR PROGRAM COORDINATION, U.S. DEPARTMENT OF HEALTH, EDU- CATION, AND WELFARE

Mr. GORHAM. Thank you. I have with me Mr. Bateman, a senior systems analyst from my office.

Senator NELSON. I would suggest then, as I did a moment ago, that I did not have an opportunity because I was out of town yesterday to read your statement in advance or I would have had some questions prepared. So, if you will read it, I will attempt to ask some questions as you go along. It would help the record if you think of something to elaborate on, if you will do it and if your assistant and Mr. Ross would both interrupt you at any time with a question or with an observation so that every point of value will be in the record.

Mr. GORHAM. Mr. Chairman and members of the subcommittee, I welcome the opportunity to appear before you today to describe the application of programing and systems analysis being made in the Department of Health, Education, and Welfare, and the contribution

which these techniques can make to more effective management, direction, and coordination of the Department's programs.

Over the last year, the administration and the Congress have compiled an impressive record of legislative achievement. But, as you know, effective government does not end with developing, recommending, and enacting good programs.

We have a dual responsibility—to the taxpayer and to those who benefit from these programs—to make sure we are achieving our overall objectives in the most efficient and effective manner. The introduction of a planning programming budgeting system in DHEW and throughout the executive branch of Government will go a long way in helping to achieve this goal.

If I might add at this point, Senator Nelson, the focus in social programs has been so much on getting attractive new programs through, that insufficient attention has been paid in the past to the balance of programs; that is, the level at which these programs go in.

Senator NELSON. Are you making the point that it is not possible under the present circumstances for either the executive branch or the legislative branch to take total look and make any evaluations as to selecting one program versus another or predicting the total cost of all programs or projecting the total cost of each program?

Mr. GORHAM. Exactly. Each new baby is held up and the question is asked. Do you want this baby? The Congress says yes or the Congress says no and they never look at the whole family together.

Senator NELSON. And then suddenly the baby grows up, too?

Mr. GORHAM. It does indeed.

Senator NELSON. Proceed.

Mr. GORHAM. Background and need.

The modest collection of disparate units elevated in 1953 to form a Department of Health, Education, and Welfare have grown both in size and complexity. The first budget prepared by the new Department totaled \$1.6 billion.

Today we have more than 90,000 personnel engaged in the administration and management of programs which account for almost \$10 billion of expenditures, or 20 percent of the nondefense budget of the U.S. Payments of about \$20 billion to the nearly 21 million social security beneficiaries will bring the fiscal year 1966 expenditures of the Department to more than \$30 billion.

Income supplements alone account for about \$23 billion. This includes social security and welfare payments.

Senator NELSON. Is there anything other than that?

Mr. GORHAM. No, the \$23 billion is for social security and welfare.

Senator NELSON. Do you have a breakdown on how much is welfare and how much is social security?

Mr. GORHAM. Yes. Would you like that introduced?

Senator NELSON. Yes.

Mr. GORHAM. Well, we will do that.

(The information requested follows:)

Expenditures of the Department of Health, Education, and Welfare for public assistance and social security¹

[In thousands of dollars]

	1965 enacted	1966 estimate
Grants to States for public assistance.....	3,059,498	3,223,900
Federal old-age and survivors insurance trust fund expenditures (benefit payments).....	15,225,894	18,125,000
Disability insurance trust fund expenditures (benefit payments).....	1,392,190	1,715,000
Miscellaneous trust funds.....	564	302
Total, social security.....	16,618,852	19,840,302
Total, public assistance and social security.....	19,678,350	23,064,202

¹ Source: 1967 Budget of the United States.

Mr. GORHAM. The remaining \$7 billion, matched in most cases with funds from State and local governments, is used to provide a wide variety of goods and services—hospitals, schools, occupational training, day care, research and development. The programs of the Department span the war on poverty; the prevention, control, and treatment of disease; the purity of our food, water, and air; the safety of drugs; and the advancement of knowledge through research and education.

The importance and scope of these programs and the desire to manage them effectively provided the original impulse to establish the Department in 1953. In his message transmitting Reorganization Plan No. 1 of that year, President Eisenhower noted that its purpose was "To improve the administration of the vital health, education, and social security functions now being carried on by the Federal Security Agency by giving them departmental rank * * *. The establishment of the new Department—will give the needed additional insurance that these matters will receive the full consideration they deserve in the whole operation of the Government."

Similar recommendations had been made many times in the past. In 1923, President Harding proposed a Department of Education and Welfare, which was also to include health functions. In 1924, the Joint Committee on Reorganization recommended a new department similar to that suggested by President Harding.

In 1932, one of the reorganization proposals of President Hoover called for the concentration of health, education, and recreational activities in a single executive department. President Roosevelt's Committee on Administrative Management in 1937 recommended placing the health, education, and social security functions in a Department of Social Welfare. This recommendation was partially implemented in 1939 by the creation of the Federal Security Agency.

A new department could not be proposed at that time because the Reorganization Act of 1939 prohibited the creation of additional executive departments. In 1949, the Commission on Organization of the Executive Branch of the Government proposed the creation of a Department for Social Security and Education.

The need for organizing the health, education, and welfare functions into a single department stemmed from the growing involvement of the Federal Government in such problems as education, poverty, and unemployment. As the Nation grew, these problems and the solutions to them transcended local and State boundaries, although, generally, the Federal Government has sought to preserve the responsibilities of non-Federal units of Government in achieving the national purpose.

The growth and diversification of Federal responsibilities alone would necessitate more central planning and direction of Federal programs. Equally important, the expansion of Federal programs has been accompanied by a division of responsibility among the various agencies for carrying out broad program objectives. Today, for example, the responsibilities for those programs aimed at breaking the cycle of poverty are found in the Commerce Department, Labor Department, Justice Department, the Office of Economic Opportunity, the Department of Health, Education, and Welfare, and I am sure there are others. Within HEW we have vocational education programs, programs of aid to elementary and secondary schools for children from low-income families, higher education programs for needy college students, occupational training programs for the unskilled and unemployed, maternal and child health programs, and juvenile delinquency programs.

Reflecting the fragmentation at the Cabinet level, these programs are the responsibility of many different bureaus in different constituent agencies within the Department.

It is important that decisionmakers at the highest levels of Government have measures of how effective these programs are, how they compare with one another in achieving our overall objectives, which should be expanded, contracted, modified, or eliminated, and whether other alternatives are available which will do a better job.

Let me say that one of the characteristics of social programs is that they are all attractive and therefore the need for evaluating the relative contribution of each is so much the greater. Social programs are very attractive for the Congress to pass. They are very attractive for the citizens who are affected. Therefore, evaluating the relative contributions of these many ways of effecting social welfare is very important.

Today, the achievement of many of our major domestic economic and social objectives frequently requires the participation of more than one bureau, agency, or department. In many cases, action taken by one organization has an important impact on the program of another. The lines of demarcation among the various agencies have become blurred and we must now focus on the overall requirements to achieve our domestic policy objectives. This is true not only with regard to the allocation of resources among existing programs, but also with respect to the development of major new ones.

Organizational problems:

While the conferral of Cabinet rank gave more visibility to the important functions being carried out by the Federal Security Agency, the creation of the Department did not automatically insure a more

unified and coordinated approach to the management and direction of programs. The first Secretary, as well as each succeeding one, was faced with an organization in which many subordinate units had been given grants of independent authority by the Congress. This general deficiency in departmental administration had been recognized by the Hoover Commission in 1949 which recommended that such practices be eliminated.

When the Department was created there was a large body of legislation which existed with respect to the individual agency making up the Department. This legislation was not overhauled in 1953; so you continued to have special and individual relationships between the Congress and the constituent agencies. The Secretary in short did not have the authority which went with his overall responsibility.

Senator NELSON. Aren't there two aspects to the problem? One of them is the problem of using some technique, here we are talking about systems analysis, for the purpose of making a total evaluation of programs of a particular department, objectives of those programs, the cost of those programs, securing enough information so that both the executive branch and the Congress can make some determination as to the comparative value of the programs and enough information to make a decision as to whether the program ought to be continued or reduced or terminated or expanded. What about the other aspect of the question, the internal management of the programs themselves?

That is, is it not possible to use the same technique of systems analysis to evaluate the administrative performance of the agency in carrying out social programs that are delegated to it by the Congress? Is there, for example, within the Federal Government—within the Federal agencies any kind of what you might call or what I have always called performance cost accounting?

In other words do we use a team from outside of the agency continuously examining the methods of production, so to speak, as you would in an industrial plant to determine whether or not they have too many stenographers, too few, or whether they are using them in a pool system or some system that is best, whether or not there is an overlap of duties within the department, whether space is being efficiently utilized, the whole business of the mechanical administration of a large agency?

Do we have a function being performed like that?

Mr. GORHAM. I think the agencies for some time have had management review concepts which did more or less rely on evaluative techniques, quantification, work measurements, and a whole set of individual time honored techniques. I think that the rubric, systems analysis, has generally been applied more to decisionmaking at more aggregative rather than to detailed management of programs.

Senator NELSON. Is there any reason why you could not use the system to look at the mechanical administration, itself? We initiated such a program in Wisconsin of using teams of experts, not part of the agency, itself, but working with the agency. A team of personnel experts, a space utilization expert, accounting expert, and a good team to go in, then in association with a team of people working in the department, itself, take a look at how the department itself functions. This would be done on a continuous year around basis.

We found out in our State that we could make some very substantial savings in space utilization alone. We were paying for new buildings \$40 a square foot. So any time you save a foot you save a lot of money. I am wondering if that kind of performance cost accounting so to speak is utilized in the agencies?

Mr. GORHAM. I think if you look closely you will find a very spotty situation. You will find some agencies which use very effective techniques of management control and some where the techniques are somewhat more archaic. I have not made such a review, myself.

Senator NELSON. I take it that it is not then the policy from the administration standpoint, the executive branch standpoint, to have outside teams working in association with the agency people themselves?

Mr. GORHAM. I think they sometimes do that, Senator Nelson. I can think of one or two occasions in the Defense Department when we in fact did bring in management consultant firms who worked with people in the agency to review a particular function.

Senator NELSON. But the Department, itself, brought the management people in?

Mr. GORHAM. Yes.

Senator NELSON. What I am trying to get straight is whether or not the executive branch, using its own personnel, has outside teams working on just management problems within the agencies?

Mr. GORHAM. I am not entirely familiar with this. It is not proper for me to talk to it. I know that the Bureau of the Budget does have teams that work with the agencies on particular functions. Again, harking back to my defense experience, in the major studies of the manpower control system of the entire Defense Department last year, the Bureau of the Budget, the Office of the Secretary and the services were involved in each of these studies.

Senator NELSON. Thank you.

Mr. GORHAM. As I said above, the Hoover Commission recommended that grants of independent authority to subordinate agencies be eliminated. Needless to say these reforms did not take place overnight. In fact, they are still going on. On April 25, the President transmitted to the Congress Reorganization Plan No. 3 of 1966, providing for a reorganization of the Public Health Service. As pointed out in that message, the structure of the Public Health Service, as presently constituted was designed at a time when administrative arrangements for health research, programs of State and local aid, health services, and executive staff resources, could be neatly compartmentalized.

Today, however, the Department supports major health programs which are not carried out through the Public Health Service. Although the Secretary is responsible for the administration and coordination of all the Department's health functions, he has lacked essential authority over the Public Health Service.

