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TRANSPORT RESEARCH PROGRAM

Progress Report -- First Six Months

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The Brookings Institution
Washington, D.C.
December 12, 1962

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Transport Research Program

PROGRESS REPORT NUMBER 1

June 12, 1962 to December 12, 1962

Overall Review

The Transport Research Program was established in the Economic Studies Division of The Brookings Institution under the terms of a grant (AID/repas-5) from the Agency for International Development, dated June 12, 1962.

The purpose of the program is (a) to increase understanding of the role that transport plays in development; (b) to shed light on the possibilities that science and technology offer for the solution of transport problems; (c) to develop criteria for judging among transport investments and between transport investments and investments in other sectors of the economy; (d) to determine the kinds of transport facilities best suited to designated tasks in a given environment; and (e) to assess what is needed, organizationally and administratively, to implement transport programs in underdeveloped countries.

The program is directed by Wilfred Owen, Senior Staff, under the general supervision of Joseph A. Pechman, director of the Economic Studies Division. Work is envisioned by a small resident staff at Brookings and by subcontracts to qualified researchers in universities and other research centers.

Accomplishments of the First Six Months

The first six months of the program have been devoted to outlining the research task, recruiting staff, interesting capable researchers in the university community and initiating certain projects which have a high priority within the program.

The first step, following the Institution's normal procedure on major research undertakings, was the appointment by the President of an Advisory Committee for the program. The following members have been appointed:

Carl F. Christ, The Johns Hopkins University
Holland Hunter, Haverford College
Louis Lefebvre, Massachusetts Institute of Technology
Edward S. Mason, Harvard University
Harvey S. Perloff, Committee of Nine, Organization
of American States
Lloyd G. Reynolds, Yale University
Robert Sadove, International Bank

In addition, Joseph A. Pechman and Robert D. Calkins serve as ex officio members of the Committee.

The Advisory Committee's first task was to guide the development of an overall statement of objectives and scope of the research program. This statement was prepared following a general meeting on August 2 of some fourteen experts on various phases of economic development and foreign assistance. A list of participants in this meeting appears as Appendix A.

The statement, which is included as Appendix B, delineates six major areas of research as the focus of the transport research program.

These are (a) the impact of transport investment; (b) transport investment requirements; (c) transport technology; (d) demand for transport; (e) organization and administration; and (f) financial policy. Examples of research in each of the six areas are detailed in a second staff paper (Appendix C). Both papers were given wide circulation within the academic community.

A high priority was given to the problem of measuring the impact of transport investment. Professor George W. Wilson of Indiana University was assigned the task of developing a working paper on Criteria for Measuring the Development Effects of Transport (Appendix D). The paper was reviewed by several scholars from other universities and by staff at a meeting on November 16, and is now being revised to take account of the comments at the meeting. The discussion centered chiefly on the problem of selection of the relevant units for measurement (from partial analysis of a local or sub-regional type to national aggregative measurement of all sectors of the economy). It was agreed that the former could be misleading and that the latter might conceal much that had happened on a regional level. Further work will be necessary to develop useful criteria which can be tested in a number of case studies. In this connection, Professor Louis Lefebvre (MIT) has begun an exploratory study on the availability of research data on the Allocation of Capital to Transport in India for a possible case study.

Three studies by Brookings staff are now underway. These include Mr. Owen's book Analysis of the Role of Transport in Underdeveloped Countries, work on which was begun prior to the AID grant. The book is an overview of the role of transport in the development process and includes an analysis of foreign aid in the transport field. A tentative table of contents appears as Appendix E. The book is expected to be ready for publication by the spring of 1963.

A second study entitled "Government Controls on Transport" was begun in October by Edwin T. Haefele, Senior Staff (on leave from Northwestern University). This study deals with the incidence, theory, and effects of using transport controls to influence development and is expected to be completed in a year. (See Appendix F.)

The third study, being conducted by Eleanor Steinberg, Research Assistant, is a background review of national development plans, country studies, and transport surveys in underdeveloped areas. This review is being undertaken to provide a comprehensive picture of available data and analysis which might contribute to the present program. A report is expected by February 1, 1963.

Negotiations have gone forward with more than a score of universities regarding possible subcontracts for research on some aspect of the program. Several which show high promise of being accepted are (a) Syracuse University (Administrative and Organizational Recommendations to Nations Receiving Transport Loans and Grants) --

the proposal has been approved and contract negotiations are in process; (b) Northwestern University (Investment Decisions for a City-Hinterland Complex in an Underdeveloped Economy); (c) Harvard-MIT Joint Center for Urban Studies (The Urban Transport Problem in Underdeveloped Countries); and (d) Harvard University (Transport Research Seminar).

Because of the fragmentary nature of knowledge of transport development in the underdeveloped world, a set of country files for current data on transport and development has been set up by the staff. In addition, a selective roster of individuals and institutions involved in research on economic development is also being developed.

Plans for the Next Six Months

Work will continue on the projects listed above and there is every indication that some acceleration of program will be possible during the second six months. A series of case studies analyzing the results of past transport investment is planned as an essential part of the development of policy guidelines for future investment. These will provide valuable data of an empirical nature to implement theoretical work on transport as a sector in an overall development plan, conceived of as a planning model, or input-output matrix. Both should begin early in 1963 with the appointment of two more senior staff members. One of these, Gary Fromm (Harvard University) will join the staff as a Senior Staff Member as of January 1, 1963. (A list of present staff is included as Appendix G.)

It is expected that, in addition to the universities now interested in participating in the program, wider interest will be generated, particularly in the area of alternative technologies of transport, including new technological developments. Discussions on this latter point are going on with the University of Illinois, Indiana University, and with the president of Rose Polytechnic Institute.

The reception of the program by experts in the transport field and by foreign aid personnel indicates the need for the study. It is expected that results of the program, particularly as they relate to policy, will be welcomed by all those concerned with this important problem.

APPENDICES

- Appendix A Participants, Conference August 2, 1962
- Appendix B Framework of the Transport Research Program
- Appendix C Examples of Projects within the Framework
- Appendix D Criteria for Measuring the Development
Effects of Transport
- Appendix E Analysis of the Role of Transport in Under-
developed Countries
- Appendix F Government Controls on Transport
- Appendix G Present Staff of the Transport Research
Program
- Appendix H Report of Advisory Committee Meeting
- Appendix I The World of Highways and Highway Transport
in 1987
- Appendix J Transport Technology and Economic
Development

Appendix A

PARTICIPANTS

Conference
August 2, 1962

Hans Adler	International Bank
Torgeir Finsaas	London, England
Theodore Geiger	National Planning Association
Kenneth Hansen	Bureau of the Budget
Kent Healy	Yale University
Robert B. Keating	Agency for International Development
James Lemly	Georgia State University
John Lindeman	Syracuse University
Edward S. Mason	Harvard University
Robert Nathan	Washington, D.C.
M. Joe Peck	Department of Defense
Harvey S. Perloff	Committee of Nine, OAS
Merrill J. Roberts	University of Pittsburgh

Brookings Institution

Robert D. Calkins
Joseph A. Pechman
Robert E. Asher
Wilfred Owen
Edwin T. Haefele

The Brookings Institution
Economic Studies Division

TRANSPORT RESEARCH PROGRAM

The Brookings Institution is conducting a major five-year program of research on the role of transportation in development. The effort to advance the state of knowledge in this relatively neglected area will enlist the participation of individual scholars, universities, and other agencies throughout the country and abroad in a comprehensive program of studies involving economics, political science, and technology.

The new program follows from a continuing series of transportation studies conducted by Brookings staff over an extended period of time. Previous undertakings have involved a variety of issues relating to national transportation policy, urban transportation, and the transport problems of Asia, Africa, and Latin America. The present effort is made possible by a grant from the Agency for International Development, which has provided \$1,470,000 for the first three years' work, with support for the balance of the program to be determined at the end of that period.

Purpose and Scope of the Program

The work to be undertaken is designed (a) to increase our understanding of the role that transportation plays in development, in order to help guide resource allocation in emerging economies and in foreign assistance programs; (b) to shed light on the possibilities that science and technology offer for the solution of transport problems, both with respect to transport methods and to innovations outside the transport field that affect transport; (c) to develop criteria for judging among transport investments and between transport investments and investments in other sectors of the economy; (d) to determine the kinds of transportation facilities which are best suited to the transport tasks to be

performed in a given environment; (e) to assess what is needed to implement transport programs, including an evaluation of alternative organizational arrangements and financial policies in the public and private sectors.

All of these factors are involved because all of them play a role in achieving an optimal use of resources for transportation. At present, there is no clear understanding of the developmental effects of transport improvements, the desirable timing of transport investments, nor the potentials for achieving economic, social, cultural, and political objectives through transport. The many factors that need to be taken into account in selecting desirable transport methods have not been given proper consideration, and there has been no systematic appraisal of the role of public and private enterprise, of various administrative solutions, nor of different approaches to financing, rate-making, and regulation. Yet all of these aspects of the transport program can have profound effects on development.

What is unique about the Brookings program is that we are studying the transport sector as it relates to the total environment. And we are exploring the problem and the benefits of achieving greater mobility with all of the ingredients of mobility under examination. This is not a study of transportation per se, but of transportation's role in development. And since accessibility and mobility are essential to almost everything that underdeveloped countries are striving to accomplish, it follows that transportation may be a key factor in the success or failure of the entire development effort. This does not mean that transport is all-important, for it is food, shelter, health, education, and jobs that are the ultimate objectives. Transport may be the catalyst, however, and this is the function that makes it important.

What research approach do these considerations imply? Essentially they dictate that the research should be concerned with applying transport technology to the realization of development objectives. At the same time, they imply an approach which not only looks at transportation as a whole (each form of transport is usually planned and provided separately), but which looks beyond transport itself to the processes of production and distribution that the transport system is called upon to serve.

One goal common to most developing countries is the production of more food. The role that transportation can play in attaining this objective is to provide access to arable lands, to help communicate new agricultural techniques, to make possible the delivery of seeds and fertilizer, and to assemble and move the increased product to consumers. If the transport goal is thought of as serving agriculture, then the research must include more than an examination of the type of transport facilities needed. It should also be concerned with the organization and financial arrangements for keeping roads passable; necessary arrangements to enable producers to purchase vehicles; and provision for transshipment to line-haul truck, railway, or inland water carrier. The objective is to close the gap between the producer of agricultural surpluses and the consumers who need food.

Looking at transport in this broader framework may lead to solutions that are satisfactory from a transportation standpoint but which are still unsatisfactory from a development standpoint. The goal of increasing the food supply may not be served best by expediting movement at all. One alternative may be to provide storage facilities. When storage is made possible in producing areas, peak traffic demands typical of agricultural economies can be flattened by spreading the transport burden over a longer time period, and transport capacity requirements can be reduced accordingly.

For some types of perishables the solution may not be storage but processing. The establishment of processing centers close to sources of supply will reduce spoilage and eliminate the need for speedy transport or for refrigerated equipment. Processing may have the added advantages of creating local employment, providing a source of local capital accumulation, making agricultural waste available for fuel or local manufactures, and reducing the weight and bulk of commodities flowing into the transport system. This kind of solution to the transportation problem may emerge if attention is focussed on the objective of raising per capita food consumption rather than simply on making areas of production more accessible.

The concept of optimizing resource use for development also applies to the accommodation of transport facilities to industry. Various aspects of the industrial program may be dictated by transport limitations, including the location and size of industrial plants and the decision to favor a concentration or dispersal of industrial activity. It may be necessary on transportation grounds to modify completely the types of industrial activities to be engaged in. Modification may be necessary because transport costs are excessive, or because transport possibilities suggest comparative advantages through interregional or international specialization and trade.

The same need to look at the total environment is encountered in the analysis of factors governing the choice of alternative technological solutions. To judge the feasibility of road, rail, river, pipe, or air transport alternatives requires matching the demands for transport with conditions governing the supply of transport facilities. What are the relative requirements for capital, managerial talent, foreign exchange, and maintenance? How much time will elapse before the investment will begin to pay off? What

are likely to be the forward and backward linkages, the multiplier effects? What kinds of direct and indirect employment will result, and to what extent will entrepreneurship and new resource development be encouraged? What social and political impacts can be anticipated?