The functions of that agency are vested in the Surgeon General and not in the Secretary. The same is true in the Office of Education with respect to the Commissioner.

Reorganization plans are designed to correct just such circumstances. As set forth in the Reorganization Act of 1949, one of the

primary purposes of reorganization plans is "to promote * * * the more effective management of the executive branch of Government and of its agencies and functions, and the expeditious administration of the public business."

Senator NELSON. Do you mean that the statute, itself, does not give the Secretary authority over the Public Health Service?

Mr. GORHAM. That is right.

Senator NELSON. So that by law this function is simply housed there?

Mr. GORHAM. I think that the body of law which existed when the reorganization took place in 1953 was not readjusted for the existence of a Cabinet-level Secretary. So that many of the authorities and responsibilities are still vested in the Surgeon General. There was no legal basis in 1953 placed at the disposal of the Secretary to give him complete responsibility and authority over all the agencies over which he had, theoretically, control.

PAST SHORTCOMINGS IN THE DECISIONMAKING PROCESS

But reorganization plans alone are not enough. In addition to the authority necessary to run the Department on a truly unified basis, the Secretary must have the tools to coordinate the activities of the separate agencies. Until now, the Secretary has lacked these tools. Because of this, he has resorted in part to what has been called the budget ceiling approach to departmental management.

The President, through the Bureau of the Budget, would indicate the general level of expenditure believed to be appropriate and the Department, by one means or another, would allocate this figure among the various agencies. In turn, each agency would prepare its budget submission, allocating its ceiling among its various program responsibilities and present additional requests which could not be accommodated within the ceiling. All the budget submissions were then reviewed together in the Office of the Secretary in an attempt to achieve program balance.

Each agency tended to exercise its own priorities, often laying the groundwork for a larger share of the budget in future years by concentrating on popular new programs and proposing expansions in existing programs which were most likely to win congressional approval.

Moreover many proposals for modifying or expanding existing programs or introducing new programs came and will continue to come from within the Office of the Secretary, from independent groups commissioned by the White House, and the White House itself. It was often impossible to evaluate these program proposals in terms of their long-range funding requirements, their impact on existing programs, and their relative effectiveness as compared with other alternatives for achieving the same objectives.

The end result was not always a balanced set of programs.

An attempt to improve the situation was undertaken several years ago by requiring the agencies to submit a 5-year budget plan. Although this represented a useful start in bringing more centralized direction and management to the programs of the department, the

5-year budget plan was prepared around organizational lines; in many cases alternatives to existing programs were insufficiently presented, and the objectives of each organization when stated at all tended to be stated in absolute terms.

In August 1965 the President directed each of the executive agencies to introduce a new system of planning-program-budgeting system (PPBS) into their operations as a means for achieving more effective coordination and direction of Federal programs.

As Assistant Secretary for Program Coordination it became my responsibility to implement PPBS in the Department.

PPBS, if successful, will place in the Secretary's hands the information and analysis necessary to make good decisions regarding the allocation of resources among the existing and proposed programs of the Department.

Senator NELSON. May I interrupt here? I take it that as soon as all the information is developed under a planning-programing-budgeting system it will be available in document form to the Congress itself.

Mr. GORHAM. I am sure that is so.

I would like to spend the next few minutes describing the program system we have developed for HEW.

The principal problem in developing a departmentwide program system was grouping the existing programs and activities into categories which assist the decision process. Since the unifying principal underlying each major program category must be a common objective or set of purposes for the programs involved, a review of the objectives of all departmental programs was the first step in developing a program structure.

The program structure which we developed, groups all of the activities and responsibilities of the department within six major program categories. These are—

- I. Human investment programs.
- II. Income and benefit programs.
- III. Institutional development and community improvement programs.
- IV. Research.
- V. International programs.
- VI. General support.

Program category I, human investment programs, contains those programs designed to increase the income earning capacity and improve the functioning of individuals and families. They include education programs aimed at raising the future income of children from poor families and providing financial support for needy college students; occupational training programs for upgrading the skills, income, and employment potential of the unskilled, the handicapped, the unemployed, or the underemployed; and other programs for raising the capabilities of individuals and families to better care for themselves. Some specific examples are title I of the Elementary and Secondary Education Act, higher education work-study programs, MDTA, vocational rehabilitation, and homemaker and home management services.

Income and benefit programs are comprised of the social insurance and assistance programs designed to provide individuals and families with supplements to their current income. These programs may take the form of cash payments, or goods and services either provided directly or for which reimbursement is made.

The cash payment programs include OASDI, old-age assistance, aid to the permanently and totally disabled, aid to the blind and aid to families with dependent children.

The programs which provide goods and services include medicare, medical assistance for the aged, the vendor payments for medical care made under the public assistance programs, and the medical care programs for Indians, merchant seamen, Coast Guard personnel, and others.

While some of the expenditures in program II are complementary to those in program I (for example, assistance payments to AFDC families, combined with work-experience programs funded under title V of the Economic Opportunity Act—both Welfare Administration programs), over the longer run, they are clearly substitutes for many subgroups in the population. To the extent that our investment programs are effective in raising the earned income of those who are not now capable of fully or even partially supporting themselves, the demands on our public assistance programs will be reduced.

In program III, institutional development and community improvement programs, are grouped the programs for augmenting the resources of other governmental and nongovernmental institutions devoted to the health, education, and well-being of the general population, and the programs for stimulating new innovations in these same areas. On the whole, the programs in this category are grouped more or less around organizational lines.

They include general public health programs aimed at the improvement of the physical environment, the control of specific diseases and the support of institutions providing health and medical care; educational assistance programs for supplementing the resources of educational institutions and increasing the supply of trained scientific and technical personnel engaged in health, education, and welfare activities by the Federal and non-Federal sectors; and the programs of innovation, demonstration, and technical assistance for improving the effectiveness with which health, education, and welfare services are delivered.

Program IV, research, contains those programs which are aimed at gaining a fuller understanding of physical and social processes and human behavior, for developing new knowledge and techniques for improving the Nation's health, for investigating new educational methods and new techniques for transmitting knowledge and information.

Program V contains those programs designed to support the health, education, and welfare programs of other nations.

In the final program category, general support, appear the costs of administration and management which cannot be directly allocated to the mission programs.

Within each major program category there are intermediate aggregations of departmental programs that have closely related character-

istics. The lowest level of aggregation within a major program category is defined as a program element. There may be as many as four levels of subclassification within a major program category. An example of the program substructure is shown below:

	Aggregation level				
	1	2	3	4	5
III. Institutional development and community improvement programs	3				
General public health		1			
Environmental health			1		
General environmental health				01	0
Air pollutants				02	0
Water supply				03	0
Disease control programs			2		
Heart disease control				01	0
Cancer control				02	0
Neurological and sensory disease control				03	0

Financial information is disaggregated at each level in the program structure according to whether the expenditure is for research, provision of facilities, provision of beneficial services, provision of technical personnel, or for administration and management. These five expenditure classifications are referred to as program activities. Within each activity the expenditure is classified as to the type of financial arrangement: grant, loan or direct operation.

Because many of the department's programs are directed to specific subgroups in the population, and in fact many decisions are made with respect to that subgroup, the program information described above is cross classified by target groups. The target group classification provides information on the age class, income level, and physical or social problem of the individuals the program is intended to benefit.

Associated with the financial data for each program element will be measures of output or product. These output measures are an integral part of the program system and are projected ahead for the 5-year planning period. The output measures are necessarily different for each program element, and, in fact, many elements have several output measures. The intent of projecting the output measures is to define the final product of each program that corresponds to the projected dollar costs of the program.

Taken together, the financial and nonfinancial information by program element, activity, and target group—projected forward for 5 years—constitutes the department's 5-year program and financial plan. Because all of the information for the first year of the 5-year program and financial plan is also coded by budget appropriation category, the translation can be made to the department's budget in the appropriation accounts familiar to the Congress.

The vast quantities of data involved and the desirability of displaying them in a variety of formats have made it necessary to put much of the operation on the computer. Although this year some of the program data are being manipulated manually, we have plans to fully automate the data processing aspects of the system next year.

Let me say a word about this. Essentially we have five categories of information which we can assemble in any way we want to. We

have it by agency. We have it by year. We have it by program element which I described. We have it by type of expenditure and we have it by target group.

You can get displays of information by any one of these categories. You can ask the question, What are we doing for poor, handicapped migrant children, which is one of the target groups?

Senator NELSON. Do you now have that information?

Mr. GORHAM. The information is now coded. The automating process is not completed yet but the information delivered by the agencies is by target group, by program activity, by type of expenditure, by agencies, and by year.

Senator NELSON. So that when it is programed into the computer—

Mr. GORHAM. We can ask a question about the particular target group and get the kind of expenditures made for that target group in total and broken out in various ways. It will be a very flexible instrument.

Senator NELSON. Previously, what was the nature of the—

Mr. GORHAM. Previously, a special analysis would have to be made. There would be a letter sent to all agencies which had any programs which might affect a particular group in the population and they would be asked to estimate the expenditures made for this group and the kinds of programs for delivering service to them. This system will provide the information in hand and will also force consideration of it for 5 years in the future.

Senator NELSON. Do you have an accounting figure for the cost of administering each aspect of a program?

In other words, if the—

Mr. GORHAM. Yes.

Senator NELSON. You can say, for example, how much administrative cost is involved in giving aid to the blind.

Mr. GORHAM. That will be true for programs which we directly operate. I am not certain as to whether we would have that information for programs in which there was a sharing arrangement between the State or the local government and the Federal Government. I don't think we would necessarily have all the administrative costs for all programs.

PROGRAM PLANNING AND ANALYSIS

The program plans incorporated in the 5-year plan will be based in part on a series of analytical studies. These studies will not be the traditional task force reports but real cost-benefit or systems studies which compare alternative ways of achieving national objectives and which try to estimate the costs and benefits of each alternative.

To provide him with the analyses and evaluations which he needs for program decisions this year, the Secretary has established five program analysis groups, which will be concerned with the following areas:

1. Programs which increase future earning power.
2. College student aid programs.
3. Income and benefit programs.
4. Selected disease control programs.
5. Child health care programs.

The program analysis groups include knowledgeable working-level people from different parts of the Department and experts from outside HEW, who will consider program issues from a departmental and national point of view. For example, these groups will consider not only the programs of HEW but where there are competing or relevant programs of other agencies, the analyses of these other agencies will be incorporated in the studies that we do.

The program analysis groups will specify the objectives of each program and ways of measuring them; they will prepare a description of alternative programs which would lead toward the objectives, an analysis of the costs and benefits of each alternative, and a discussion of the basic assumptions upon which the conclusions depend and the uncertainties which affect the estimates. For example, program analysis group 3 will make a thorough review of the role of public assistance and its relation to other income maintenance programs. The group will address the question of how objectives in this area should be defined and will consider how they might best be achieved by different mixes of programs, including social security, family allowances, negative income tax, demogrants, extensions of medicare, and public assistance. These and the studies of the other groups will be used by the Secretary and his staff as a basis for preparing program memorandums which will provide the analytical support for the funding requirements shown in the 5-year program and financial plan.

In sum, we have introduced a programing system in the Department and set in motion a number of studies covering major segments of the Department's responsibilities. With these assets to draw on, the Secretary will be in a better position to effectively coordinate and direct the vital activities of the Department.

I might say a word about when these groups may really contribute effectively to the development of a well-balanced departmental program. We are starting on these five groups which will encompass about 60 or 70 percent of the expenditures of the Department this year but these groups will not, in the short 6 months that they will be working, be able to come up with totally valid and usable results in the areas which they are investigating. So, I would suspect that 2, 3, or 4 years will be necessary before we build a foundation of analytical studies with which we are comfortable in developing longer range programs.

Thank you.

Senator NELSON. Among the program analysis groups, you will have some experts from outside HEW? Will they be private contract employees?

Mr. GORHAM. They will be consultants. We have them now. They are consultants from universities. We are getting other Government people who are also experts in a particular field; the OEO, Treasury Department, Council of Economic Advisers have contributed personnel to work with us in these groups.

Senator NELSON. Will these program analysis groups work on a continuous basis or is it just one job?

Mr. GORHAM. Right now they have a schedule to complete their initial studies by the end of August so that initial results might have an impact on the 1968 budget decisions. It is inconceivable that all of the work of these groups will be completed by August.

Senator NELSON. But even once we have completed it, does a continuous job of evaluation go on?

Mr. GORHAM. Yes.

Senator NELSON. So this function will be performed continuously?

Mr. GORHAM. That is true, it will be performed continuously but I think it is unrealistic to plan an intense analytical effort and get very good people to work on it if the effort is to be indefinite. You just would not get them. You have, therefore, to deal with specific periods of time. This is a study which will last 4 to 6 months and I am asking for their time during that period.

One of the important tasks of the groups will be to expose the unknowns and to lay out future research which should be done. Successive groups will have to be organized, as you properly observed.

Senator NELSON. Senator Javits, who could not be here, had a question that he wanted me to ask for him which is whether the impact of PPBS on programs cuts across departmental lines, for example, manpower training, HEW has vocational rehabilitation, vocational education, work study, work experience, labor has MDTA, apprenticeship training, neighborhood youth centers, OEO has the Job Corps. His question is, Will the program analysis group or groups working on these programs within HEW have a relationship to similar groups in other departments or agencies?

Mr. GORHAM. I think I have answered that question, Senator Nelson. I indicated that we have included in our program analysis groups representatives of the other agencies who, it is expected, will provide us with the analytical information on their programs which are competitive with our programs.

Senator NELSON. I did not understand that coordination would be part of their function.

Mr. GORHAM. They won't be coordinating the programs but the analysis will encompass competing programs in other departments of the Government. For example, I would expect the MDTA programs of the Labor Department would be considered along with vocational education and work experience programs. These are all programs contributing to the same objectives and therefore are properly considered together.

Senator NELSON. Do I understand, for example, that the program analysis group that is working on vocational rehabilitation will also have a representative working from HEW, from Labor and from OEO?

Mr. GORHAM. Yes. Vocational rehabilitation will be one of about 6, 7, or 10 programs which will be looked at at the same time because they are programs in fact which should be looked at together.

They are programs contributing to similar objectives.

Senator NELSON. But each agency that has a function that may overlap, that is doing something for somebody in the same or similar field, will have a representative on the program analysis group in HEW?

Mr. GORHAM. Let me make something clear. What we have in these groups are not representatives as such. There is no representation within the agency on the groups. That is, we don't have representatives from the Vocational Rehabilitation Administration and from Welfare and from the other agencies of Government.

They are not representatives. These are generally analysts. Many of them are drawn from the agency because they have specific information about programs. They are not representing their agencies. Similarly, with respect to the individuals—and I stress the word “individuals”—which we have invited to participate from other agencies, they have been invited as individuals who would contribute to the analytical examination of these programs.

This is not meant to be a deliberative body or a blue ribbon committee coming up with the best program. It is a group whose major purpose is to develop analysis, and develop ways of comparing competing programs. It has an analytical function principally.

Senator NELSON. So, the systems analysis group in HEW will have working as part of that team an expert on any program in any other agency that is performing a similar function in a similar field?

Mr. GORHAM. Either an expert from that agency or an outside person who has done analysis in that subject.

The object is to get good analysis done. That means drawing on the best people you can, from within your agency, from universities, and from other agencies.

Senator NELSON. Is each agency going to have a program analysis group as HEW does for their agency?

Mr. GORHAM. I don't know the approach which the other agencies are taking on their analytical work. I don't think they are all doing it this way.

Joe, you might say a word here.

Mr. KERSHAW. We are, at OEO, very much interested in the same kinds of things that Mr. Gorham is, of course. We do it a little differently. We do it largely with in-house people except that we prepare papers and circulate them to other agencies and then hold inter-agency meetings based on those papers and try to arrive in that way at a coordinated, intelligent position on whatever the subject may be, public assistance, for example, or manpower or whatever.

Now we, of course, have a charter which is broader than OEO. We are directed by our statute to engage in this interagency sort of coordination which Mr. Gorham has not. Perhaps this accounts for the difference.

Senator NELSON. So the program planning and budgeting function is not going to be performed on the same basis in the department.

Mr. GORHAM. No, there is no directive from the Bureau to do it either way. When you look at the problem of the different agencies I am not certain that a uniform approach in the development of analytical work would serve the interest of getting good work done uniformly.

The agencies have developed differently. They have different relationships within them. I would be surprised if the same system would work in every agency.

Senator NELSON. For anyone who wants to make an examination into programs that do cut across agency lines, what does he get hold of to get an analysis of how those functions are being performed?

Mr. GORHAM. Well, where we have decided to compare our programs with competing programs doing similar things there will be an analytical basis for such comparisons. When this base will be

available to make a valid comparison remains to be seen. We hope fairly soon.

Senator NELSON. If you were to give a brief explanation of the concept of systems analysis what would you say its main elements were?

Mr. GORHAM. I would say first it is logical. It is quantitative insofar as it can be. It pushes the particular problem to the limits of quantification. It is very careful about determining what it is you are trying to do. It is surprising how many programs exist in the Federal Government and elsewhere where the objective of the program is not clear.

This kind of problem is not as prevalent in industry where the objective is profitmaking. There usually is not a question about that being the objective. The question may be whether it is long-term or short-term profit or the sort of things that contribute to profit but the end objective, profit, is a very clear thing.

In government programs it is not so clear. Programs very often have a set of objectives. Take education, for example. It would be very difficult to reach a consensus on a single objective of education.

One can think of at least three or four things. One can think of preparing people for fruitful work. One can think of preparing them to enjoy life, to be able to appreciate life fully, to realize their potential, not just in terms of income earning capacity but in terms of getting pleasure from life.

One can think of the values of education toward developing a citizenry which makes democracy work. Education is a good example of the kind of activity which has many objectives, some of which would be difficult to get everybody to agree on. The relative importance of each objective might be difficult to get agreement on. Defining the objectives and the evaluation of alternative programs toward achieving those objectives is a very important aspect of systematic study which we call systems analysis.

Senator NELSON. It seems to me that Congress, looking at it from the legislative viewpoint, needs some kind of analysis of programs that cut across agency lines.

Mr. GORHAM. The function of the Bureau of the Budget is of course in the end the function of presenting to the Congress a balanced budget program at a total level of expenditure which is felt to be consistent with the national interest. That is the natural place for the overall governmental program balancing decision.

Senator NELSON. I am talking still about what information does Congress have to act on. You recited in your testimony some functions that are divided among six, seven, or eight agencies. If Congress wanted an analysis of all the manpower functions that are performed at OEC, Labor and elsewhere and what their objective is, how much they cost, who the people are, is that information available now?

Mr. GORHAM. It may not be available now. I can say that after this system is operating, obtaining this information will be facilitated. I am certain if your committee or any other committee of Congress desired information of that kind they could obtain it.

Senator NELSON. You mean as to all the agencies, all the functions that do cut across agency lines, when your analysis is over with and the analysis of all the other agencies is over with, that there will have

been some careful evaluation of what is being done in all aspects of any program that cuts across agency lines and what the objectives and what the cost is? HEW will be able to say we are performing such and such function affecting some class of people, here is the objective and in each agency there will be an overall analysis of these functions that do cross agency lines so that a total picture will be available?

Mr. GORHAM. I would hope so.

Senator NELSON. Is that one of the objectives?

Mr. GORHAM. That is a question that I think Mr. Rowen could have answered more expertly than I can since the plans for coordinating the several analytical activities of the agencies really has to be in the hands of one agency in the White House. The Bureau is the proper place.

Senator NELSON. The concept of systems analysis, as you are well aware, having been in the Defense Department, has been used for the purpose of developing a weapon system. So the question raised by these hearings and the purpose of the introduction of S. 2662 is to find out whether or not it is feasible to use this technique to tackle social problems.

I take it the fact is that the systems analysis technique you are using in the agency is a useful and valid technique to use in analyzing social problems. Am I correct in stating it that way?

This bill proposes that grants be made by the Federal Government, to industry, to State governments, to contract with Rand Corp. type organizations for the purpose of making analyses of social problems that confront State governments, for example. Do you think that can be a useful function at the State government level?

Mr. GORHAM. Yes, I do.

Senator NELSON. What about the availability of qualified personnel to perform the functions of systems analysis?

Mr. GORHAM. I think they are in very short supply.

Let me, if I might, say a word about systems analysis at other government levels.

The crucial factor I found is to make sure that the person asking for the study knows what he wants and is therefore in a position to understand what he is going to get. If funds are available for systems analysis they will be used.

The real question is, Will they be used wisely, not only because of the financial aspects of the question but also because of the limitations in qualified personnel? The person who has administrative control of the program or decisionmaking responsibility has to define this problem for the systems analyst to get something worthwhile back.

Senator NELSON. You talk about the systems analyst. Is this a kind of generalist who understands the broad concept? Are there any particular technical qualifications that are needed by an analyst? I really realize that if you are analyzing some aspect of a special problem that it might be helpful to be a chemist or a mathematician or something else but the systems analyst does not have to have any—

Mr. GORHAM. Very often a systems analyst is not one person or should not be one person. It depends on the problem. The most successful examples of systems analyses that I have been engaged in usually involved a team of people with quite different backgrounds, some of whom were particularly gifted in the conceptual problem—at

the problem of defining the problem carefully, laying it out carefully; others of whom provided technical inputs, cost analysts, engineers, even anthropologists. There is no one person who is a system analyst.

They are very often teams of people. If there is one person, usually characteristic of his background is some quantitative training because it is a quantitative business.

Senator NELSON. There may be as necessary elements of the team a mathematician, physicist, chemist or engineer.

You can't pick up just any chemist or mathematician and call him a system analyst.

Mr. GORHAM. He may become an analyst.

Senator NELSON. Yes, he may become one and the analyst may understand the concept.

Mr. GORHAM. That is right. Usually he will come from a discipline which has a fairly high quantitative content. He will have been an economist or he will have been a statistician or he will have been a mathematician or an engineer. Once in awhile you meet one that was a historian or a philosopher but that is rare.

Senator NELSON. So far as I know there is no course in this country devoted to training systems analysts as such. I am not inquiring about those elements of the team that involve technical specialties, scientists and so forth. As we begin to use the concept of systems analysis, where do you find the people and how do you train the people who have the broad concept of system analysis?

We had a superb one in Wisconsin who just had a bachelor's degree. He was a budget analyst who had an instinct for public administration. He understood the concept as well as anybody else in the country.