These questions are all part of the process of selecting wisely among technological alternatives because the ultimate objective is higher standards of living, and not merely higher standards of moving.

Topics for Research

Thinking in these terms, with higher levels of living as the goal, makes clear that there is an essential unity in the program despite an apparent heterogeneity. The fact that the program has many aspects stems from the fact that transportation performs many functions. But the following general categories cover all of the principal research needs:

1. Evaluation of the Role of Transport in Development .
2. Determination of Transport Investment Requirements .
3. The Economics of Technology .
4. Minimizing the Demand for Transport .
5. Organizational and Administrative Solutions .
6. Financial Support and Expenditure Policies .

The objectives of research under these several categories are described below, and examples are given of the kinds of inquiry that each area of study might include.

1. Evaluation

There is no clear understanding of what role transport really plays in the development process. What has happened as a result of transport investments in underdeveloped countries to date? What economic, social, and political objectives have been served? What have been the effects of improved transport on resource supply, on productivity, and on levels of living? How has the lack of transport inhibited development? These questions suggest a better understanding of what took place in the more developed countries: the U.S., Soviet, Canadian, and Japanese experiences for example. They also call for case studies of underdeveloped countries and before-and-after studies of specific transport projects in underdeveloped areas. They suggest the study of transport's role in relation to national goals, including an assessment of the role that mobility plays in education, agricultural productivity, industrialization, and so on.

2. Transport Investment Requirements

It is important that a developing country invest enough in transport to enable it to accomplish its objectives in other sectors. It is also important that advantage be taken of the role that transport can play in promoting development. At the same time, the possibilities of unnecessary expenditure and of poor timing must be guarded against if transport is not to drain resources from other urgent needs. How have countries in various stages of development determined what proportion of their resources should be invested in transport? What have been the approaches and the results of Indian and Pakistan experience? Of policies in the Soviet Union and Japan? In Colombia and Egypt? What have been the underlying assumptions and techniques employed in the various country surveys and consultants' reports on transport needs? Can we develop new techniques to help determine the desirable proportion of investment in transport?

3. Transport Technology

More needs to be known about the economics of alternative transport methods, including not only comparative transport costs, but costs in the broader context of production and distribution processes. What are the factors that should be taken into account in the selection of transportation techniques? What has been the experience in both the developed and underdeveloped countries with road, rail, and other forms of transport? What advantages are to be gained from the early development of air service? What types of transport are most appropriate in different stages of development? How can modern transport technology be adapted to the special problems of underdeveloped countries, and what programs for further research and development are called for to hasten needed innovation?

4. Transport Demand

The possibilities of avoiding commitments for transport offer one of the most significant challenges. If the developing nations were obliged to follow the same evolutionary course as the developed nations, the burden of supplying needed transport would certainly be overwhelming. For this reason the greatest promise may lie in achieving certain transport objectives through decisions outside the transport sector: through political decisions, economic planning decisions, and scientific innovations that have an impact on transportation requirements. Mention has already been made of storage, processing, and the location of industry as factors that can reduce the hauling of freight. The burden on transport may also be avoided through innovations in the type and distribution of energy resources. What is the economics of nuclear power and national power grids when transport factors are added to the equation? How can telecommunications achieve some of the

social, political, and cultural objectives previously attainable only through transportation? What are the transport implications of population shifts from rural to urban areas, and should national policies seek to stem the tide or to accommodate urbanization trends by physical planning designed to minimize transport problems?

5. Organization and Administration

Whatever decisions are made, and however ideal they may prove to be from the standpoint of economics and technology, transport performance will be poor if organizational arrangements are poor. More needs to be known about present organization of the transport function in underdeveloped areas and the advantages and disadvantages that administrative experimentation has revealed. Have public corporations and various types of authorities proved more desirable than the government bureau or the ministry of transport? What are the organizational requirements for a total transportation approach, including the necessary integration of transport and planning commission objectives? What role should be played by the private sector? Is the transport company a feasible solution, and to what extent is economic regulation relevant to the problems of developing nations? What international arrangements for transport operation are possible? What institutional arrangements are needed in the U.S. and elsewhere to provide research and training in transport and development? How can transportation promote the objectives of regional economic integration?

6. Financial Policy

How are transport facilities now being financed and what lessons are there in world experience to date? Is the goal to make transport self-supporting? Why are most of the world's railways in financial difficulty? How can railway rate policies influence development? What approaches might be taken to alleviate the financial burden of the road

program? To what extent should roads, ports, and airports be financed by tolls or other user charges, and what are the implications for development? How can foreign aid policies in the transport sector make the most effective contribution to development?

The range of inquiry is broad, and to some extent the specific areas discussed above overlap. But focus can be maintained by using these six major categories of research as benchmarks. There will be priorities, of course, but priorities should be developed within each category rather than among the major groupings, since all aspects are important to the total objective and should be studied simultaneously.

Organization of the Program

The Transport Research Program is directed by Wilfred Owen. The Program is one of the major research activities of the Economic Studies Division of the Brookings Institution, which is directed by Dr. Joseph A. Pechman.

The Washington nucleus for this activity will include a small group of professional staff members and research assistants, supplemented from time to time by research scholars and technical experts on special assignments, and by visitors from other countries. The central staff will be responsible for the major portion of the research effort as well as for the organization of relevant information, the conduct of meetings, and the arranging of outside agency participation. It will also provide a clearing house for information on research, completed and underway, relating to the role of transport in development.

An additional responsibility of the central staff will be the improvement of international communications among transportation and development scholars and public officials from the United States and foreign countries through the conduct of meetings on specific

problems . The purpose of these conferences will be to foster an exchange of ideas and information among those responsible for development programs and transport activities abroad, and among participants in foreign assistance programs . The staff will also be called upon from time to time to provide advice on transport problems at the request of the Agency for International Development .

Cooperative undertakings will be organized with universities and other research agencies, as well as with individual scholars . Arrangements will be made for the conduct of research projects calling for varying numbers of participants, depending on the nature and complexity of the subject . The conduct of research seminars in various university centers will also be supported .

One of the aims in staffing the program and in supporting outside research will be to encourage younger people to direct their attentions to the transportation field as it relates to economic growth . Better understanding and greater creativity in this field are urgently needed by countries in all stages of development .

The research itself, whether it is centered in Washington or elsewhere, will include conceptual studies designed to provide the theoretical framework for the program; fact-gathering and descriptive materials to provide a background of information that does not now exist or is unavailable in useful form; and the analytical and policy work based on these theoretical and factual studies .

These undertakings will involve a heavy reliance on foreign statistical information, previous foreign study materials, and on personnel with experience in development work in the less developed countries . Foreign travel will be necessary to supplement these sources of information .

The allocation of funds to the various projects under the Transport Research Program will be made by the Board of Trustees of the Brookings Institution, with the guidance of an advisory committee of outstanding economists and transportation experts. Results of the studies undertaken will be published by the Brookings Institution in the form of books, pamphlets, special reports, and reprints from professional journals. These materials will be broadly disseminated among agencies and individuals interested and involved in development problems here and abroad.

Inquiries concerning the program may be submitted to the Director, Transport Research Program, The Brookings Institution, 1775 Massachusetts Avenue, N.W., Washington 6, D. C.

September 7, 1962

The Brookings Institution
Economic Studies Division

EXAMPLES OF PROJECTS WITHIN THE FRAMEWORK
OF THE
TRANSPORT RESEARCH PROGRAM

Summary

I. Impact of Transport Investment .

1. Criteria for Measuring the Development Effects of Transport .
2. Case Studies of the Impact of Transport .
 - a) The Transport Program in India .
 - b) The "Big Push" in Colombia .
 - c) Transport Modernization in Turkey .
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VI Financial Policy .

1. Influence of Financial Policy on Transport and Development .
2. Effects of Foreign Aid Financial Policies .

I. IMPACT OF TRANSPORT INVESTMENT

1. Criteria for Measuring the Development Effects of Transport and the Lack of Transport.

The purpose of this staff paper is to explore methods of evaluating the effectiveness of transport improvement as a means of promoting development, and conversely to explore the relation between immobility and poverty.

Certain indices relating to movement itself will reflect the impact of transport investment: declining cost per mile or cost per ton-mile, the growing volume of movement accommodated, time savings in transit, and the increasing safety, frequency, and reliability of service. Other indices also directly related to the provision of transport may include employment in construction and operation, creation of entrepreneurial and technical skills, access to new lands and other resources, expansion of markets, and reduction in the prices of agricultural and industrial products. Further indirect effects of transport may be found in the growth of supporting industries and other economic activities created by improvements in transport. Where transport has been a major part of the development program, national economic indices may provide an indication of the influence of transport improvements.

Looking at the problem in reverse, there are also criteria for measuring the drag on the economy resulting from inadequate transport or the absence of transport: the amount of land that is inaccessible, the resource potentials that remain unused, the excessive costs of transport, the restricted radius of markets, the losses suffered in transit through breakage, pilferage, and spoilage. The size of business inventories, the percentage of unused industrial capacity, the cost of breakdowns, the limited geographic coverage to which public officials and technical personnel are restricted -- these and many other facts can provide an indication of the obstacles to development imposed by lack of mobility.

2. Case Studies of the Impact of Transport on Development.

Guided by the conceptual framework established in the initial paper on relevant criteria, a series of case studies will be undertaken to help shed light on the importance of transportation to development.

Some of these case studies will concern individual projects -- the construction of an entirely new road or railway, the improvement of an existing facility, or the initiation of scheduled air service. Other studies will involve the development of a system of improvements -- the dieselization and re-equipment of an entire railway system, or the improvement of a network of farm to market roads. Still other case studies should look at the total transport sector and attempt to measure the impact of the total effort.

Case studies must include a variety of types of transport undertakings, as well as projects that have been in operation long enough for their impact to be felt. Selection must also take account of whether "before" as well as "after" information can be obtained. And projects should be located in countries representing different conditions and different stages of development.

At this time a few examples are given of the kinds of cases that might be undertaken in a first approach.

a) The Transport Program in India.

Transport is one of the bottlenecks in the Indian Third Five-Year Plan. This has occurred despite the substantial allocations of public capital to the transport and communications sector (18, 29, and 20 percent respectively for the three five-year periods) and despite large-scale foreign assistance (three quarters of a billion dollars from principal U.S. and international agencies during the past decade).

The specific nature of the current Indian transport difficulties should be identified, along with the underlying factors. Purpose of the analysis will be to determine desirable policy changes in the transport sector to strengthen the Indian program, and the lessons that may be applicable to other countries.

b) The "Big Push" in Colombia.

During the past decade a very heavy proportion of total public investment in Colombia has been allocated to transport. The special transport difficulties have resulted from the large area and difficult terrain of this country. The emphasis on overcoming some of the natural handicaps to transport has had spectacular results in achieving a closer integration of four previously isolated regional economies, and national economic growth appears to have been notably aided by the decision to concentrate on improving mobility and accessibility. At the same time, education, housing, health, and other social investments have been neglected.

What have been the specific accomplishments of the transport program to date? Was better transport a necessary precondition for moving ahead in other fields? In retrospect, would a more balanced development program have been more successful in accomplishing higher levels of living? Is the present transport plan designed to make the most effective contribution to development, considering both its relative magnitude in the development program and its internal composition?

c) Transport Modernization in Turkey.

Sufficient time has now passed since the large-scale initial effort to modernize Turkish transport through the Greek-Turkish Aid Program. A number of studies already have been

made of the impact of this program to improve the railways and ports and to create a nation-wide road transport system. In many parts of the country there has been a sharp reduction in transport costs and in the price of agricultural commodities. Social, political, and cultural impacts have also been of major importance.

Along with the benefits of the transport effort, there were many unfavorable repercussions, including severe inflation, a heavy drain on foreign exchange reserves, the neglect of urgent needs outside the transport field, and imbalances resulting from the absence of a planned development effort.

The large scale of this military aid program and the emphasis on transport provide a good opportunity for studying the impacts of the "big push" in transportation. Available studies plus additional field work should provide valuable assistance in assessing the advantages and disadvantages of similar emphasis in the development programs of other countries.

d) Evaluation of Individual Projects.