When he left the service as director of the department of administration he understood the concept very well. He had no training whatsoever except the technical background of being a budget analyst.

Where do you find these generalists and who is training them?

Mr. GORHAM. Training them are the people who are doing systems analysis. The best way to find a systems analyst is to look for a man who is engaged in systems analysis. As you quite properly pointed out, a particular curriculum does not lead to a degree in systems analysis although there is a possibility that such a thing could be created.

Senator NELSON. I think that is all the questions I have. Does anybody want to make any observation on Mr. Gorham's testimony?

Mr. KERSHAW. I think your question, where do you go to find these people is an interesting one because in his city those of us who are practitioners have been looking awfully hard to build up our staffs. Of course the places we go are the Defense Department, and the new agencies, and the new PPBS organizations are now coming to my office to try to hire my people away.

We all look to Rand Corp. to try to get our people. But it is a very difficult thing to find enough of these people. I think Mr. Gorham is quite right, the real hope is to get bright young people who have had some kind of quantitative training in economics or mathematics, and put them in with people who are doing system analysis.

They learn quite quickly. This is not an occult science or art. You can, if you are bright, and if you are young, and flexible, and know a little mathematics, grasp them quite quickly. I find, for example, that graduate students from MIT, which has a quantitative tradi-

tion in economics, is a very good source of these people. There are other places of this sort around the country that are producing them in much too small numbers, I am afraid.

Senator NELSON. Are any of the universities attempting to give background particularly in this field? Schools of public administration provide a good background for it. But are any of them tackling it from this specific aspect?

Mr. Ross. Did Harry Rowen mention yesterday the training program that the Budget Bureau has worked out cooperatively with a group of universities who are giving advanced—graduate training—for Federal employees in a specially designed course?

Senator NELSON. Carnegie Tech is one?

Mr. Ross. That is one. Massachusetts Institute of Technology, University of Maryland, University of Chicago.

Senator NELSON. These are training, specifically, Federal employees?

Mr. Ross. Yes. These are Federal employees who have had a relatively strong undergraduate and possibly even some graduate training in one of the relevant disciplines. It is an attempt to give them the quantitative aspects that they might have missed in their basic training program when they passed through the university originally.

Senator NELSON. In the concept, too. They are not system analysts now.

Mr. GORHAM. They are not now. They are people who have been working in one of the programs, in an area of public service where quantity—quantitative applications to systems analysis have relevance. They will be doing more and more of that kind of work as they return.

Senator NELSON. Yes. I talked to the dean of Carnegie Tech about that. As I understand it, they don't have their first class yet.

Mr. GORHAM. I think the variety of departments which are participating from the 7 or 8 universities is indicative also of the source from which systems analysts will have to come. Business administration schools, department of economics, industrial engineering departments and divisions, the Woodrow Wilson School at Princeton. There is no pattern. This variety is part of the strength of the system analysis.

Senator NELSON. Thank you very much, Mr. Gorham. I appreciate your taking the time to come. Our next witness will be Mr. Kershaw, Assistant Director, Office of Economic Opportunity.

STATEMENT OF JOSEPH A. KERSHAW, ASSISTANT DIRECTOR, U.S. OFFICE OF ECONOMIC OPPORTUNITY

Mr. KERSHAW. Mr. Chairman:

I am very pleased to be with you this morning. I have a personal reason for being pleased. Three of the four witnesses you are having once worked for me in Rand Corp., where we were all engaged in systems analysis of one sort or another.

Senator NELSON. You had some very talented employees.

Mr. KERSHAW. I would like to discuss this morning the application of planning, programing, and budgeting systems to our national programs of social and economic assistance at OEO. Planning, programing, and budgeting systems are, as you know, a collection of tech-

niques and principles which were designed and implemented initially in the Department of Defense and now are being applied to the domestic civilian programs of the executive branch of the Government. The hope is that the use of these techniques and principles will give the top level decisionmakers new perspectives and new insights into old problems. The old problems are, in general, how to allocate available resources among competing proposals and programs in a way which will give us, overall, the maximum benefits for a given cost.

The value of these techniques is that they require us to look beyond some of our traditional conceptual limitations and in doing so to sharpen the judgment and intuition of decisionmakers at various levels of Government. PPBS principles and techniques require us first to look beyond the limits of traditional classifications of resources and effort. This is their structural contribution. Secondly, they require us to look beyond the limits of traditional forms of information needed for decisions between alternatives. Finally, they require us to look beyond the limits of our traditional systems for the analysis of alternatives. This is their analytical contribution.

I would like to describe, today, what these principles have required us to do in order to extend our perspectives in the development and implementation of the antipoverty program of the Federal Government. These new perspectives, of course, do not replace common-sense and good judgment. They are not substitutions for the more traditional approaches to problems but useful supplements to the decisionmaking process.

NEW CLASSIFICATIONS OF EFFORT

In my office, in the Office of Economic Opportunity, we are now involved in the second annual planning cycle through which the Director, Mr. Shriver, develops a recommended plan for the President. The plan describes the possible future courses of the antipoverty program of OEO and of the other agencies which have responsibility for programs in the Federal war on poverty.

In developing these recommendations and proposed plans, we are using a new frame work for classifying and considering alternative proposals. More traditional planning processes have characterized prospective governmental efforts in terms of the types of resources to be used (such as personnel, equipment, and facilities). These are sometimes called input categories. In the past, resources have also been classified by the organizational elements responsible for providing the efforts, or by the specific types of problems that the efforts were intended to alleviate, such as illiteracy or delinquency. We do not ignore this type of categorization, for it is useful in the analysis process.

However, we have put our emphasis, in the planning process, on (a) a classification of effort or resources that looks to the end products (sometimes called "output" categories); (b) on goal-oriented functional services which cut across organizational lines; and (c) on efforts which are directed toward eliminating the causes of the poverty problem rather than its symptoms.

In order to classify our proposed efforts by end objectives, we have developed a program structure for the antipoverty plan which encompasses six major program categories. You will notice, among

these, the strong use of the word "opportunity" which is in line with the basic relationship between providing economic and social opportunity and the elimination of the cause of poverty.

I might suggest that is the relationship that clearly exists between our categories and Mr. Gorham's. Ours are—

- I. Employment opportunity.
- II. Educational opportunity.
- III. Other social and economical opportunities.
- IV. Income maintenance.
- V. Basic poverty research.
- VI. General support.

Subcategories and elements which further refine our classification of efforts into specific output units have been developed for each of the six program categories. I have copies of our detailed program structure for OEO's own programs which I would be happy to submit for the subcommittee's use.

This basic classification serves as our principal frame of reference for research, planning, programing, budgeting, and evaluation through which we compare alternative proposals for providing the desired opportunities and social and economic services. In the development of our recommendations for the multiyear antipoverty plan, we try to compare and analyze the alternative program approaches for the accomplishment of these program objectives. Included in the analysis are those major programs which are being put forward by other related Federal agencies as well as by OEO's own direct and delegated programs.

NEW FORMS OF INFORMATION

To look at our problem quantitatively and to come up with some ideas as to what we should be doing to help people out of poverty, we need better data. There is a great deal of information available, but it never seems to be quite right to answer our questions. The data on the domestic economy available in the U.S. Government, of course, are nearly unlimited, but it is amazing just how much information there can be and how it is never exactly what you need.

In our business, we are thirsty for new forms of information, and we have discovered that there are lots of gaps in the existing data. For instance, the Council of Economic Advisers has estimated that about 30 percent of the poor population moves in and out of poverty from year to year, but that is all we know. Are the same people crossing the line in both directions, frequently, or are different people moving in and out? This kind of information is not available. We are having to collect it with the help of the Census Bureau.

Incidentally, there is a lot of data being generated by the programs we are running. We have established a fairly extensive information collection and handling system in OEO, which will begin to make available much valuable information about social and economic assistance programs over the years.

NEW SYSTEMS FOR ANALYSIS

Following the new principles, we have emphasized analysis based in part upon the examination of future year costs and projected bene-

fits of the program alternatives. Both the numbers and the judgments obviously get softer as we go further into the future, but we think that it is important that planning and programing be done out into the future because the future implications and commitments of current proposals are sometimes not obvious. For example, the headstart program, which we regard as one of our more successful efforts, probably will not really pay off unless the participating children are given some followup experience in the first grade and maybe even beyond. This means that money we spend this year may have to be followed up by money in the later years of their elementary education. It is important that the decisionmakers see this kind of implication, because it affects their freedom of choice in the future years.

Now let me turn to the question of cost-benefit analysis and evaluation, and suggest how they come into play in planning. We have had the interesting job of doing cost-benefit analyses of alternative program proposals when we know a good deal about cost but very little about the benefits of the services which our programs will provide. We do not have measured benefits from our programs of assistance because for the most part they have not been operating long enough for us to gage the ultimate increase in social or economic productivity of the people receiving the services. But we think that we can do useful things even if we do not have all of the hard numbers. We can get a fairly good grip on one of the two needed numbers; that is, the cost, present and projected.

Lacking hard figures for benefits, and knowing that these will not be available for years, in some cases, we look for "proxies." For example, the purpose of headstart is to reduce high school dropouts 15 years from now, or to raise incomes 25 years from now. Clearly, we cannot wait that long to measure the output of that program. So we look for a proxy; in this case, the performance of headstart children in first grade as compared to similar children who did not have the headstart experience.

The ultimate use of cost-benefit analysis is to assist the decision-maker in comparing the effectiveness of alternative programs. The greatest single difficulty in utilizing this technique is to find comparable objectives that two systems are trying to achieve. Let me illustrate this problem with a couple of examples. We in OEO are running two programs which appear to have roughly the same objective. Both Job Corps and Neighborhood Youth Corps are designed to serve disadvantaged youth and to give them the necessary work experience, education, and vocational training to permit them to get and hold jobs in private sector. We ought to compare these two systems by examining their respective costs and outputs.

We know that Job Corps costs about four times as much as Neighborhood Youth Corps; if it produces five times the results it is a better program; if it produces three times the results, it is the inferior program. The results in this case appear to be fairly easy to compare, although this ease of comparison disappears if, as is likely, we decide that Job Corps should serve more difficult youngsters than Neighborhood Youth Corps. It may be that for these difficult youth, Job Corps is the only program which can reach them effectively, and thus its

benefits are infinitely greater than any alternative. But in any case with some additional experience in the two programs and some knowledge about what happens to youngsters who go through each of the programs, which we do not yet have, we will be well on our way toward making effective comparisons.

Most other comparisons are a good deal more difficult. How do we decide, for example, that \$1,000 is better spent for free legal services for the poor than for free child care services for the poor? Both of these services are needed and both contribute to the welfare of the people served. But you would find this is a difficult task indeed and it doesn't help very much to say both services are designed to get people out of poverty. This is true enough, but the relationship of the services to this ultimate objective is a difficult one to quantify. Here, I would say, is the greatest limitation on our new techniques. We are dealing with matters that are frequently not subject to quantification. In my view, we shall never really solve this problem of quantification of objectives, and this is the prime reason why systems analysis or cost-benefit analysis will never reach the stage where the machine will replace the human decisionmaker. I am sure we all agree that this is a good thing. It doesn't follow from this that the new techniques do not contribute significantly, in my view, to improvement in the decision-making process; but here, if any was needed, is a demonstration of why the system has its limitations.

I would like to close with a brief discussion of one aspect of the PPBS system which seems to me to have great potential. I refer to the program change system which has been developed in great detail in the Defense Department and which we are now engaged in trying to implement.

This is a system by which changes from the officially adopted program are made. It requires the person proposing the change to submit costs of his proposal, and it requires a staff in the agency to examine alternative ways of financing the new proposal. When the package reaches the director for decision, the system requires him to recognize that a decision to spend more money on a good idea also requires at the same time a decision to spend less money on something else. With proper staff work, this system forces the decisionmaker, all during the year and not only at budget time, to make choices on a rational basis with as much information as possible at hand, and it forces the recognition of the fact that every decision is a choice among alternatives. This is clearly the road to better decisions.

Thank you, Mr. Chairman.

Senator NELSON. I take it you consider it useful to use the systems analysis technique and applying it to evaluating social problems, despite its limitations.

Mr. KERSHAW. I certainly do, sir; yes.

Senator NELSON. In the event that there isn't a system analysis, what other technique is there to add to the information for the decisionmaker in any event?

Mr. KERSHAW. That is a very good question. I think it goes to the heart of what system analysis really is. I have a colleague who insists that it is nothing more than organized commonsense. In a sense, that is what it is. It does have a structure, as Mr. Gorham pointed out,

which I think tends to differentiate it from what has gone before. It clearly does not answer all the analytical questions we have, and it clearly is not, as I think Mr. Rowen pointed out yesterday, it is not a black box which has magic in it.

I believe that moving in this direction has great promise for improving the quality of decisions. But we shall always have to continue to use many of the techniques that have been used in the past, which, I think, needs intelligent men at the decisionmaking places.

Senator NELSON. What appears to be mysterious to some people is, that one of the aids in the system analysis, is the computer, which as an aid does a very remarkable thing. Therefore, people think that the computer is solving the problem, when it is just a substitute for several hundred mathematicians.

Mr. KERSHAW. That is right. It can do a lot of things faster, or it can do a lot of things that you could not do at all.

Senator NELSON. As I mentioned to Mr. Gorham, this bill proposes that funds be made available to be used by States for development of systems analysis, including the use of private industry, or a Rand-type organization, as has been used by the Defense Department. Do you see useful possibilities from that for the purpose of evaluating the problems that we have at the State government level?

Mr. KERSHAW. I see no reason why the technique is not just as valuable at other levels of government as it is at the Federal level. I think anything we can do to encourage its use is all to the good.

Senator NELSON. Senator Murphy, do you have any questions?

Senator MURPHY. Yes; thank you, Mr. Chairman.

Have you any concrete examples that you can give us as to the changes in policy which have been brought about by the study through systems analysis in OEO?

Mr. KERSHAW. Senator Murphy, the problem, of course, is that our programs have been operating for such a short period of time that we do not have hard numbers on which to base firm recommendations.

Senator MURPHY. Don't you have, for instance, numbers so that you can say you have an average cost in the Job Corps, what the average cost is from the time you pick a boy up until you place him, and how many have been placed?

Mr. KERSHAW. I was going to go on and say that one example—which may not be quite as specific as you would like—is the Job Corps. We have discovered that costs in the Job Corps are very difficult to get down. They are high, as we all know. There are some special reasons for that, but that is not relevant here. We have also discovered that the costs in the Neighborhood Youth Corps are much lower. One consequence of this analysis, if you will, is that we have essentially decided to recommend that the Job Corps not expand very rapidly and that the Neighborhood Youth Corps do expand.

Now in time, it may be that that is a decision that should be reversed. If we should discover, for example, that Job Corps can do things that no other system can; or if we discover that its success rate, when compared to its cost, is advantageous, compared to competing systems, then that is a decision that ought to be reversed.

We are essentially making a decision to keep the Job Corps at a modest level, experiment with it, and evaluate it, with all of our

capability. And this has been a decision which has resulted from this sort of analysis.

Senator MURPHY. Another question which may not be relevant, but is interesting. Have you any idea of the percentage of use of the hardware that already exists? For instance, in the Defense Department, I know, they have many setups of the actual hardware to accomplish these jobs.

Mr. KERSHAW. You are talking about computers?

Senator MURPHY. Yes.

Mr. KERSHAW. No; I have not. The general principle is that any computer is rapidly used up to its capacity. They seem to have a voracious appetite.

Senator MURPHY. My point is, that I have had experience in private industry before I came to the Senate, and we had instituted a system of computers for the first time in motion pictures, which was very important because we had to know exactly each day the condition of the product of 8 to 15 different productions. We found that we were only using about one-tenth of the capacity.

We finally made arrangements to rent out, lease out, and do work for all the companies. I was wondering if this had been considered or if this is a practical thing to consider in regard to this.

Mr. KERSHAW. Our own computer is very heavily used. In fact, we go outside all the time and borrow, beg, and buy space on other computers.

Senator MURPHY. How many employees at OEO are used to feed the computers?

Mr. KERSHAW. To feed the computers?

Senator MURPHY. Yes. That are concerned with the actual operation of the system.

Mr. KERSHAW. We have an information center which employs 82 people. Approximately 35 people are in the data processing division which feeds the computers.

Senator MURPHY. I have no other questions.

Senator NELSON. Thank you, Senator.

Thank you very much, Mr. Kershaw.

Mr. KERSHAW. Thank you, Mr. Chairman.

Senator NELSON. The next witness is Mr. William Ross.

**STATEMENT OF WILLIAM ROSS, DEPUTY UNDER SECRETARY FOR
POLICY ANALYSIS AND PROGRAM EVALUATION, U.S. DEPARTMENT
OF HOUSING AND URBAN DEVELOPMENT**

Mr. Ross. Senator, I would like to stress just two or three elements of systems analysis and program budgeting which I think, myself, have particular relevance in the area of the kind of urban problem that we deal with at the Department, and which also have great relevance for the applications of this type of analysis at other levels of government which I understand is a strong interest of your subcommittee.

Senator NELSON. Yes.

Mr. Ross. First of all, my own personal bias is to treat systems analysis as the very broad concept that you have earlier indicated in

questions to Mr. Gorham. This includes operations analysis; it includes systems analysis; it includes the things that are now going under the name of the planning, programing, and budgeting system. It is based on a very broad definition of multidisciplinary, quantitative, and explicitly logical analysis of problems.

The second aspect of it, which appears particularly vital to me, is the concept that this is a problem-solving device. That is, all of the analysis that we do under these various names is for the benefit of decisionmakers. These decisionmakers are not abstract people, they are people with specific responsibilities.

In our case, we are working for program managers at the Federal level—for secretaries of the departments, for the President, and for the legislative branch. There are equally valuable and equally important needs that would be met by providing the same kind of analysis for mayors, for county or city departmentheads, for county or city managers, for Governors, and for heads of State departments of government.

Again, the analysis that we do is not research, and it is not abstract. It feeds from research—the research that goes on into the basic causes of problems, the basic relationships—which helps the decisionmaker understand what he is dealing with, and to help him make the decision which involves a minimum of intuitive judgment; which helps him to question his intuitive judgement where it has a strong basis; which helps him to reject intuitive judgement when what he is doing has become either uneconomic or ineffective, not because it was never right, but because the circumstances and the situation which made it a proper response in an earlier situation have changed.

The kind of analysis that we would do identifies the underlying relationships, so that we can spot a change for the benefit of the decisionmaker—not after he has gotten himself into trouble by applying an obsolete response to a new version of a problem.

In looking at the analysis as having several levels of application, I think it is also important to distinguish between the degrees of sophistication and the scope of the problem. It makes no sense to a mayor who has a trash collection problem, to talk to him in terms of substituting inflammable plastic containers as the basic device for transmitting commodities and distributing commodities at the local level. This is not something within the mayor's power; nor is it something that he can effect. If we respond to his problems by telling him that he should not worry about trash collection but that he should worry about the total packaging and disposal problem of the Nation, he is not going to be happy, and he is not going to be served.

In the meantime, while we are working at national levels on problems of that kind, he has a problem of economic service for the residents of his city.

Another reason why I think this kind of information is most relevant at State and local levels is that the decisionmakers at these levels are even more aware than are we at the national level of the finiteness of the resources with which they work—the tax base which they operate from, and the ability to borrow. In other words, to postpone total resource decisions or to avoid making them is an option much less available to the local or the State decisionmaker.

Now with this understanding of the values of the process, I start with the approach that the decisionmaker has to become involved at all levels of analysis and all stages of analysis.

We do this not really so much to make him happy, but because his perception of the problem essentially has a basis in experience. He understands the goals, and when we help him articulate the goals in some cases he will understand them better himself; and he certainly will help us to understand what we need to do in order to provide the kind of analysis that is usable for his problem solving.

This is not to underestimate the need for doing research in the very broad social problems for the kind of things which Mr. Kershaw indicates may never be quantifiable or may never be quantifiable in a way that will be satisfactory. But it does mean that we have to provide the decisionmaker at the same time with the kinds of analysis for the level of the problem that he does perceive now and for the kinds of action which he can take now.

In the case of the trash collection—which comes back, I think, primarily because this is a very pervasive local government problem and also one to which analysis has relevance—we can consider the question of whether a city manager should try to get an incinerator constructed or whether he should continue to use the system of hauling trash out to a sanitary landfill, which in many respects serves the same purpose equally well. In looking through the kinds of system analysis which Mr. Gorham, Mr. Kershaw, Mr. Rowen, and Mr. Enthoven have mentioned, in looking at the total systems cost just for the definition of that problem, or that subsystem of the problem, we have a tradeoff between the operating cost of hauling, the extra time involved in the collection and hauling of trash to distant points—and as these points become more distant year after year, hauling costs become higher—or the question of developing and building an expensive incinerator which permits the city to then reduce the volume of trash substantially and make a much less frequent or much more efficient form of hauling away that amount of waste which cannot be handled by incineration. This is the kind of tradeoff between capital cost and operating cost for which our knowledge is completely adequate. It is the kind of problem on which the local city manager may tend to make continually the wrong decision, if he does not look at total systems cost because he does not have to go for a bond issue in order to continue to pay the extra cost for hauling trash back and forth unnecessarily. He does not even have to defend that decision. He is carrying on traditional practices, and no one questions it.

But I think the engineering analysis—the physical relationships, the analysis of capital costs, the differing efficiencies of different sizes of incinerators, the relative wage costs of incinerator operation versus trash hauling and trash collection, the increasing difficulty of getting people to work in these aspects of public service—provide him with a basis for making a totally new decision, which is admittedly a very simple application of systems analysis. But it is one for which 3,000 counties, 18,000 cities, and 50 States will be well served by having analysis done in a careful, documented way, as an indication of how we go about a full appraisal of the relative aspects of the problem and producing a solution which is not the first and obvious solution of

adding an additional trash truck when your city department runs into problems of capacity.

I think these kinds of applications can be used to build a stronger sense of need on the part of the State and local managers for whom these problems are very severe. We have found in our Department that there is a tremendous amount of interest. We have had solicitations from the National Association of City Managers, from the Council of State Governments, from the Conference of Mayors, and from specific cities for financing systems analyses that can be used in their cases.

Senator NELSON. You have had requests from these various groups for appropriations to help finance that kind of analysis or systems analysis?

Mr. Ross. For a system analysis program, without being specific about the types of projects in which they would be involved.

Let me mention two, Senator, that are very specific where the city management is strongly behind the development of better analytic techniques and has an idea of where it would like to start.