The most fruitful effort to evaluate the impacts of transport improvements may be found in the analysis of individual projects or groups of projects. Twenty to thirty undertakings have been selected that might yield useful before-and-after information. What has happened as a result of the following projects, for example, and what factors contributed to the outcome?

i) An IBRD loan was made to Ethiopia in 1957 for extending the all-weather road network to about 3,400 miles and for the construction of six new roads with a total length of about 530 miles. Three of the new roads branch out from Jimma, the heart of Ethiopia's coffee producing area. At the time this loan was made, only a small fraction of the crop was picked because of the difficulty of transportation. These roads were expected to facilitate marketing and to stimulate production.

Another road was to be constructed from Addis Ababa to Burie, and was to open up a densely populated region suitable for the commercial production of oilseeds, grain, cotton, and livestock. The expected annual increase in the production of cash crops was estimated at \$25 million. In addition, the new roads were to help improve government administration, schools, local industries, and trade.

ii) In 1960, the Eximbank and DLF jointly extended credits to Guatemala for the completion of a highway between El Molino and the Rio de Paz. This new highway was to run through a populous and productive area in the southern part of the country, facilitating access to markets for farmers and ranchers and opening up forest areas for lumber operations.

iii) A DLF loan was made in 1959 for the construction of a 148-mile all-weather road between Quito and Quevedo, a part of the highway linking the mountainous interior of the country with the principal port, Guayaquil. Anticipated results were to be the opening of fertile but inaccessible land for raising bananas and cocoa, and the promotion of industrial development.

iv) An IBRD loan was made to Sudan in 1958 for the construction of two new railway extensions branching out from the country's main-line system. The 210-mile western extension was to provide for the movement of gum arabic, groundnuts, sesame seed, and livestock, and the southern extension was to open up wood and grass lands with good potentials for oil seeds, rice, timber and tropical produce. Both of these regions were inaccessible at the time the loan was made.

v) An IBRD loan was made to Ruanda-Urundi in 1957 to help finance a modern port on Lake Tanganyika at Usumbura, and the building of a paved highway from Usumbura to the central plateau where most of the population and economic activity are concentrated. Most of Ruanda-Urundi's exports and imports pass through the port and over

this road. The bulk of coffee and mineral exports are produced on the plateau and brought down by truck for shipping through the port of Usumbura. It was believed that the replacement of inadequate and obsolete facilities by a modern port would expedite the movement of goods, reduce costs, and accommodate the growth of traffic.

e) Transportation as a Factor in World Hunger.

In addition to case studies on a geographic or project basis, study of the relation between transportation and development should be focused on certain functional areas. The most important of these is agriculture.

There are numerous indications of the degree to which transportation or the lack of it has a bearing on the food supply. Large areas of arable land lie unused because they are out of reach. Where it has been possible to bring land under cultivation, the problems of getting produce to market remain. Even the isolation resulting from an absence of all-weather transport has an important bearing on production, for the introduction of new ideas and new techniques depends to a large extent on personal mobility. Where surplus production is possible, the will to produce for the market may be stifled when it is known that the chances of getting things moved are poor.

This study will examine the effects of adequate and inadequate transport on agricultural production and marketing in a number of countries. Attention will be directed not only to transport itself but to related measures for improving the food situation, including farm cooperatives, storage, and processing.

3. The "Multiplier Effects" of Transport Development .

The importance of transportation to development lies not simply in the movement of people and goods but in the public and private enterprises that support it . In the United States, Japan, and Western Europe, these supporting activities have played a major role in economic growth . In the newly developing areas of the world new industries and employment stemming from transport improvements can likewise provide an important stimulus to growth and to the training of entrepreneurs and skilled workers .

If the full benefits of transport improvement are to be realized, it appears that greater emphasis may need to be placed on nurturing these supporting economic activities . This study will survey in selected countries the extent to which these "multiplier effects" are being realized, the factors inhibiting greater progress in this direction, and the possibilities of relating development plans and foreign assistance more closely to the industrial potentials introduced by the expansion of transport facilities .

II. TRANSPORT INVESTMENT REQUIREMENTS

1. Statistical Analysis of Present Practices and Planned Programs of Expenditure for Transportation .

This background study will assemble available information on public and private investments in transportation and their relation to total investment . Where possible, information will be compiled on other outlays for transport, including maintenance and operation, to provide a total picture of the employment of resources in this sector . Data will also be obtained to show the relative emphasis on various types of transport investment in countries of different characteristics and stages of development .

2. Historical Studies of Transport Investment in the Industrialized Countries.

The now industrialized countries invested heavily in transportation in the early stages of their development. Is it still necessary to place this extraordinary emphasis on the transport sector? In some countries, notably the United States and Japan, this concentration on transport was in advance of industrialization, while in Western Europe much of the early development took place before the mechanization of transport, and transport improvements had to catch up with industry.

What can we learn about today's problems from the drive to provide basic transport facilities and the lead time and lag in transport investment in the more advanced countries? To what extent are past policies relevant to present problems?

3. Critique of Present Methods of Determining the Proportion of Investment in Transport.

The problem of determining transport requirements and of arriving at an investment program for transport that makes the most effective contribution to development as a whole calls for advances in theoretical approaches and in empirical knowledge. The Indian and Pakistan experiences provide examples of the more scientific approaches to determining what proportion of the development program should be assigned to transport. Methods of estimating transport needs and of allocating funds in these countries should be reviewed in relation to the actual demands for transport that have accompanied growth, and the successes or failures of anticipating transport demand.

Other approaches to determining transport needs should be studied, including efforts in such countries as Colombia, Venezuela, Brazil, Iran, and Nigeria.

Obviously, different approaches and different degrees of sophistication will be called for in countries in different stages of development. Variations in procedure will

also result from the fact that estimating transport requirements to facilitate other known development projects is considerably different from allocating investment to transport in advance of development .

While general prescriptions cannot be expected, the development of greater skills and more satisfactory procedures is an urgent need in most developing countries . The fact that transport is a significant ingredient of other development programs stresses the importance of better guides to investment policy in this sector . And since allocations to transport are always substantial, any excess of investment not actually needed for transport may mean the disruption of other important programs .

4. Transport Needs for Regional Economic Development .

The most advantageous plans for development will often need to be designed on a regional basis to take into account the comparative economic advantages of individual countries . Transportation will then be called upon to provide the essential integrating mechanism . At the present time, however, lack of transportation or excessive transport costs are frequently the most imposing obstacles to development on a regional basis . Many country programs for transport development fail to reflect the need for transport facilities that will permit an efficient international organization of industry and agriculture; and conversely, many of the programs for industry, power, and other economic activities fail to reflect the possibilities for specialization that the ease and economy of modern transport provide .

Studies should be made of the development plans of contiguous groups of Latin American and African countries to determine in what ways transport systems preclude

desirable regional economic developments, how transport plans need to be adjusted for this purpose, and how development programs might be reevaluated to take advantage of emerging transport capabilities .

III. TRANSPORT TECHNOLOGY

1. Criteria for the Selection of Transport Technology.

Selection of the appropriate methods of transport needs to be based on the broad objective of promoting the maximum rate of development . For this reason the criteria for selection will need to take into account not only the relative cost and service factors of alternative transport media, but other considerations relating to resource use and the impact of different technologies on development .

Among the considerations to be weighed will be the initial capital requirements, the availability of materials, the demands on foreign exchange, possibilities for stage construction, extent of maintenance requirements, demands for trained personnel, possibilities of financial self-support, opportunities for employment, potentials for the creation of supporting industries, and the opportunity to hedge against obsolescence or to avoid over-commitment of resources . These and other guides to the selection of road, rail, air, and other transport methods will be developed from empirical studies of the actual cost and service characteristics of different transport methods, and the impact they have had on economies in different development stages .

For the measurement of relative cost, service, and performance characteristics, data from the more developed countries will be useful, but the principal need is to obtain similar facts from selected developing countries . Some of this material is available in recent transportation survey reports of the AID, International Bank, and other agencies,

and some data can be developed from official government reports. Much of the material, however, will have to be obtained in the field.

2. Future of Railway Transport in Developing Countries.

Analysis of the factors governing the selection of alternative transport media will be followed by more intensive examination of the roles of specific types of transport. In some respects the future of the railways is the most important and perplexing question. In all parts of the world, with few exceptions, the railways are operating at a deficit. Many rail systems are in a state of deterioration, their costs are high, and their traffic is increasingly vulnerable to competing carriers. The questions in numerous countries are to what extent existing rail plant should be modernized, what rail facilities are going to be necessary to accommodate growing industrialization, what abandonments are desirable to adjust to growing competition, what changes should be made in rate policies to assure a more economic basis for the allocation of traffic, what regulations should govern railway competitors, and what further trends in air, road, and pipeline transport should be anticipated.

Case study materials are already available in such reports as the Chile, Colombia, Nigeria, and Argentine studies under World Bank auspices, together with individual project appraisals for new rail facilities. This type of information will have to be supplemented by data from suppliers and users of transport services and from public officials in the countries selected for case study.

3. The Role of Air Transport in Development.

There are many examples of the capacity of the airplane to meet urgent needs for transport in areas of difficult terrain and poor surface transportation. Yet aircraft have thus far been used more for international passenger operations than for the types of regional and local

service that might assist development in the early stages .

The economics of air transport and the political and social aspects of a highly developed air system need to be analyzed in relation to the goals of selected development programs . The great distances, sparse population, and poor surface transport of the African continent make this the logical geographic area to concentrate on . Air transport economies need to be viewed broadly from the standpoint of the long-run costs of alternative transport media, and with total production and distribution costs in view . The possibilities of accomplishing the necessary research and development to yield air vehicles more closely geared to the special needs of underdeveloped economies also need to be explored .

4. The Economics of Containerization.

The frequent transshipment of cargo in underdeveloped countries where the transport network is incomplete is a major cause of breakage, pilferage, delay, and excessive cost . The interchangeable container is thus a promising possibility for a substantial increase in transport efficiency and economy . This study will weigh the costs and savings of making the shift to container movement for both industrial and agricultural traffic in selected countries and groups of countries . One approach might be a case study in Colombia which would compute the costs and benefits of a container system compared to the ten-year transport improvement program just completed, which omitted consideration of containers .

5. Designing a Passenger Transportation Model.

Only minor steps have been taken to provide a national system of passenger transport that reflects the particular economic advantages of rail, air, and bus transport . Should investment programs, regulatory policies, and passenger fare structures be aimed at such a system? Or are there greater advantages in supplying each form of transport separately?

This project will study some of the physical, financial and administrative problems of designing an integrated system of intercity passenger transport where road, rail, river, and air transport are all being independently provided. East Pakistan and Colombia might be useful cases.

IV. DEMAND FOR TRANSPORT

1. Transport Demand and Energy Resources.

Power and transportation together constitute approximately half of the public capital investment programs of the underdeveloped countries. Much of the capacity of the transport system is required for the movement of solid and liquid fuels. The possibility of reducing the heavy burdens on the transport system might help to accelerate development, and might be achieved if power and transport needs were assessed in combination and efforts made to develop power sources that would minimize transport needs.

What will be the economic feasibility of nuclear power, solar energy, and the substitution of oil or gas for coal when transport costs are included? What is the outlook for energy resources and for energy distribution systems, and how do the prospects for changing technology affect long-run plans for transport investments?

Energy needs and resources of selected countries should be surveyed and their impact on the transport system weighed in the light of the technological potentials for energy sources and distribution. Would a larger allocation of resources for new power sources be justified by transport savings? Should foreign aid programs include support for research and development in the energy field to save capital in the transport field?

2. The Transport Demands of Urbanization.

Industrialization accompanying economic development is creating heavy concentrations of population and economic activity in large cities. The shift of population from rural to urban living has already greatly intensified capital requirements for transportation in these urban centers. There is an urgent need not only to assure the necessary capacity for urban transport but to avoid unnecessary transport requirements growing out of current trends. The latter may be possible either by urban design aimed at minimizing the generation of traffic, or by national policies aimed at altering the present distribution of new employment opportunities to avoid the further build-up of major urban concentrations. Can urban and regional planning of the arrangements, densities, and types of land-use avert further costly congestion of transport? Should industrial location and other policies seek to achieve a dispersal of economic activities? What policies promise the greatest net advantage for the development program?

This study should analyze urban transport conditions and requirements in major metropolitan cities, and project the situation that can be anticipated on the basis of present trends. Comparison of transport costs and service should be made on the basis of alternative measures for the accommodation of urban growth in selected countries. What other advantages of urban concentration need to be taken into account? What can be learned from U.S. experience?

3. Reducing the Weight and Peaking of Transport Demand.

Much of the burden on transport systems is the result of peak load pressures and the need for fast delivery of perishables. There is also considerable movement of waste materials, both agricultural and mineral, which could be eliminated by processing at the

source. The avoidance of these burdens through storage and extraction methods offers substantial promise for reducing capacity requirements in the transport sector.

This study should analyze the economic consequences of peaks of traffic in predominantly extractive economies and examine the possibilities of mitigating these traffic profiles by investments outside the transport field and through the application of new scientific methods for food processing and preservation (freezing, salting, drying, irradiation, etc.). Other aspects of investment in processing and storage facilities should be assessed, including local employment and new uses of agricultural by-products. What research and development needs are indicated in agricultural and industrial sectors?

V. ORGANIZATION AND ADMINISTRATION

1. Administration in the Public Sector.

A variety of organizational arrangements for the provision of transport facilities are now in effect throughout the world. Transport responsibilities are generally lodged partly in ministries of transport, departments of public works, and public corporations or authorities with varying degrees of independence. There are varying degrees of centralization of transport responsibility and a variety of state and local organizational arrangements particularly for road, airport, and port facilities. In some countries mechanisms have been developed for coordinating transport policies among the several independent transport organizations and for relating plans and programs in transportation to national goals established by national planning bodies.

For the most part, present administrative arrangements make it impossible to take a total view of the transportation problems of a developing country, to weigh the desirability of alternative transport technologies, and to design a total transportation network

that will minimize waste and duplication and maximize economy and service. Decisions to invest in one form of transportation or another are made independently, and the opportunity to weigh the advantages and disadvantages of these decisions, if it does arise, is generally in the final stages of investment allocation by the planning commission. At that time it is generally too late to make more than superficial adjustments in the requests for funds by the individual transport claimants.

An evaluation of the various administrative arrangements now in operation needs to be made, and the most effective administrative approaches need to be known for countries in different circumstances and stages of development. One method of doing this is to review the stipulations with respect to transport administration that have been included in arrangements for loans and grants to developing countries. Much of the financial aid being granted in the transport sector carries with it certain provisions with respect to how the program is to be organized and administered. An effort should now be made to analyze the basis on which these stipulations have been made, the degree of consistency among the recommendations made in various countries, the extent to which these recommendations have been complied with, and the effects of compliance on transport administration and on the relation of the transport program to other aspects of development.

A related subject for research is the role of the private sector in the provision of transportation. Although most basic facilities are government owned and operated, transport equipment is frequently provided through private capital and management, and promising mixes of public and private responsibility need to be explored.

2. Government Controls in Transport.

The separate provision of transportation facilities that has resulted historically from the gradual evolution of new transport technologies has led to various attempts to control, coordinate, and integrate separate parts of the transport system into a more effective total system. Out of these attempts have come a number of regulations governing the competitive relations among transport media, including investment allocations, control of entry, rate regulation, and controls over routes, types of traffic, radius of operation, and allocations of equipment and parts. These efforts have often been ineffective, but to the extent that controls have achieved their purpose the results have often been dubious. There are also serious doubts that these efforts have made a net contribution to development.

All the developing countries face the question of whether or to what extent they should attempt to follow the experience of the more developed nations in establishing controls in the transport sector. There is need for a review of the types of controls now in effect in the developing countries, their economic implications, and the alternative approaches that might be taken to arrive at the objectives these countries are striving for. Two new approaches are possible in this area. Coordination may be achieved through physical measures such as the use of interchangeable containers which would go a long way toward integrating transport media, or by organizational arrangements such as transport companies which would own and operate all types of transport equipment. These and other approaches to a more rational organization of transport need to be weighed against the advantages and disadvantages of competition and the frustrations of attempts at economic regulation.

3. Regional Arrangements for Transportation.

The high cost of transport facilities and the growing radius of transport operations suggest the need for international cooperation in the administration, financing, and physical planning of transportation facilities. It is especially obvious in the case of air transport that groups of countries will need to cooperate in the provision of high-cost international air carrier services. Joint provision of air traffic control facilities and joint purchase, operation, and maintenance of costly aircraft are obvious necessities in the jet age. But the possibilities of regional arrangements are not limited to aviation. The laying out of international highway routes is another obvious area for cooperation among contiguous countries, and reciprocal arrangements with respect to vehicle size, weight, safety regulations, and other technical aspects of road transport are growing with the extension of road services across international boundaries. International arrangements for rail, water, and pipeline transport are also growing needs.

The cost and service advantages of regional arrangements need to be evaluated by case studies of individual countries and groups of countries that are now participating in regional arrangements or which are failing to take advantage of the possibilities that regional solutions to mutual problems provide. Foreign assistance policymakers are in a particularly strategic position to point the way toward the kind of regional integration in transport that is such a vital need in the progress of the European Economic Community.

VI. FINANCIAL POLICY

1. Influence of Financial Policy on Transport and Development.

Financial policies have an important bearing on the choice of transport facilities, their design and condition, and the volumes of traffic using them. An important set of policies having these effects are those which determine the extent to which transport should pay its way through rates, fares, and user taxes. Where rates are too low, traffic volumes may be unnecessarily high, maintenance poor, equipment over-age, and faulty decisions with respect to types and locations of economic activity may be encouraged. Where rates are excessive, development may be inhibited and traffic allocations among competing modes may be uneconomic. Financial aid from central governments for the construction of transport projects often proves wasteful where measures are not provided for local governments to command the necessary resources for maintenance. Partial or fully self-supporting port or airport facilities and toll roads, on the other hand, may produce special incentives to achieve adequate standards of design and maintenance.

These and other aspects of transport financing policy are a powerful influence not only on the nature of the resulting transport system, but on the development program as a whole. In some countries, for example, railway deficits constitute a major item in the national budget. Whether railway revenues should be sufficient to eliminate the use of general funds or contribute to the supply of investment capital for other development projects are significant issues.

Study of the effects and potentials of financial policy should begin with the analysis of present methods of financing transport in selected developing countries, followed by case studies of specific results under alternative financial arrangements.

2. Effects of Foreign Aid Financial Policies.

The foreign exchange requirements of transport investment programs are substantial, and the influence of foreign grants and loans is often far reaching. In some cases, the readiness on the part of donor nations to support transport projects may stem from the long-term financial attractiveness of certain types of projects more than from their inherent value for development. In some circumstances, the selection of transport technology may be unduly influenced by the lender. There is also a danger that the accumulation of debt service for transport undertakings may become a serious drain on national budgets.

Foreign aid policies sometimes encourage transport investments that may be unsuited to countries in early stages of development because political considerations are considered to outweigh the primary concern for raising levels of living. The full implications of these practices need to be evaluated, and criteria developed to assist in achieving the most desirable net impact from aid expenditures.

MEMORANDUM TO WILFRED OWEN

FROM
GEORGE W. WILSON

On
"Criteria for Measuring the Development Effects of Transport"

The precise nature of the relationship between development of transportation facilities and economic growth is unknown. Yet every text book on transportation begins with a eulogy of the impact of transport upon national unity, production costs, military potential, social change, population movement, and so on. That there are real disadvantages from improved transport is generally conceded but the net effect is universally deemed to be favorable. Indeed, ever since Adam Smith's dictum that "the division of labour is limited by the extent of the market," an intimate connection between rising productivity and additional transport capacity has been taken as a matter of course. Nor is the a priori relationship between transportation and over-all efficiency difficult to discern. But the cause and effect relationship is far more complex even on the aggregative, a priori level of analysis. For example, was the spirit of enterprise cause or consequence of the rapid expansion of U.S. transport facilities? Most people would argue both ways-- i.e., that it was the enterprising spirit, the belief in manifest (economic) destiny, the quest for profits with all that this implies with respect to incentives, attitudes, outlook, and government support, that led to the spurt of railroad construction in the latter half of the 19th century. At the same time, given this set of incentives, etc., the existence of abundant transport facilities naturally stimulated output, widened the market and had all the positive effects on economic growth, political unity, etc., so frequently stressed. Yet the question remains which was

more important, the set of attitudes or the existence of the physical facilities? It seems evident that the psychological outlook and institutional factors provide the key; that the mere existence of abundant facilities, natural or man-made, is not decisive. Most of the underdeveloped countries today have relatively abundant natural resources and not a few have taken over a set of physical facilities constructed by former colonial powers which exceeded the relative quantities of such assets available to, say, Western Europe in the period immediately preceding its rapid rise in real output per head. This cannot be adequately documented and, of course, it is true that, say, the Indian railways were constructed to get raw materials out and otherwise had the effect of discouraging indigenous manufacturing industry. The fact remains, however, that many underdeveloped economies possess what to an early 19th century U.S. or U.K. resident must resemble a surfeit of transport and other physical facilities. Yet few underdeveloped economies exhibit many symptoms of economic dynamism. Resource and asset availability, per se, cannot therefore be decisive. Indeed, a comparison of Japan, Denmark, and Switzerland with India and Indonesia, at least in terms of available and accessible natural resources even on a per capita basis, would suggest an inverse correlation between such resources and output per head. Many special circumstances may largely account for this but the point is clear, namely, mere resource or asset availability is not enough. In the realm of transport this means that while such facilities are doubtless necessary conditions for economic growth they are not sufficient.

This in turn means that the relationship of transport improvement to economic growth will depend upon a vast variety of additional factors: hence there can be no unique set of functional relationships applicable to a variety of countries at different stages of economic, social, and political development. In this sense, every country may be sui generis and require an independent analysis of transport and growth. The possibility of more general relationships must not be excluded but these should not be deduced or assumed a priori.

Furthermore, we first need to examine the variety of forms involved in the phrase "transport improvement." Transport improvement means any one or combination of the following: better road, rail or water ways (or in the case of air, better navigation facilities), better moving equipment, better terminal facilities where "better" means technically or economically superior. All of these permit, though do not guarantee one or more of the following: faster, safer, cheaper, more flexible, more dependable and/or greater volume of movement of people and things from place to place. In other words, each of these types of improvement allows a greater quantum of transport and/or better quality and/or lower per unit transport costs. Better quality, of course, leads to reduced non-transport costs depending on particular shipper situations. But the impact on quantum, quality and unit costs is not the same for each type of improvement. That is, a given amount spent on improved or additional road-bed for a particular mode of transport will not affect quantum, quality and cost in the same way as the same amount spent on another mode, on better motive power or terminal and storage facilities. This means that an aggregative approach relating, say, a certain value of transport investment to particular growth indicators may hide as much as it reveals. The problem is compounded when it is recognized that existing relative prices or values in underdeveloped economies frequently fail to mirror adequately relative needs and scarcities--thus pecuniary aggregates of investment or national income may be especially misleading. Furthermore, it is everywhere the policy in such countries to change existing price relationships to accomplish particular purposes thus rendering present prices, often established in highly imperfect or protected markets, inappropriate guides to policy. In short, the aggregation problem is especially acute in underdeveloped economies. Any careful examination of the national income aggregates, for example, will indicate the enormity of this problem. This means that in terms of aggregative indicators of both growth and transport investment (or output) the empirical evidence presently available may be singularly misleading.

In assessing criteria we are essentially looking for potentially quantifiable relationships between various transport and growth indices. These indices may take the form of pecuniary magnitudes (such as value of additional investment or transport output) or physical quantities (tons, miles, number of trips, elapsed time), to which it may or may not be desirable or feasible to attach a monetary equivalent. At the same time we wish to examine the relationship of such magnitudes and changes therein to selected growth indicators such as real GNP (total or per caput), particular output changes of selected industries in money or real terms (such as tons or value of steel produced) or other items such as growth of new industries in new or already settled regions and so on.

It is clear that we can examine such relationships at any level of aggregation desired from aggregate transport investment and GNP to specific changes induced by virtue of a new transport facility between a particular pair of points. But in view of the aggregation problem, it is probably best in the initial stages of research to place primary reliance upon non-pecuniary magnitudes which in turn suggests a highly dis-aggregative approach to pierce through the veil of possibly irrelevant or misleading valuations attached to physical magnitudes. This does not mean that existing aggregative data should not be examined but, rather, that such be viewed with great skepticism until otherwise verified. In this regard there are generally enormous statistical gaps. Except for railways and airlines, the data on the physical dimensions of transport availability, performance, and so on are either completely lacking or woefully incomplete. Some empirical box-filling will be essential from the start.