The city of Detroit is shortly going to receive a research contract from us to develop program budgeting and system analysis applications for their city. At the present time, they have two specific studies in depth in mind. One of these is the kind of trash collection problem that I described. The second is manpower utilization for the police force.

The California State Study on Crime and Delinquency as a system points to the broader aspects of this problem but within the city another relevant aspect of this problem is the question of scheduling the police force, determining the basis of patrolling, the density of the units of patrol, and so forth. The crime statistics by location, by type of crime, by seriousness of disorder, and so forth, which police departments have been collecting for a long time, can produce a lot of relevant information that helps to make rational decisions about scheduling.

This is, again, a sort of operations research-type application. The analysis of how to get a more efficient police department—when efficiency is defined in terms of the amount of crime or in terms of reductions in the incidence of crime, or an improvement in the apprehension and conviction of criminals—will be of great help to other cities, all of whom have this same problem and all of whom are trying to deal with it in one or another way.

The second case with which I am acquainted where a city has made specific plans is the city of Oakland, which, with the help of a group from the University of California at Berkeley, is going to be doing studies of the use of manpower in both the police and the fire departments—again using essentially the operations research methodology and, again, looking at placements of fire and police stations and scheduling of manpower.

But the systematic techniques of analysis are very definitely applicable and there are many problems for which a body of data and analysis already exists.

Senator NELSON. May I interrupt you for a moment?

Mr. Ross. Certainly.

Senator NELSON. Are the problems involved, for example, in trash collection, proper and best utilization of your police force, best utilization of your firemen, street department or any other service that the city performs—are the problems involved in comparable size cities sufficiently relevant to other cities so that a system analysis of any one of these problems in a city of 500,000 would have a relevant application to another city of the same size?

Mr. Ross. I think, Senator, the demonstration of the approach—what kind of statistics you gather, what kind of alternative responses are available to you—all of these sorts of things are transferable from one city to another. The last thing that we would want to transfer from one city to another city would be the results.

For instance, one city found that it could change from two-man patrols to one-man patrols in certain types of areas. We would not necessarily want to imply that that particular device would be usable in any other particular city, or that any other particular city could identify the exact circumstances. But the kind of analysis which went into the decision to make that kind of change in scheduling would be applicable.

The sort of thing I have in mind is an illustration of what system analysis looks like applied to a problem which you, as mayor, Governor, or city manager of a department recognize. What kind of data went into analysis of the problem? What kind of definition went into the selection of goals and the narrowing of goals? What kind of relationships do you have to understand in order to devise alternative solutions and how to choose among solutions?

Senator NELSON. This bill, S. 2662, as you know, provides grants to States and authorizes contracts with private industry. The idea of using it with cities, and transferring the benefit of the method to other cities, had not occurred to me. Would you see any value in a proposal which made grants available to various class cities, classed by size, in the United States so that you would then end up with a system analysis of a number of problems common to all cities in that class? Would you see value in having grants made for a systems analysis of these problems which would then be available to another city with comparable problems?

Mr. Ross. I think this kind of grant would be relevant, Senator. I am not so sure that legislation is necessary. We can identify at least four existing authorities which are usable for this kind of device, either directly or indirectly. For example, title VIII of the Housing Act of 1965 gives us authority to make grants for training purposes to States and State instrumentalities in response to plans that the States submit to us. These cover both training and research. I think this is a very legitimate application of both training and research in municipal metropolitan problems.

So that, if that authority is funded, as we hope it will be this year, we will probably make grants to any State which felt prepared to develop this aspect of the program of training and research.

Senator NELSON. Have any States or municipalities received any grants for this purpose up to date?

Mr. Ross. No; that program has not been funded. We do have proposals from several States in anticipation of funding.

Senator NELSON. The program has been authorized but not funded? Mr. Ross. That is right.

Senator NELSON. How long has it been authorized?

Mr. Ross. It was authorized in 1964. Funds were denied last year. A request is pending again in this session of Congress.

Now this is a very modest program. It is not anywhere near the dimensions of the draft bill that you are holding hearings on. But it is a device which is applicable and for which the funding levels could be raised as needed, as the demonstration of value is made—I would think.

There is another authorization, also. Title I of the Higher Education Act of 1965 provides for grants by the Office of Education to State centers for a similar type of training and educational work, which could include some research-type activities of the kind that the University of California at Berkeley is doing in the City of Oakland.

The Secretary of Commerce has authority under Public Law 89-182 to make technical services grants for the diffusion of the results of scientific knowledge to business and industry, which could be relevant.

Another, strangely enough, we are finding is at the head of the race. NASA has been making grants for the spin-off of space-age technology for demonstrations of this type of activity to various universities. The work that the University of California at Berkeley is doing in Oakland will be financed from that source.

We have indications from at least one or two other university groups who are receiving NASA funds that they are interested also in this kind of application.

I think these are the essential points that I wanted to make. Dr. Kershaw might want to comment on them.

Senator NELSON. Do you have any comments you would like to make, Dr. Kershaw?

Mr. KERSHAW. I might make one point that occurred to me while Mr. Ross was talking.

In the military area, I think one of the most valuable things to come out of systems analysis is the invention by the analysts of alternatives that people had not thought of. A very essential part of system analysis is to consider the various alternatives and to compare their attractiveness as much as possible. We found in the 1950's that very frequently an alternative which the military were not even considering might be invented, if you will, by the analyst or the analysts and might turn out to be a better alternative than any that had been considered.

I would suppose this could happen also in the field of public welfare, to visualize your trash collection problem leading to a solution which no one had thought of before until the analyst really began to examine the thing with great care. I think what happens is that, in the case of solutions which people have thought come close to being equally effective, the analyst says to himself, "I wonder if I could not combine the best in each of these two?" And he does and that is a new system. And then he costs it out and finds out that it is more effective than any of the old ones were. Quite frequently, as I say, in the military field this has been the result.

Senator NELSON. Thank you very much. We appreciate your coming.

The record will be kept open for those who could not attend to submit their statements and related material.

(The material on hand and subsequently supplied for the record follows:)

PREPARED STATEMENT OF CARL F. STOVER, EXECUTIVE DIRECTOR, NATIONAL INSTITUTE OF PUBLIC AFFAIRS, WASHINGTON, D.C.

In response to your invitation, I am pleased to offer my judgments on S. 2662—a bill to “mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation’s manpower resources to solve national problems.” These are my own professional views, however, and should not be construed to represent the position of any organization with which I am associated.

I am in full accord with the expressed intent and major provisions of this bill.

If the Nation is to achieve effectively and economically the ambitious domestic goals the people have set, ways must be found to bring the best of the Nation’s problem-oriented intellectual resources to bear on the task. Experience in the atomic energy, defense, and space programs has shown us how this can be done, drawing into common pursuits the capabilities of government, industry and the academic community. The time has come to employ similar patterns in dealing with domestic problems. Unless we make such an effort, we may not be able to resolve those problems at all.

One of the fruits of the atomic energy, defense, and space programs has been the development of more sophisticated techniques for analyzing problems, designing means for their resolution, and managing the implementation of those means. These techniques are often referred to as systems analysis, systems engineering and systems management because they offer ways of dealing with complex problems and tasks as functional integrated wholes instead of dealing with each of their parts in isolation. Clearly, this is exactly the kind of capability needed to deal effectively with such problems as unemployment, crime, delinquency, environmental pollution and transportation, which result from many varied causes and are closely linked to the total life of our metropolitan areas.

To some, the prospect of employing systems approaches to human problems seems reprehensible because they think it means that people will be “engineered.” Briefly, they argue that systems techniques are largely the province of engineers and have had their fullest development in handling physical tasks involving hardware not people, that systems engineers as a group have too little appreciation of social and human factors, and that the idea of system management implies the control of individual action, which is undesirable in democratic communities. Certainly each of these points holds an element of truth and the dangers identified should be guarded against, but there is much more to be said.

For example, although engineers are important in systems work, economists, psychologists, biologists and representatives of several other disciplines have also played a large part both in developing theory and in practice. The systems approach affords a way of integrating all relevant knowledge and technique in analyzing and formulating ways of handling a problem. It should also be noted that although physical and hardware problems have been central in the past, there have been many instances, particularly in the space program, where the emphasis has been on adapting technology to man rather than man to technology. In the final analysis, systems approaches are simply powerful tools, which like all tools can yield harm if badly used, but if used well can be a source of substantial good.

The foresight of the State of California in sponsoring feasibility studies to determine how systems approaches and the systematic development of appropriate technological means can help in such public problem areas as transportation, waste management, government information, and crime and delinquency has helped us all to understand that good. The State is to be applauded for this contribution to the Nation’s well-being. The results of this work have implications for the entire country and have helped to demonstrate how the fruits of our national investment in advanced technology can be used effectively in the continued improvement of life for all our citizens—and, indeed, for the citizens of countries throughout the world.

As I understand it, S. 2662 will foster the extension of California's innovative pattern to other States and will provide funds to assist all qualifying States in this endeavor. These are highly desirable actions, not least because they encourage the active involvement of the States in projects designed to deal with their own problems and will thereby serve to strengthen the State's governmental capabilities.

In the past, much has been made of the importance of this kind of undertaking because it could result in new public markets for those firms now heavily employed in the defense and space programs, should federal defense and space expenditures be reduced. Although this could be important, I do not believe it is the primary reason for supporting this bill. The primary issue is not preparation for arms reduction or weathering an economic storm. It is the discovery and development of new opportunities for putting man's knowledge in the service of action to achieve high human purposes. Since industry's capabilities are relevant, industry should share in this—not because they need help, but because they have significant contributions to make.

If man can govern technology to release the atom's energy, move faster than sound, or travel to the moon, he can also govern it to help provide a clean environment, good cities, sound urban transport, and better lives for all our citizens. Your bill promises to strengthen significantly the beginning that has already been made in pursuit of this goal. It should be enacted.

PREPARED STATEMENT OF HUGHES AIRCRAFT CO., CULVER CITY, CALIF.

WHY HUGHES IS BEHIND THIS BILL

The Scientific Manpower Utilization Act of 1965 will help put scientific know-how to work in solving some of the problems of modern urban living. These problems include unemployment, crime, air pollution, transportation, water resources and waste disposal, among others. These problems are difficult. Some of them are chronic problems. But they can be cut down to size, and, in some instances be eliminated through the exploitation of scientific techniques. For this reason, Hughes Aircraft Company endorses the scientific utilization program. As an aerospace company, Hughes is convinced that the reservoir of scientific skills—indeed, the vast reservoir of what is now ordinary engineering skills—developed by the defense industry in recent years, is *readily applicable* to these tasks.

As a civic-minded company, Hughes is disturbed by the *disparity* between the accomplishments of military technology and those of social technology. The electronics type of engineering certainly doesn't have all the answers for society, but it just as certainly can help out on the technical aspects in a big way. Putting aside dramatic advances, like nuclear science and space flight, the ordinary benefits of modern electronic science, its engineering methods, materials and analysis techniques, are too seldom enjoyed in civil affairs, and for no good reason. Finesse with computers, for example, is an ordinary engineering skill to an aerospace company. Its use hasn't yet scratched the surface in civil affairs and urban problems.