Possible Developmental Effects from Improved Transport

The fundamental problem facing underdeveloped regions is to raise yields per man and per acre in agriculture; to create a vastly enlarged agricultural surplus.

This is necessary both to feed the growing populations and to raise the real incomes of the great proportion of people living in rural areas. This is, however, not essential to provide labor for the small, though expanding, industrial sector as it was in 19th century Europe since unemployment is now prevalent in all areas which naturally reduces incentives to economize further on a resource already in abundance. This, of course, abstracts from the quality of labor available. While it is true that labor surplus (however the term may be defined and measured) is ubiquitous in a quantitative sense, there is at the same time general scarcity of even relatively skilled labor; hence the need for "education" and training. But if any significant economic growth is ever to occur, it must be preceded by a substantial increase in agricultural productivity. The relationship of transportation to this is obvious--if agricultural producers are to increase their output beyond immediate needs, it must be possible to sell the rising surplus. This requires both that cheap and dependable transportation be available to ship the physical product in larger quantities over increasing distances and that agricultural prices do not rise significantly relative to other consumer prices--especially in the early stages of growth. Transportation facilitates both objectives.

As a point of departure, we may therefore examine the most probable dimensions of the impact of, say, a new road in a region or between a pair of points. Assume that the new road links a particular village to a market center with which only sporadic and irregular shipments had in the past been made via crude vehicles over rough roads. This type of transport investment should probably have high priority as a practicable means of bringing the rural community, where the key to development lies, into closer contact with more advanced sectors. The problem is staggering in a large country like India with over one-half million villages but, even here, there is merit in several "demonstration" attempts. Nothing sustainable or dynamic may happen in many areas and certainly more than provision of improved

transport facilities is required; but without this type of facility there is even less chance of progress. Thus, this simple example of providing better access for a village to a more rationalistic, economically oriented commercial center is not so trivial as it may seem at first blush. Quantitatively, it should be possible to obtain data comparing the volume of goods and number of passengers moved over the new facility with the previous volume and number; compare any price changes in the products marketed and change in producers' net receipts; examine whether there are improved or additional vehicles or not, change in extent and nature of the dependence upon middlemen or money lenders, new crops or lands brought into use, attitudinal change, net migration, and so on. If there is improvement along any of these lines, it should be possible to trace the further impact upon the village community, its hinterland, and in the market center itself.

It is difficult to know in advance whether any, all or none of these changes will occur. Attitudes, incentives, and so on differ widely among particular regions even of the same country (see, for example, Kusum Nair, Blossoms in the Dust). In some regions the new facility may be used; in others it may not to any greater extent than before; hence any improvement in ease or time of accomplishing the usual tasks will be taken out in the form of more leisure. It is therefore difficult to evaluate in advance whether the road will "pay off." But after the fact, it may be reasonable to assess benefits and contrast with road costs, (maintenance, operation, and depreciation) to assess whether the investment itself was worthwhile and whether it should be maintained at a high level or not. This should provide future guidelines for policy.

As suggested above, the anticipated impact will differ depending upon the type of transport improvement. A priori it should be possible to catalogue the most probable immediate consequences depending upon mode and whether the improvement is in the right of way, vehicle (motive power and/or cubic capacity) or terminal

(including storage) facilities. Abstracting from the mode we have the following:

A: Right of Way - I. Improvement of an existing facility. Permits faster service, less wear and tear on vehicle, greater quantum of movement per time period due both to faster service and ability to accommodate more and/or better vehicles, and lower cost per unit of weight and distance which permits reduced freight and passenger fares. This means that the same amount of activity can be performed at lower cost and in a shorter time period which permits, causes or induces a) a greater total movement if production and travel per time period is stimulated, b) more leisure c) more congestion if the shorter average time in transit is not offset by improved storage and terminal services or better scheduling of arrival of goods and passengers. Items a) and c) result in additional needs and pressures the response to which will determine whether any permanent and sustainable improvement will occur. If subsidiary investments are not made either by those whose net receipts rise or by government, the improvement is likely to be short-lived.

II. New facility (i.e. connecting another region or place to a production or marketing center). Here we must distinguish between (i) a new right of way constructed in response to a prior investment and designed to move the raw material to producing centers or the finished product to consuming centers and (ii) a new facility whose purpose is to stimulate new activity and movement. These are not mutually exclusive since excess capacity in the former case may be established to accommodate whatever additional activity may be induced both by the existence of new productive facilities and the excess capacity of the related transport supply. In both cases, however, results comparable to AI would be relevant. But here additional objectives of growth tend to be met to a greater extent, namely,

national cohesion, regional equality, and so on. The potential economic and social opportunity is more in AII than in AI -- at the same time, there would appear to be greater risk and a somewhat lower probability of secondary stimuli at least in the short run and especially under (ii).

- B: Improved Vehicles and Containers (locomotives, box cars, cars, trucks, carts, barges, tugs, etc.). The effects here are comparable to those in AI, except in the case of those vehicle types capable of penetrating new areas without additional rights of way where both AI and AII may be relevant. Particular effects here are, however, relatively different. Thus, elapsed time may be reduced more significantly than in AI, potential cost reductions per unit of weight and distance will differ and so on, depending upon the specific nature of the improvement.
- C: Improved Terminal and Storage Facilities. Where congestion is already present, better terminal and storage facilities may be more significant than additional right of way or motive power. If congestion is alleviated, then the consequences of AI are relevant, again, however, in relatively different degrees with respect to elapsed time, cost savings, etc. If congestion is apparent, it is possible that improved scheduling and information services involving re-routing, new communication investments or altered freight rates may suffice.

These are only a few of the possible effects of the vast variety of types of transport investment. Much depends on the region involved and whether or not additional non-transportation investments are made. All too often the backwash effects swamp the so-called spread effects. But the great variety of types of transport improvement offer especially wide ranges of choice which can be tailor-made to specific circumstances and conditions uniquely relevant to needs in underdeveloped regions.

My guess is that in most underdeveloped regions far more than transport or other facilities are required. There must also be substantial inducements of various kinds as well as some clear and simple demonstration that benefits are attainable. Probably a new industry needs to be located along the right of way to stimulate use, generate additional income and employment and provide some tangible evidence of achievable benefits. Perhaps I am too impressed with South Asia where a skeptical peasantry all too often sees no virtue or even economic gain through using better facilities and techniques, especially if payment for the use thereof is involved and the gains accrue disproportionately to the already more affluent. Things may be different elsewhere although I doubt it. Any such transport facility must be geared to other aspects of regional development, including education and other investments, or it is liable to make no fundamental change in the pattern of rural living. It should, however, be possible to develop quantitative measures of the impact of regional transport for such situations as envisaged above. Indeed, these should be done in a variety of regions where similar investments have already been made. If there are a variety of developmental effects, these would cry out for explanation--from which should emerge some answers to the relation of transport to development.

At a higher level of aggregation we could examine the relationship between total ton-miles and an index of physical goods output, modified by inventory change. For example, in the U.S. a close relationship exists between the ton-mile index and a composite index of industrial and agricultural output corrected for inventory change. Data on industrial output are usually quite reliable in underdeveloped countries although the evidence on agricultural production and especially ton-miles and inventory changes ^{has} ~~has~~ many serious gaps. In any event, it should be possible to examine what is available and come up with some sort of relationship. If a

reasonably close relationship is found to exist and assuming persistence of the present locational pattern, some crude, aggregate measure of transport "needs" (in ton-miles) related to planned output could be derived and compared with present over-all capacity. With some knowledge of the physical productivity of additional transport investment $\left(\frac{\text{i.e. ton-miles}}{\Delta \text{ in } K} \right)$, one could then deduce the amount of new transport investment required to fill the gap between estimated needs and present capacity. Of course, this is too aggregative an approach but as a first approximation, it might be a useful point of departure; valuations would have to be used but these could be taken from the prices used by the Planning Commission. This is, however, a rather static approach since one of the aims of developmental policy is to change existing locational patterns as well as relative prices which may entail more or fewer transportation inputs than would otherwise be required by the static relationship developed from past data. Furthermore, it is not the case that a ton-mile by one form of transport is the same as another--there is again an index number problem. But as a first approximation this approach may have merit.

Even higher levels of aggregation are possible--(e.g., change in total transport investment and real GNP) and should be examined despite the probability that they will reveal little for reasons already suggested.

The foregoing has stressed the economic side of growth. There are, however, other goals of development to which transport is closely related. Leaving aside the military and national unity aspects, every underdeveloped country seeks to lessen to some extent the ^eexisting degree of inequality. Since an important aspect of inequality is regional, it is clear that improved transport facilities concentrated in relatively poor regions may reduce the wide disparities in regional income or output per head either by stimulating production or facilitating emigration.

Nor is mobility unrelated to education. The shortage of training facilities suggests that one way of making existing facilities serve a broader region is the

provision of faster and cheaper access thereto. Likewise transportation improvement permits teaching personnel to cover wider geographic areas.

The impact of transport improvement on inequality and education is at least potentially measurable in terms of regional output changes, population movement, changes in regional distribution of school attendance, and persons receiving instruction.

But all of the foregoing suggests the need for local or regional analysis, for abandoning the nation as the appropriate unit of study. Although transport improvement may have widespread (and backwash) effects in a highly mobile society, its impact in an environment where mobility has traditionally been relatively circumscribed is bound to be more localized. Furthermore, it is usually the case that backwash effects tend to be relatively stronger in underdeveloped (i.e. relatively immobile) than in developed economies. Thus, prime attention needs to be focused on particular regions or even smaller units. A series of studies of particular villages may even be revealing from a purely transport point of view. It seems to me, however, that we need deliberately to move away from the kind of nationwide aggregative analysis which so pervades the Western approach to economic growth and development. Underdeveloped countries are not unified economies in the Western sense--they aim to become so but analytical approaches based on the presumption of national economic (and even political) unity are bound to be misleading. In short, we wallow in ignorance regarding the particular impact of a given type of transport "improvement" at the local or regional level. We can hypothesize ad nauseam, apply ratios and so on deduced from the experience of developed economies, but these experiences are probably irrelevant and the multitude of potential hypotheses need to be tested and filled with a volume of empirical evidence not presently available. The case study and/or local survey and data collection approaches may not be very

sophisticated but refined analysis and marginal adjustments are not what the underdeveloped nations need. They need evidence and patterns stemming from their own particular set of circumstances so that reasonably informed investment decisions can be made. There is no room for quibbling about the merits of a little more or a little less; a massive, gross, unsophisticated even "rule of thumb" approach using some rough guidelines is mandatory in the interests of accelerating growth to keep ahead of the population "explosion" (I hate this term) and to prevent lagging dangerously behind the "rising expectations" (I don't like this term, either). Quick and "good enough" policy guidelines can emerge from case studies and sample surveys. Refinement and marginal jiggles are luxuries for the already developed economies.

Appendix E

Transportation and Development
The Role of Mobility in Development

by
Wilfred Owen

The Brookings Institution
Washington, D. C.

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Appendix F

An Analysis of Governmental Controls on Transport

Background

Transport is everywhere subject, in varying degrees, to governmental controls on investment, entry, abandonment, service, prices (rates), location, ownership and safety. In addition to these direct controls, the supply of and demand for transport are both heavily influenced by government ownership and operation, by subsidies and by tax policies, all tending to distort the commercial function of transport, i.e., to provide for the movement of people and goods at prices established in the market place.

In newly developing countries attempts have been and will continue to be made to use direct and indirect controls on transport to shape, stimulate or otherwise influence aspects of the economy and the social life of the country.

To illustrate, the charging of uniform freight rates on certain commodities, irrespective of distance, in some British African territories is an instance of transport controls being used to further a larger governmental policy. The restrictions on truck haulage in terms of distance, as have been practiced in South Africa and India are another. The fixing of limits on the number of operating licenses allowed, practiced in various forms by many countries, is a third. Control on importation of trucks and auto parts is yet another instance of interference, for certain goals, with the free flow of resources in the transport field.

These controls and control patterns in transport have been subject to critical review in many underdeveloped countries. A committee of the Indian

Planning Commission recently posed a series of fundamental questions concerning its future policy with regard to transport.^{1/} The questions all hinge around the pivotal issue of whether transport should be allowed to develop freely as a commercial enterprise, with unrestricted competition among modes. The ramifications of this issue, particularly in regard to "public service" features of the railroads, are many and complex; moreover they have never been resolved satisfactorily in America or Europe.

The second five year plan for Pakistan^{2/} and the most recent transport survey in Colombia^{3/} both recommend increased freedom from controls in truck transport—in Colombia, because the control (rate regulations) could not be enforced; in Pakistan because the controls were inhibiting development of motor carriage. The situation in Pakistan with regard to rail rate policy is even more revealing of the dilemma faced by such countries. The second five year plan states first that "the railways (are) basically commercial undertakings. . . ." but proposes that the "level of charges (be) adjusted from time to time in the light of incentives and dis-incentives needed for economic development."^{4/}

^{1/} Preliminary Report, Committee on Transport Policy and Coordination, New Delhi, 1961, pp. 126-133.

^{2/} Planning Commission, Government of Pakistan, The Second Five Year Plan, 1960-65, 1960. See pages 304-5.

^{3/} Parsons, Brinckerhoff, Quade and Douglas, "Plan for Improvements in National Transportation (Colombia)," 1960, pages II-160, III-5.

^{4/} Op. cit., page 289.

There are, naturally, economic consequences of using controls on transport contrary to market forces. Using the uniform rate example, for instance, it is likely that the result will be misallocation of resources, strictly speaking. Bauer takes the following view:^{5/}

"The payment of uniform prices to producers irrespective of their location, and the charging of uniform freights irrespective of distance, are practices which have been widely adopted in British African territories. They encourage production distant from the ports and consuming centers, and discourage nearby production. This means that a given volume of output absorbs an unnecessary volume of transport resources. This results in uneconomic use of resources, because some of the production which takes place would not have been undertaken if the producers had had to bear the full cost of production and transport, so that the value of this output is less than that of the scarce resources used in its production."

This view may be, however, at once too narrow and too severe. It overlooks possible external economics, social welfare considerations and concerns beyond the economic allocation of resources on the part of government. Governments do usually have concerns beyond economic allocation of resources at one point in time, however, and it is by no means clear that these other concerns are of less importance in establishing conditions for growth.

The issues involved in applying controls in transport are these: First, what controls, if any, are needed, given the objectives of policy; and second, will they work. The former depends on the internal consistency of theory and fact which relates means to ends. The latter is influenced importantly

^{5/} P. T. Bauer, Economic Analysis and Policy in Underdeveloped Countries. (Durham & Cambridge) 1957, pp. 88-89.

by the validity of assumptions made by the control pattern about the workings of the economy and the social structure. Evidence from developed economies suggest that such controls often do not accomplish what they were intended to accomplish; moreover, they sometimes have unintended side effects on the economy and society, e.g., widespread violation and circumvention of the control by legal, extra-legal, and illegal means.

Proposal

It is proposed that an analysis be made of the nature of transport controls^{6/} which are employed by government in furtherance of its economic, political and social policies; the extent to which the controls can be applied consistent with different assumptions of freedom of economic enterprise; and the probable consequences, in the transport sector, the overall economy, and in terms of social welfare, of pursuing various control patterns.

Method

The first stage in the analysis should be the identification of the major transport controls utilized by various underdeveloped countries together with the stated rationale for the controls in each country. No exhaustive or encyclopedic collection will be necessary, for while varying in detail, a relatively small number of general patterns is expected to emerge. From this survey it should be possible to choose several cases which would be

^{6/} By "controls" we mean to infer the usual range of direct and indirect regulation of economic activity; but, inevitably, wider government activity such as investment, ownership and operation of facilities, subsidies and taxation will enter into the analysis, particularly when dealing with political and social policies.

illustrative of the several patterns of controls which are theoretically distinct and important. It is expected that some four to six cases would be chosen, hopefully covering widely different stages of economic development, differing formal administrative patterns and distinct geographical separation. It might be, however, that contiguous country studies would reveal interesting contrasts.

The second stage involves an assessment of the assumptions, explicit and implicit, about the economy and the society which are contained in each part of the transport control patterns which are chosen, and an analysis of the consistency of the control patterns in terms of these assumptions. Such consistency, or lack of it, may be internal, i.e., are parts of the control pattern working at cross purposes with other parts, as in the case of encouragement of small private truck operators but prohibitively high truck license fees; or external, i.e., is an assumption about the economy wrong, such as assuming capital and labor are perfectly mobile and hence encouraging modal competition.

The third stage would attempt to assess the success or failure of the controls in terms of the objectives sought and in terms of an independent critique of the actual results, wanted or unwanted, and the contribution of those results to development of the country. The results would be examined not only for their direct economic effects but also for their effect on such factors as encouragement of entrepreneurship, agglomerative economies in the political sector (e.g., schools, hospitals), and other considerations of social welfare deemed desirable by the country in question.

The final stage of the analysis would be an attempt to make policy recommendations concerning the use of government controls on transport to accomplish stated goals, i.e., given the goal, what pattern of controls is likely to aid in its achievement.

Budget and Personnel

The work would be conducted by Edwin T. Haefele of the Senior Staff at Brookings with the aid of a research assistant. Expenses of approximately \$30,000 over one year are contemplated.

Summary

The foregoing is an attempt to formulate a research project which deals, in a general way, with an important part of the problem of transport in undeveloped areas, namely, the incidence, theory and effects of using various patterns of transport controls to influence development. The methods proposed are chosen to avoid the unusable abstraction on the one hand and the particular case that cannot be generalized on the other. The patterns of control chosen for analysis will be selected from real patterns, but the analysis itself will be general and not always constrained by the conditions of any one country.

9/19/62

STAFF

The following persons have participated in the program during the first six months:

Joseph A. Pechman, Director of Economic Studies
Wilfred Owen, Director of the Transport Program
Edwin T. Haefele (Northwestern University, Senior Staff Member
George W. Wilson (Indiana University), Senior Staff Member, on part-time, non-resident basis
Louis Lefeber (Massachusetts Institute of Technology), part-time, non-resident consultant
Mrs. Eleanor Busick Steinberg, Research Assistant
Mrs. Inai Bradfield, Research Assistant
Mrs. Edna Lusher, Administrative Assistant
Miss Joan Canzanelli, Secretary
Mrs. Ruth Darmstadter, Secretary

Attention was called to the need for a balance between "long-range" and "short-range" research, with the latter taken to mean research of rather immediate practical usefulness to AID personnel, here and overseas. It was generally agreed that case studies were a necessary part of short-range research, and that, ideally, they should use tools of analysis developed by more general or long-range efforts to crack some of the hard economic analysis problems. It was also suggested that, whenever possible, researchers and research groups choose the same countries for case studies in order to economize on data collection, and, more importantly, to have a single country studied from more than one point of view.

It was agreed that the two criteria areas in parts I and II of the outline of research represented areas for first priority work either by Brookings staff or scholars closely associated with the resident staff.

A suggestion was made that regional (more than one nation) transport studies were almost never undertaken and that, in the future, intra-continental economic interdependence would loom much larger, making such inter-country transport development mandatory. Thus, research on this problem which assumed economic interdependence would be a most useful supplement to country plans.

Considerations of Proposals

Government Controls on Transport. (This proposal is attached as Appendix C.)

Mr. Haefele outlined this proposal as an attempt to measure the effects of economic controls on transport as aiding or hindering overall economic growth or of influencing the direction of such growth. The Committee, in discussing the proposal, made the following points -- first, the work should avoid becoming a purely descriptive study of the incidence of such controls; second, it would be necessary to understand how controls are rooted in the traditions of the country, e.g., Europe turned to nationalization because of its general heritage of trying to solve economic problems in this fashion; third, that the focus of the work should be on policy alternatives and their probable effects.

The proposal was approved.

Railroad Pricing Problems. (This proposal is attached as Appendix D.)

This proposal was outlined by staff as covering the theoretical consequences, with case studies, of alternative rail pricing policies on economic development. The Committee, in discussing the proposal, were generally agreed that the subject was an important one but too narrowly conceived to be highly

relevant to the underdeveloped world. There was dissatisfaction with the emphasis on U.S. and Canadian experience and some feeling that the researcher's past experience and training was not oriented directly to problems of economic development.

The Committee withheld its approval of this proposal.

Administrative and Organizational Recommendations to Nations
Receiving Transport Loans and Grants. (This proposal is attached as Appendix E.)

This proposal was outlined by staff as one which would identify administrative recommendations placed on nations receiving loans or grants for transport projects, analyze their relevance in the local setting, and measure the degree to which these recommendations were followed and the effect of following them or not.

The proposal was approved.

Other Business

The Committee suggested that, in the future, biographical material on the researcher be furnished along with the proposed research outline. Staff agreed this would be done.

The Committee adjourned sine die.

Appendix I

The World of Highways and
Highway Transport in 1987*

by Wilfred Owen, The Brookings Institution

Delegates to the 17th World Meeting of the International Road Federation:

There is a special significance in the fact that 1987 finds us back together again in the beautiful city of Madrid. For it was exactly a quarter of a century ago, in 1962, that the road transport officials of the world convened in this very same building. And while these twenty-five years have been only a moment in the history of Spain, they have been truly momentous in the history of transport.

The most dramatic illustration of transportation progress, of course, has been in the air. The morning rocket from Washington made it to Madrid in fourteen minutes. We were late as usual. The fact that my baggage went to the moon in no way detracts from the achievements of modern science. As recently as 1962 only seven people had ever ventured away from the earth, and they simply went around in circles.

Contrast today's rockets with the primitive methods of trans-Atlantic travel in 1962! The U. S. delegation to the Fourth World Meeting of the IRF took fifty times longer to get here. Passengers were told how to inflate their life jackets, and were then forced to eat complimentary meals until swimming became out of the question.

* Address delivered to the First General Assembly of the IV World Meeting of the International Road Federation in Madrid, October 1962.

When we look back to 1962, however, it is clear that surface transportation was in an even more rudimentary state of development. Nearly one hundred thousand people were being killed on the world's highways every year. Several millions were being seriously injured. It is hard for us to believe that twenty-five years ago we had not even begun to use electronics to prevent vehicle collisions. Even by 1962 standards, road transport was behind the times. For while travelers fastened their seat belts in airplanes, they refused to install them in automobiles!

In 1962 every big city in the world was bogged down in traffic jams. The ability to be motorized and urbanized at the same time was apparently beyond man's ingenuity. Since then, of course, we have learned many ways to make the motor vehicle and the city compatible. Today we design efficient systems of urban transport that take advantage of all types of surface and air vehicles. We design our cities and their circulatory systems to assure adequate transportation, just as we assure adequate systems of water and power. We have also created many new urban centers on the vast areas of land that have been released from agricultural uses by advances in synthetic food production. All these steps have helped us avoid the foolish overcrowding that made city life in the sixties so frantic.

But while some parts of the world were bogged down in too much transportation, most of the world of 1962 was bogged down for lack of transportation. Great areas of land and tremendous riches in forest and mineral resources remained untapped because they were inaccessible. The nations of South America that we now look upon as an integrated economic unit were in

1962 a series of separate economic islands isolated from each other by lack of transport. In 1962 there was no continental network of transportation for Latin America, no unifying system for the African nations.

In the early 1960's, Africa and Latin America, with 52 percent of the world's area, had 7 percent of the world's surfaced roads. Asia, with 47 percent of the world's population, had 3 percent of its motor vehicles. How could we have missed the point back in 1962 that poverty was largely the result of immobility — that nations were poor because their wealth was inaccessible and their people immobile?

Over 16 billion of the 19 billion U.S. dollars being spent for the world's highways every year were being spent in North America and Europe. The rest of the world, where 80 percent of the world's people were living, accounted for only 15 percent of the total expenditure for world highways. In many countries the per capita outlay for roads was less than a dollar a year compared to \$62 in the United States.

What has been happening since then is certainly the most important subject that commands the attention of the International Road Federation today. I refer, of course, to the exciting story of how, in the short space of twenty-five years, we have narrowed the transportation gap that once separated the rich countries from the poor.

How has it been possible within the lifetime of most of us here for such tremendous forward strides in transport to have been achieved in such a relatively short span of time?