As a participator in American business, Hughes is anxious that the Nation's possibilities for economic growth be kept well stimulated by further departures in technique. This kind of stimulation that was brought on by the transistor, the computer, or jet engines, for example. Such purely technical stimulation will surely continue to be a most important catalyst in the economy, as it has been for the past 100 years.

TRANSPORTATION A GOOD EXAMPLE

A good example of how scientific methods can be exploited for everyday problems of society is in transportation. Transportation in all its forms is a major element of the gross national product—roughly 20 percent of it. Steps taken to improve the design and operation of transportation would measurably increase the productivity of the whole nation. This is because adequate transportation is one of the key requirements for economic growth. When transportation approaches saturation, or the transportation efficiency is poor, growth ceases.

Improvements, however, are easier to talk about than to achieve. Any changing, of course, has to be done on the basis of appropriate research. For example,

it has been estimated that the demand for intercity public transportation in the Northeastern part of the U.S. will almost triple by 1980, in comparison with the present demand, *if* the convenience to each traveler could be kept at the present (rather poor) levels. However, we believe that no economically feasible enlargement of superhighway, airway or airport facilities *along current patterns* could hold the line on convenience. There is simply not enough space, on the ground or in the air.

Hence this potential demand, representing net growth, will be incompletely realized unless new and better departures in transportation modes, or new patterns of employment, are devised. By any accounting, growth which might have been achieved but is not achieved is an irretrievable economic loss.

THE "SYSTEMS ANALYSIS" APPROACH

Supposing we are in agreement that improvements should be based on "appropriate research," how does one go about achieving that? One way it's achieved in the aerospace industry is through a research technique called "systems analysis."

Systems analysis is a scientific method of dealing with the total design problems of large facilities. It uses special techniques such as computer simulation to study the design alternatives and to find the best way to do the job for any given set of requirements.

Currently, Hughes is undertaking applied research, using the system-analysis approach, on the transportation problem. The ultimate goal of this research is the design and control and communication equipment for the proposed high-speed ground speed ground transportation system of the Northeast Corridor being studied by the U.S. Department of Commerce. The program affords an excellent example of the use of systems analysis on the solution of a complicated urban problem. In this instance, the basic difficulty is achieving safe, reliable and efficient operation of public trains moving at up to 400 mph.

An enormous number of technical problems must be solved in developing a system such as this, and they embrace much more than the disciplines of aerodynamics, propulsion or suspension design that one usually associates with railways. Whole new concepts of control and communication emerge, posing new problems in sensors and data processing that are quite similar to those in the military systems being created for our defense. The challenge to the systems engineer in all this will be to find the best configuration of energy, materials and information to balance equipment effectiveness against cost over the expected life of the system—just as he does now for his national assignments.

GREAT SKILLS AVAILABLE

Like many companies in the aerospace-electronics field, Hughes brings to the urban research programs the ability to analyze and solve exceedingly complex technical problems. Being a leader in five related fields: missiles, sensors, computers, satellites and communications, Hughes is well prepared to tackle large systems engineering jobs because of its diversity of talents. Indeed, all the experience and tools perfected by the aerospace industry in the last twenty years are available in some measure for use on urban projects. Along with the authors of the Scientific Manpower Act, Hughes believes the tapping of the scientific reservoir should be started. As briefly outlined in these paragraphs, there are three reasons as Hughes sees it for doing so:

- (1) Many urban problems can be solved by scientific methods.
- (2) Technical advances tend to stimulate economic growth.
- (3) The skills of system engineering are well suited to the nature of the problems and are available in some depth.

The Congress is to be congratulated for its recognition of this situation and for taking the initiative in capitalizing on the scientific resources of industry.

[From the Congressional Record, Oct. 18, 1965]

A SPACE AGE TRAJECTORY TO THE GREAT SOCIETY

Mr. NELSON. Mr. President, why can not the same specialist who can figure out a way to put a man in space figure out a way to keep him out of jail?

Why can not the engineers who can move a rocket to Mars figure out a way to move people through our cities and across the country without the honors of modern traffic and the concrete desert of our highway system?

Why can not the scientists who can cleanse instruments to spend germ free years in space devise a method to end the present pollution of air and water here on earth?

Why can not highly trained manpower, which can calculate a way to transmit pictures for millions of miles in space, also show us a way to transmit enough simple information to keep track of our criminals?

Why can not we use computers to deal with the down to earth special problems of modern America?

The answer is we can—if we have the wit to apply our scientific know how to the analysis and solution of social problems with the same creativity we have applied it to space problems.

The purpose of the proposed Scientific Manpower Utilization Act of 1965 is to test new ways to use the scientific manpower and know-how of the space age to solve a great variety of social problems.

This bill authorizes the Secretary of Labor to contract directly with private firms, universities, or nonprofit institution, and with States or groups of States. They would undertake studies of the use of systems analysis and systems engineering for a broad range of local and national problems. A 5-year program totaling \$25 million per year is suggested in this proposal.

This bill is an attempt to build creativity upon the successful first step work undertaken by the State of California.

A little over 6 months ago, Gov. Pat Brown, of California, decided to see if space engineers, and private space firms, could apply their know-how to a number of social problems faced by the State.

Approximately \$400,000 was set aside for four research contracts. These were first-stage contracts, feasibility studies. They were surface-scratching efforts to test a new idea.

Four space companies, and four teams of space engineers, were asked to look at the problems of crime, pollution, information control, and transportation in the State.

They were asked to be broad gaged in their approach. The question was: Can we take a scientific look at each of these problems in a new way, as a system of subproblems, as an integrated whole, and thereby devise new, overall, integrated approaches to their solution?

Can we put the State in a laboratory and the problem in a computer?

Another question was stressed: Can we estimate the cost of various possible approaches—or mixes of approaches—and use computers to figure out the most efficient and economical way to do a job? In other words, can we get some idea of the cost-effectiveness of a variety of social programs?

The results of the first stage are now in. They are a success. California has proved that the concept of using space engineering on these problems is a feasible one. These preliminary studies reveal truly exciting possibilities for solving incredibly difficult social problems. I think Governor Brown's idea is the most creative idea in many years. We must now follow up the initial demonstration studies with full-blown experimental research. This means testing several projects to see how various proposals now sketched by the computers will actually work in practice.

This is one of the major purposes of this bill. Another is to try to find new uses for a great national resource: our highly trained scientific and technical manpower.

Let me give you one example of what just one California study showed.

We know that space engineers have designed a system to get information to and from space capsules. They even got us photographs from Mars. California asked whether they could not use the same techniques to help government get more accurate information right here on earth.

Our earthbound information problem is huge. In this 1 State, 23 county departments report information regularly to some 28 State departments. They submit almost 600 different kinds of reports. In 1 year, 1 county will typically transmit nearly 10,000 separate reports.

Today we are still using horse and buggy techniques to handle this vast amount of information. In California alone there are already 75 miles of State and local government filing cabinets which store information—in a more or less

efficient way. By 1990 there will be 354 miles of filing cabinets unless something is done.

By 1974 the documents stored could pave a paper trail to the Moon and back—and anyone who knows typical office procedures knows that finding the one needed piece of paper in a filing cabinet may well be as difficult as getting it back from the Moon.

All this need not be. Scientists today can put the information collected at city, county, State and even Federal levels, into computers. With a flick of a button the precise information desired can be pulled back out of the computer. It can even be done by remote control as telephone wires connect one city to another and computers "talk to each other."

This is not only an efficient way to store and process information; it is economical, for one computer can eliminate thousands of filing cabinets, millions of pieces of paper, hundreds of file clerks, and scores of frustrated executives who never seem to be able to get the right information at the right time.

Another California study has showed that these same computers can provide the information necessary to effectively deal with crime and juvenile delinquency.

The basic work of this study was completed before the tragedy of the Watts riots in Los Angeles. The study showed, with amazing pinpoint accuracy, that this clearly defined block-by-block area within the city was a dangerous and unstable spot. The study showed that there was every reason to expect trouble—and it showed precisely where that trouble might occur.

It is estimated that the Watts riots resulted in at least \$50 million in direct losses, and another \$50 million in indirect costs. Had we understood the meaning of this study beforehand, we might have been able to apply the principle of an ounce of prevention.

As this example indicates, one feature of the computer, systems-analysis approach, is a scientific attempt to pinpoint the dimensions of a problem with high accuracy.

In Watts there were five menacing indicators that pointed out the troubles: Low family income; Negro population concentrations of more than 75 percent—with little integration; living conditions with more than 10,000 people per square mile; extremely high school dropout rates; and a high arrest rate—100 or more per 1,000 in the age-group 10-17; 25 or more arrests per 1,000 total population.

Using the proper criteria to identify the problem is only the first step. The second step is to find the answer—or more important—to find the right combination of answers, at the lowest cost.

One way to fight crime is to put a criminal in jail for life. This will keep him from committing a further crime, but it is extremely costly. It costs a great deal of money to keep a man in jail for a year.

Another way to prevent crime is to take each first offender, and instead of putting him in jail at his first offense, spend substantial amounts of money for counseling, job training, psychiatric care, to try to help him onto the right track for a productive, noncriminal life. This may cost more at first, but if it means society would not have to pay to keep the man in jail for the rest of his life, the initial cost may be cheap in the long run.

Our first response to juvenile crime is often to call the police; it is not obvious that we might perhaps be better advised to call the employment and counseling service.

The first California studies indicate that it might even be wise to look to other parts of the social system if we really want the cheapest, most efficient way to reduce crime. It may well be that a new welfare system, and new poverty programs, dollar for dollar, could do more to reduce crime than could bigger and better prisons.

The studies do not attempt to offer a pat solution to crime. We have none. What is suggested is that we must look at a great variety of problems, seemingly distantly related, to see if pulling on one strand of the tangle here may untie a knot elsewhere.

This is one way to describe systems analysis. What we are really trying to do is figure out in great detail what that ounce of prevention idea is really about.

We want to find out if an ounce of counseling, psychiatric care, and job training, at the outset of a juvenile delinquent's crime career will, in fact, prevent a pound of robbery and theft later on.

We want to see if 3 ounces of new probation counseling will prevent 5 pounds of crime.

In fact, we want to know precisely how many ounces of each possible approach to prevention will produce the most pounds of cure.

And we want to know the cost: We want to know—throughout the whole system—what is the most economical and effective way to deal with this problem, and what is the cheapest mix of solutions we should adopt.

To do this we must build a miniature world—a mathematical model of the real one—inside a computer, and test various solutions on this world instead of on the real one. This is the systems approach, and the cost-effectiveness method.

It is the same method used by Secretary of Defense McNamara to work out the best mix of weapons for our national arsenal; and the same method used by space engineers to work out the best mix of techniques for trips to the moon.

Another California study showed the value of systems engineering for quite a different problem. Today Federal, State, and local governments are spending hundreds of millions of dollars on research and engineering to solve problems of air and water pollution. But there are no research and planning studies of the interrelationship of these problems. There is no attempt to achieve a total solution through a comprehensive and integrated system of waste management.

We can take some of the microscopic solids out of industrial smoke to reduce smog, but if we dump those solids into a river or lake we have converted an air pollution problem into a water pollution problem.

What is needed is a study of an overall scientific system for waste management, taking into account the interrelationships of geographic regions and the effect of industry and urban areas on air, ground, and water pollution. Such a system is every bit as complicated as a Gemini flight and it would involve the same disciplines of biology, physiology, mathematics, physics, engineering, and others. Bringing together all of these disciplines and applying them to solving a problem is systems engineering.