If you will think back to 1962, I am sure that many answers will occur to you. I have tried to single out the three I consider most important:

First are the great advances that have been made by science and technology: new vehicles, new sources of energy, and innovations in communications and in other areas outside the transport field, but having such an important impact on it.

Second are the advances in our understanding of the role of transportation in helping to attain social and economic goals. We finally began to see that transportation was an integral part of almost everything else we were trying to do, and we planned for transport development accordingly.

Third is the new philosophy toward foreign aid that led the wealthy countries to assess themselves a definite part of their income to support their less developed neighbors. We finally came to realize that peace and prosperity could not be hoped for until all people everywhere commanded a fair share of the world's material resources.

These, I believe, are the central reasons why from a transportation standpoint we find ourselves so far advanced in 1987 toward an integrated world economy.

Regarding the first point, the advances made by science and technology: In 1962 all motor vehicles were equipped with wheels, and highways were used exclusively to roll ourselves where we wanted to go. Ground-effect machines had only just appeared. Indeed, the very first air cushion vehicle in commercial service began carrying passengers in 1962. Still the idea that

millions of vehicles would someday be supported by downward jets of air rather than pneumatic tires was hardly being given serious attention.

It was not until a decade later that further developments in cushioncraft made it possible for a substantial volume of highway transport to get off the ground. The cushioncraft motor vehicle also came to be as much at home on the water as on the road. And road transport was no longer thwarted by the absence of bridges or by the unstable road surfaces that once halted road transport during the monsoon.

With the coming of the ground-effect machines, the road engineer was well prepared to meet this new challenge. Many thousands of miles of low-cost roads or guiding tracks were built to accommodate the new machine. As we all know now, this was one of the great breakthroughs that enabled us to achieve very quickly the low-cost transportation now enjoyed by the people of Asia, Africa, and Latin America.

You will recall too that in 1962 most of our transportation was powered by petroleum, just as an earlier generation had burned wood to drive locomotives! Now, with electric vehicles powered by the fuel cell, and with nuclear power and solar energy, we not only have overcome the noise and fumes of motor transport, but we have released large quantities of petroleum to help meet many of the world's most important raw material requirements.

Many other innovations have played an important role in alleviating the transport burdens of developing countries. One of them, the growing movement of solids by pipeline, has been especially significant for the

movement of bulk commodities. In 1962 the technique of grinding solids and mixing them with water to enable them to be moved by pipe was in its infancy. It is true that coal was already being pumped over 100 miles by pipeline in the United States, but the use of pipes for moving a great variety of solids over long distances was only hinted at.

Another simple but extraordinarily successful innovation has been the universal container for the movement of freight. The reliance we place on the use of these uniform containers by all forms of transport throughout the world today makes it easy to forget that this method of coordinating transport had just begun to play an important role in 1962. Yet the fact that freight can now move so readily from road to rail, and by air and water, whichever ways will get it there fastest and cheapest, has effected tremendous savings.

Another is the phenomenal role that has been played by vertical take-off and landing aircraft which have been the workhorses for freight movement in the early stages of development. These aircraft helped overcome many of the difficult natural obstacles that had so long prevented us from breaking the transport barrier.

But many of the solutions to the transport problems of the developing nations came to us through innovations outside the transport field. The use of solar energy is an example. Since the sun is a ubiquitous source of energy, our ability to use it for generating power has greatly reduced the burden of hauling fuels. Nation-wide and international electric power grids have likewise

provided a means of transporting power over long distances by wire. And the advent of low-cost telephone and television communication on a world-wide basis by means of communication satellites has made it possible to accomplish much of the educational work and the technical training which at one time was possible only by traveling to remote places.

These technical advances, as you know, have helped us to concentrate roadbuilding efforts where they were most needed and to establish more effective priorities in the interest of development objectives. We have also been able to avoid much costly and time-consuming construction of transport facilities, thus freeing more resources for other urgent needs.

The second factor I mentioned as being so important to overcoming the transport problems of the less developed parts of the world is the broader understanding of the role that mobility plays in economic progress. Many people in 1962 failed to grasp the idea that transportation was an integral part of almost everything else they did; that transport really served as the catalyst that brought men and resources together to produce wealth. And so in those days there was a tendency to look at the transportation needs of a country in isolation from the goals that transportation could help to achieve.

We have since learned, of course, that transport is a key factor in the success or failure of the entire development effort. For while food, shelter, health, education, and useful jobs are the ultimate goals, transport is essential to their realization. Accordingly, transport development has come to be planned as an integral part of over-all development programs.

The point can be illustrated by the approach the transportation

industry finally took to the problem of providing food. Twenty-five years ago half of the world's population was hungry. Most of the effort to alleviate these conditions was directed to increasing the productivity of agriculture, despite the fact that it was often poor transport rather than poor farming that was the most important reason for the lack of food. A large percentage of the world's potential food producing areas was completely inaccessible due to the absence of roads. In some countries less than ten percent of the land available for agriculture was actually being used.

Where land was under cultivation, poor transport and high-cost transport made it impossible to market agricultural produce. Many crops rotted in the fields. Oranges were being used for fertilizer. Enormous tonnages of food were lost en route to market due to spoilage resulting from delays in transit. Many farmers refused to produce for the market due to the uncertainties of transport. And even where food was finally moved to the consuming areas that needed them, transport costs had so added to the final price that few could afford to buy what they needed so badly.

When we looked at transport in terms of overall development goals, we discovered that the solution to the problem of marketing agricultural produce did not lie simply in the supply of more transport, but that often the most effective course was to minimize movement by storing or preserving what was grown. When storage facilities were built in producing areas, peak traffic demands typical of agricultural economies at the time of the harvest were flattened by spreading the transport burden over a longer period of time. Investment in transport capacity was reduced accordingly, and foods that

would have been lost were made available for the market.

But the failure to look at the transport problem in relation to development goals was not the only weakness of our approach to economic growth in the sixties. We even failed to relate roadbuilding to the ultimate goal of providing road transport. Roads were often built without even taking into account the need for vehicles that were to use them. Often a country embarked on a road program and then proceeded to restrict the production, importation, and use of motor vehicles. As a result, the potential benefits of the roads were left unrealized, and the capital invested in roadbuilding was wasted.

This policy in the sixties of emphasizing the importance of roads and minimizing the importance of vehicles was the exact opposite of what earlier history had taught us in the United States. For example, during the early stages of motorization in America it was the motor vehicles that came first, and the roads that followed. It was the sudden appearance of large numbers of horseless carriages that created the demand for all-weather roads. The owners of these vehicles as well as the bicycle rider and the farmer with horse and wagon exerted pressure on public officials to build the highways needed to accommodate the growing vehicle population.

Today we are well aware that to promote the development of road transport we must focus on the vehicle as well as the roads. This understanding has already led, as you know, to the design and production of a basic, low-cost road vehicle that is useful, durable, economical, and easy to maintain. These stripped-down vehicles have provided a combination freight and passenger car for use in the fields as well as on the road, and the expanding numbers of

motor vehicle owners formed the good roads associations in Asia, Africa, and Latin America which clamored with such success to get the roads and road maintenance they needed.

The repercussions of this new mobility went far beyond breaking down rural isolation and reducing transport costs. What also happened was that thousands of new entrepreneurs and small businesses sprang up in connection with the advancing road transport industry, and millions of people developed the mechanical aptitudes that the situation demanded. These aptitudes then found their way into many different occupations where they were badly needed. And finally, great numbers of beasts of burden that had been eating well while people went hungry were retired from the transport system.

The third point I wish to make is that we accomplished many of these things through a change in our attitude toward foreign aid.

In the early sixties the foreign aid programs of all the developed countries combined amounted to very little in relation to the urgent need for capital to finance the world's transportation needs. For example, the assistance being given for transport amounted to only 20 cents per capita per year for India, 70 cents for Brazil, and 13 cents for Thailand. With all the technological know-how of the advanced countries, and with all the wealth at their command, there were many in 1962 who still fought the effort to spread the transport revolution to those who had been by-passed!

The fact that every nation able to do so is now participating in a world-wide program to aid countries that are lower down the economic development scale has been given special impetus by the control of armaments.

In 1962 the world was spending \$14 million per hour just to support armies and armaments. There were 75 million men either in military service or supporting the military. Much of the world's best brain power was devoted to better ways of blowing things to pieces.

With the achievement of harmony and respect among all the world's people, it became possible to launch the big push. We were finally able to afford the time and effort as well as the money to break the transport barrier that had held much of the world in bondage since the beginning of time.

What this has meant for the prosperity of the economically advanced countries as well as for the recipients of this assistance is too obvious for me to repeat here. It is sufficient to say, as Barbara Ward had already told us in 1962, that even for man's self-interest, generosity is the best policy.

The idea that all prosperous nations should assess themselves a certain amount to assist less fortunate countries has proven to be good business sense as well as good common sense. When the gross national product of the U.S. reached one trillion dollars a year, the country set aside two percent, or approximately \$20 billion a year for foreign public loans, grants, and technical assistance. Other nations have assessed themselves a proportionate amount, and these resources administered by the United Nations have provided the support that was so urgently needed.

Not the least part of this world-wide economic and technical assistance program has been the research and development effort that has accompanied it. You will recall man's early efforts in the fifties and sixties to design the necessary vehicles and navigation systems to enable him to travel to other

planets. This interplanetary transportation system was made possible by learning as much as possible about the environment of outer space, and by using scientific and technical knowledge to adapt the new transport to that environment.

The very same approach, as you know, has made it possible to design appropriate transport systems for the underdeveloped areas on our own planet. In the early 1960's we greatly accelerated our studies of the causes of underdevelopment and the role that greater mobility might play in helping to step-up rates of growth. We studied the environmental factors present in those parts of the world where the physical obstacles to transportation have been so forboding. And we designed transportation solutions to meet the challenge.

The organizations that began the transportation research and development programs so badly needed in the 1960's included the U. S. Agency for International Development, the International Bank and its affiliates, the Organization for Economic Cooperation and Development, the Organization of American States, and, of course, the International Road Federation in its capacity as a consultative organization to the United Nations. Among the results are the Transportation Centers that we know so well today— such as those in Santiago, New Delhi, Paris, Bangkok, Lagos, Tokyo, and Washington. These centers had their beginnings in the sixties, when we finally faced up to the fact that there were many things still to be learned about the role that transportation plays in the development process. It was out of these efforts that we evolved a strategy for mobility that has paid off so handsomely, for countries in all stages of development.

Today we honor the farsighted members of the International Road Federation whose help made it possible to realize the new era in transport that all of us all over the world now enjoy. Let us remember in our deliberations this week that it was here in Madrid that many of the ideas and decisions leading to the transport revolution of the sixties and seventies originated. And then let us look forward once more to another eventful period in which new victories over time and space will continue to serve all mankind.

TRANSPORT TECHNOLOGY AND ECONOMIC DEVELOPMENT*

by Wilfred Owen
The Brookings Institution
Washington, D.C.

- (1) There is a definite relation between immobility and poverty. Countries with low standards of living are characteristically countries with inadequate methods of moving. The reason for this relationship is obvious. Transportation is an essential ingredient of almost everything man does to supply himself with the necessities of life.
- (2) Science and technology now provide the means of overcoming the obstacles to movement which throughout most of history have restricted the effective use of the world's resources. Man has at his disposal a choice of technological methods not even conceived of a few decades ago. It is no longer necessary to move slowly and laboriously through each successive stage in the process of transport evolution as it was for nations that developed in an earlier period. The newly developing countries of today can reap all at once the accumulated benefits of the transport revolution.
- (3) Already we can see the tremendous strides being made in the transport systems of Africa, Asia, and South America. In the past decade, railway freight on these continents has more than doubled, and the number of trucks and buses has increased one and a half times. Transport has opened the way to previously inaccessible land and resources, and has made possible new agriculture and mining, new industry, new markets, and the communication of new ideas.
- (4) The transportation gap between the rich countries and the poor, however, remains. Asia, with 53 percent of the world's population, has 3 percent of the world's motor vehicles. Africa and Latin America, with more than one-third of the land area of the world, have only 7 percent of its surfaced roads. Two nations—the Soviet Union and the United States—account for 75 percent of all the world's railway freight.
- (5) The fact is that the transport revolution has by-passed two-thirds of the world's people. To date the efforts to make science and technology serve the urgent transport needs of the newly developing countries have totally failed to break through the transport barrier. If a major breakthrough is to be achieved, it will be necessary to face up to major obstacles that are preventing us from realizing the full benefits of modern science and technology in the transport sector.