The California studies suggested that in the future sewage system construction could be integrated with the construction of roadways. Tubeways would consist of traffic roadways and rapid transit systems above, on, or just below the surface. Electrical power and communication lines would be located near or under the road surface. Below this network would be water lines, sewer lines, treated waste water lines, gas lines, and perhaps, gasoline and chemical lines. By handling all of these problems at one time in an integrated way, huge sums could be saved.

Another idea is that municipal solid waste are not expected to be collected in the household, carried to trash cans, and carted to the street for collection, as at present. With a general high standard of living, homeowners are expected to insist on a more advanced solid waste handling system. This might be to provide all households and industries with grinders which could grind solid wastes fine enough to be effectively handled in the sewer system.

Or, the homemaker might deposit any solid waste into a wall inlet in each room and never be troubled with it again. Solid wastes from each room and garden wastes from outdoor inlets would be collected in a container beneath or beside the home. One idea would be an underground conveyor belt that transports the waste out to and under the street and deposits it on a central underground belt running beneath the center of the street.

Some homesite processing of liquid waste may be desirable. A homesite liquid waste processor and compactor could function as a primary treatment device for extracting solids from the liquid wastes before being broken down—the stabilized solids could be combined under the house with the solid refuse.

Perhaps instead of using tin cans, our solid waste disposal problem could be solved by using plastic combustible containers which present a minimal disposal problem.

But these are only a few of the many possible ideas arising out of systems analysis. Instead of looking at the narrow question of how to dispose of our present deluge of tin cans, the systems analyst looks at the broadest possible question, asking himself why we do not do away with tin cans altogether.

For waste management, for crime, for data—in short for almost any complicated problem facing the Nation, the secret is that no one facet of a problem can be isolated from the broader problem. All sides of any problem must be looked at together—as one system.

That is the purpose of this bill. We hope to build upon California's successful experience. Because of the brilliant work and leadership of Governor Brown, we know the basic idea is feasible. Now we need to do further research to test

which specific approaches, and which specific solutions will work best. We need to move beyond feasibility studies to demonstration research tests.

Both the social problems we are dealing with and the men we are asking to deal with them are matters of concern to all of us. For this reason the bill provides that the actual studies are to be conducted in the various regions of the country where the problems require urgent attention, and where the talent to do the job exists. The results of any one study are to be made available to all States with similar problems.

Perhaps one of the most exciting aspects of this approach is that we will take maximum advantage of our highly trained manpower just as our best private firms are doing.

The leaders in this field are the space firms which have paved the way in California. They have developed the techniques of systems analysis and engineering. And they have the commitment to national objectives which is so important to the success of this proposal.

The aircraft-missile industrial complex alone employs more scientists and engineers on research and development than the combined total of chemical, drug petroleum, motor vehicle, rubber, and machinery industries.

These figures show not only that the aerospace industry has a huge portion of the scientific manpower in America today, but also that we have committed this tremendous national resource to activities which are not directly related to the solution of our Nation's social problems.

It would be highly in the national interest to begin devoting a portion of the talents and brains of our defense and space industries to other national goals of a Great Society. This would require no diminution in either our defense or space commitments. We can do both—we can have guns and butter; we can have a moon shot and a national plan for the abatement of pollution; a polaris project is not incompatible with a new and scientific attack on the terrors of crime. Moreover, the California studies have shown that private firms can help us achieve this objective since many companies in other industries have developed a systems engineering capability.

In fact, this capability and brainpower already available throughout the Nation is a great secret weapon. It is a scientific weapon of demonstrated power, and a resource which represents a huge national investment.

Our task is to recognize that we have the scientific know-how, and the men, to solve almost any problem facing this society. Once we understand this, I am confident we will choose to use the resource; we will choose to set our highly trained manpower loose not only on space probes but on down-to-earth problems; we will choose to use systems analysis, computers, and every modern resource available to us in the quest for progress.

If we do that, we will have launched ourselves on a space age trajectory to the Great Society.

I ask unanimous consent to have printed in the Record a copy of the bill, and various materials relating to it.

The ACTING PRESIDENT pro tempore. The bill will be received and appropriately referred; and, without objection, the bill and material will be printed in the RECORD.

The bill (S. 2662) to mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation's manpower resources to solve national problems, introduced by Mr. NELSON (for himself and other Senators), was received, read twice by its title, referred to the Committee on Labor and Public Welfare, and ordered to be printed in the RECORD, as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the 'Scientific Manpower Utilization Act of 1965'.

"Sec. 2. It is the purpose of this Act to facilitate and encourage the utilization of the scientific, engineering, and technical resources of the Nation in meeting urgent problems facing the Nation or localities within the Nation, by promoting the application of systems analysis and systems engineering approaches to such problems. The problems referred to in the preceding sentence include, but are not limited to, problems in the area of education, unemployment, welfare, crime, juvenile delinquency, air pollution, housing, transportation, and waste disposal.

"Sec. 3. The Secretary of Labor (hereinafter referred to as the "Secretary") shall carry out the purposes of this Act by—

"(1) making appropriate grants to States, and

"(2) by entering into appropriate arrangements (whether through grants or contracts, or through other agreements) with universities or other public or private institutions or organizations,

for the purpose of causing the systems analysis and systems engineering approaches to be applied to National or local problems of types which the Secretary, by regulations, designates as being within the purview of this Act.

"SEC. 4. (a) Any grant made under section 3 to a State shall be used only for the purpose for which the grant was made, and may be used by the State for such purpose directly, or through the State's entering into appropriate arrangements for the carrying out of such purpose (whether through grants or contracts, or through other agreements) with universities or other public or private institutions or organizations.

"(b) No grant under this Act shall be made to a State unless the Secretary finds that—

"(1) the knowledge and experience expected to be gained from the employment of such grant would have substantial relevance to problems within the purview of this Act which exist in other States;

"(2) the State has presented a plan setting forth in detail the purposes for and manner in which such grant is to be used, together with the objectives expected to be achieved from the use of such grants;

"(3) the State has designated an officer or agency of the State who has responsibility and authority for the administration of the program in which such grant is to be employed; and

"(4) the State agrees fully to make available to the Federal Government and to other States (and political subdivisions thereof) data and information regarding the employment of such grant and the findings and results stemming therefrom.

"(c) There shall not be granted to any State under this Act amounts the aggregate of which exceed 20 per centum of the aggregate of the amounts which have been appropriated to carry out this Act at the time amounts are granted to such State hereunder.

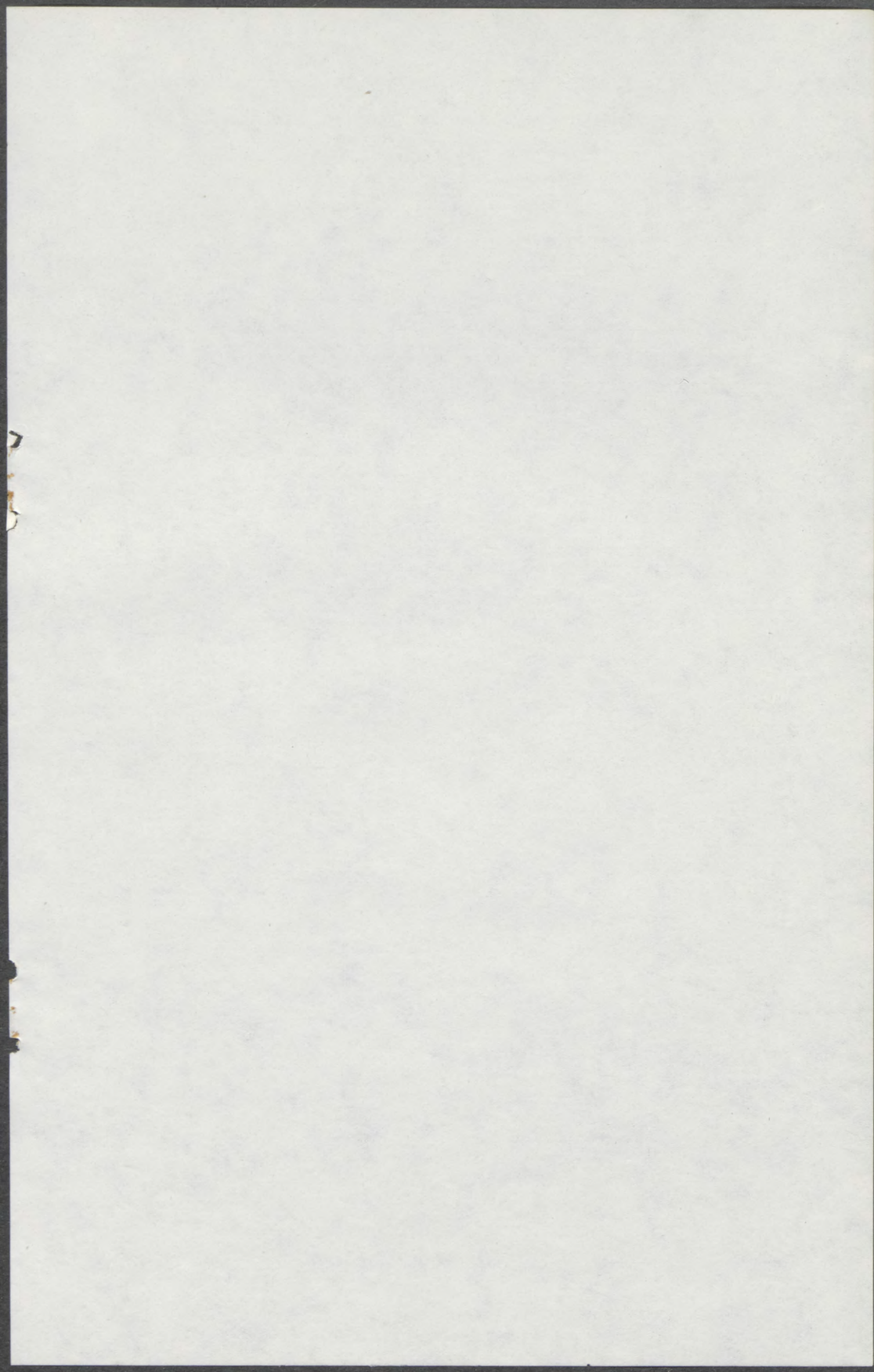
(d) Two or more States may combine to apply for one or more grants jointly to carry out the purposes of this Act with respect to one or more of the problems which they have in common and which are within the purview of this Act, and in any such case, the provisions of subsection (b) shall be deemed to require the submission of a joint plan for the utilization of the grant and the designation of one or more officers or agencies having responsibility and authority to carry out the joint plan. Each State participating in such a joint plan shall be deemed, for purposes of subsection (c), to have received an amount equal to the amount produced by dividing the amount of the grant received to carry out such plan by the number of States participating in such plan.

"SEC. 5. The Secretary, in awarding grants to States and in entering into arrangements with universities or other public or private institutions or organizations, shall follow procedures established by him for the purpose of assuring that the grants or other expenditures made to carry out the purposes of this Act will be equitably distributed among the various major geographic regions of the Nation.

"SEC. 6. For the purpose of making the grants and entering into the other arrangements provided under section 3 of this Act, there is hereby authorized to be appropriated, without fiscal year limitation, not more than \$125,000,000."

(Whereupon, at 12 noon, the subcommittee recessed subject to the call of the Chair.)





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