* United Nations Conference on the Application of Science and Technology for the Benefit of the Less-Developed Areas, Geneva, February 1963.

(6) What is needed is a total strategy for mobility. This strategy should be aimed not only at introducing effective technological advances in transport, but at creating the necessary conditions for assuring that technology can make its most effective contribution to higher standards of living.

A Total View

(7) Accessibility and mobility are essential to almost everything that underdeveloped countries are striving to accomplish. It follows that transportation can be a key factor in the success or failure of the entire development effort. For while food, shelter, health, education, and useful jobs are the ultimate goals, transport may be the catalyst essential to the realization of these objectives. This implies an approach which not only looks at transportation as a whole but which looks beyond transport itself to the processes of production and distribution that the transport system is called upon to serve.

(8) The point can be illustrated by food. A goal common for most of the countries of the world is to provide enough for people to eat, and to supply the kinds of food that will assure an adequate diet. The role that transportation can play in attaining this objective is to provide access to arable lands, to help communicate new agricultural techniques, to make possible the delivery of seeds and fertilizer, to assemble and move the increased product to consumers, and to provide the incentive to produce for the market. If we think of transport as a means of overcoming hunger, then our approach must include more than the appropriate technology. We will need to concern ourselves with the organization and financial arrangements for keeping the roads passable; the necessary cooperatives to enable producers to purchase equipment for local haulage; the necessary information on market conditions; and the necessary long-haul transport by road, rail, or inland water carrier. The objective is to close the gap between the producer of agricultural surpluses and the consumers who need the food.

(9) But even when we look at transport in this broader framework, solutions that seem satisfactory from a transportation standpoint may still be unsatisfactory from a development standpoint. The goal of increasing the food supply may not be served best by expediting movement at all. An alternative may be to introduce new methods of storing or preserving what is grown. When storage is made possible in producing areas, peak traffic demands typical of agricultural economies can be flattened by spreading the transport burden over a longer period of time, and investments in transport capacity may be reduced accordingly.

(10) For perishables the establishment of processing plants close to sources of supply can reduce spoilage and eliminate the need for speedy transport or refrigerated equipment. Freezing, drying, or irradiation of foods may be the technology that is needed, not transportation. This type of solution may have the added advantages of creating local employment, providing a source of local capital accumulation, making agricultural waste available for fuel or local manufactures, and reducing the weight and bulk of commodities flowing into the transport system. An entirely new approach to the transportation problem may emerge when science and technology are focused on the objective of increasing the supply of food, rather than increasing the supply of transportation.

(11) In the industrial sector the concept of optimizing the use of resources for development also requires that we expand our perspective of the potentials of transport technology. It is not enough to prescribe what transport accommodations are needed to serve the industrial program. Industrial technology itself may be dictated by transport potentials and limitations. The type, location, and size of industrial plants and the decision to favor a concentration or dispersal of industrial activity are all decisions that must take into account the technological potentials of transport. It may be necessary on transportation grounds to modify completely the types of industrial activities to be engaged in. Modifications may be necessary because transport costs are excessive, or because transport possibilities suggest comparative advantages through interregional or international specialization and trade.

(12) The same need to look at the total environment is encountered in the analysis of factors governing the choice of alternative transport technologies. Obviously we have to know what will be moving, in what volumes, and over what distances if we are to judge the feasibility of road, rail, river, pipe, and air transport. But the desirability of these alternatives requires also that we measure both the inputs and outputs that will be involved in the supply of transport facilities. What are the relative requirements for capital, managerial talent, foreign exchange, and maintenance? How much time will elapse before the investment will begin to pay off? What supporting economic activities are likely to be created? What kinds of direct and indirect employment will result, to what extent will entrepreneurship and new resource development be encouraged? What social and political impacts can be anticipated?

Minimizing Transport Through Innovation

(13) The above questions are all part of the process of applying modern transport technology wisely and effectively because the ultimate objective is higher standards of living, and not merely higher standards of moving. Indeed, science and technology may ultimately make a more significant contribution to transport by eliminating the need for transport than by supplying more capacity. Every avenue needs to be explored to reduce unnecessary transport requirements, both physical and financial, if we are to overcome the tremendous cost in time and money that the movement of people and goods entails. A successful attack on transport demand may be the most effective approach to shifting resources to other neglected sectors of the economy.

(14) One approach to reducing transport demand is suggested by the very large amounts of fuel being transported for heat, light, and power in industrial societies. The task of hauling fuels is a major burden on transport systems and coal is often the most important single commodity moving on the railways.

(15) Science holds the promise of reducing this burden through the development of nuclear power, solar energy, and other innovations. In many countries solar energy is one of the promising possibilities for throwing off the burden of transporting fuel, since the sun is a ubiquitous source of energy. The possibilities of cooking, heating, refrigerating, lighting, and operating communications systems on solar energy have already been demonstrated. Further advances are

of particular importance to low-income countries, for most places poor in transport are rich in sunshine.

(16) New capabilities for long-distance transmission of electric power also furnish a means of reducing transport requirements. National power grids can extend the radius of hydroelectric power distribution or distribution of electricity from thermal plants located at the mine head. The cost of constructing new high-voltage lines may be more than offset by savings in the cost of transporting coal.

(17) A further possibility for minimizing avoidable transport is the reduction of agriculture's dependence on fast transit of perishables. This can be accomplished by preserving and processing foods and by extracting edible proteins from vegetation that is available nearly everywhere but cannot be digested in the natural state.

(18) Another extensive field for development is the substitution of communications for transportation. A century ago, transport and communications were a single field because communication was possible only by transporting messages. But with the development of telegraph, telephone, radio, and television, communications no longer depend on transportation and are often an effective substitute.

(19) The practical implications of scientific advances in communications are highly relevant to the task of overcoming transport barriers. The limited capacity of the transport system in underdeveloped areas can now be compensated by communications that achieve with relative speed and economy many of the political, social, and cultural effects that would otherwise have to await the building of roads, rail lines, and other transport facilities.

(20) Classroom radio and television can provide a partial substitute for transporting pupils to consolidated schools, and they can multiply the effectiveness of scarce teaching personnel. In a number of countries mass education by radio is being accomplished in writing, arithmetic, agriculture, and in public and personal health. Operation of world-wide television through the use of communications satellites will further the effectiveness of communications as a transportation substitute.

The Promise of Science and Technology

(21) The world is on the threshold of a new revolution in transport technology. For the first time in five thousand years the wheel is being displaced as the symbol of transportation progress. Among the most promising innovations are the vertical take-off aircraft, the ground effects machine, the pipeline for solids, liquids, and gases, the hydrofoil ship, and new sources of energy such as the fuel cell, nuclear power, solar power, and the gas turbine. The transport revolution that is gathering momentum in the second half of the twentieth century may prove to be one of the greatest potentials for economic development. The world needs to marshal all of its research resources in this area to accelerate these potentials. The objective must be to short-cut costly and time-consuming methods of achieving mobility that one were necessary but which need no longer frustrate developing nations today.

(22) The potentials of road transport can be enhanced by improvements in the design, performance, reliability, and economy of the motor vehicle, and by the introduction of new power sources. Better roads and better techniques for road construction are still capable of greatly reducing transport costs and improving the standard of truck and bus services. Gas turbines could reduce the cost and complexity of the motor vehicle, reduce the number of moving parts, and provide an engine that runs on almost any liquid fuel. Further development of the fuel cell could introduce another important possibility for motor vehicle propulsion, especially where petroleum supplies are scarce.

(23) Another significant innovation that needs to be advanced for countries newly embarked on transport development is the ground effect or air cushion vehicle that operates off the surface of the ground or water. This new form of transportation has particular promise where roads are poor or non-existent, where there are swamps or difficult river crossings, and where shoals or other obstacles impede navigation.

(24) Further cost reductions might be achieved through the development of vehicles requiring a minimum of maintenance and repair. Highway funds can be stretched and transport costs reduced by road designs that take maximum advantage of native materials for low-cost surfaces. Important progress is still to be accomplished in soil stabilization, the use of sand-clay mixtures, soil-cement surfaces, and the use of oil and chemicals as dust palliatives and stabilizing agents. More adequate surfaces will mean substantial reductions in transport costs and reliability, including reduction of vehicle maintenance and repair, lowered fuel consumption, lessened tire wear, and reduction in accident losses.

(25) Developments in aircraft for newly developing countries need to be aimed at design and performance for greater safety, simplicity, carrying capacity, and economy. These trends could completely alter the outlook for cargo and passenger movement by air. For relatively short distances the improvement of vertical take-off and landing aircraft may in the near future furnish better and more economical service by air than by surface methods. And the agricultural and industrial uses of air vehicles can be greatly extended.

(26) We have hardly begun to realize the potentials of air transport in countries where natural obstacles to surface movement loom large. An illustration is furnished by the situation in East Pakistan, where a network of unbridgeable rivers cuts up the area, and the monsoon makes surface transport exceedingly difficult and often impossible. The trip from Dacca to Faridpur by steamer and rail takes 15 hours. The same trip by plane takes 30 minutes. From Dacca to Bagerhat, 84 airline miles, takes three days by river and rail.

(27) A major research and development effort in air transport is needed to assure that aviation capabilities are used to the fullest in the early stages of economic development. Much of the capital being invested in ground transport facilities today will have a lengthy economic life, but in all probability a rapid rate of obsolescence as well. The possibilities of science and technology in aviation need to be clearly understood and development programs made sufficiently flexible to avoid unnecessary long-range commitments.

(28) The potentials of pipelines in the transport system have been demonstrated by the successful long-distance piping of bituminous coal. The coal is ground to the consistency of coarse sand, mixed with water, and pumped a hundred miles in thirty hours. Any material that can be broken into small pieces, suspended in liquid, and restored at the end of the journey without destroying its usefulness can be moved by pipe. Thus far the drawback has been the cost of preparing solids for such a trip and afterwards reclaiming them, but engineering advances promise that a much wider variety of solids will be pumped overland in the future where traffic volumes warrant the investment in pipelines and where alternate low-cost water transport is not available.

(29) Comparison of pipeline transport costs with the cost of water transport of bulk materials has led to the conclusion that where high volume movement is involved, pipeline costs are competitive with water transport, even taking into account the costs of processing the materials before and after pipeline transmission. Comparison of rail and pipeline costs for the movement of large volumes of bulk commodities showed that rail line-haul costs under the most favorable circumstances were seven or eight times large-diameter pipeline costs.

(30) But changing technology could also further revolutionize the efficiency of water-borne commerce. The barge and towing vessel have introduced greater power and capacity to serve the growing number of industries which involve mass consumption of raw materials and mass output. Newly developing countries will find modern water transport increasingly important as industrialization introduces steel mills, chemicals, cement, power plants, aluminum production, paper mills, petroleum refining, and other economic activities to which water transport is particularly well adapted. To meet the requirements of these industries, diesel-powered tow boats and barges can accommodate tremendous volumes of traffic at very low cost. New types of vehicles, further mechanization, and the use of electronics for navigation can expand the role of water transport in the development of many parts of the world.

(31) While the most spectacular possibilities appear to be focused on the newer forms of transport, rail technology is by no means standing still. All over the world, the trend toward diesel power has reaped tremendous gains in economy and performance. Added to this have been substantial improvements in equipment and new methods of roadbed construction, rail installation, and maintenance. The introduction of electronics is completely altering previous methods of traffic control, and the revision of rate-making practices, market analyses and cooperative relations with competing carriers are supplementing to an important degree the more sensational engineering innovations.

(32) For economical freight movement, however, there is an urgent need for developing a total transportation system approach through some form of universal container interchangeable among all forms of carriage. While the container is generally thought of as a labor saving device, its importance to underdeveloped areas lies in the fact that it is a capital saving device as well. When container ships are loaded and unloaded, it has been found possible for a crew of men to move five hundred tons per hour compared to twenty-five tons by conventional methods. Containers reduce the need for berth capacity by speeding port operations, and they stretch the supply of shipping space by shortening turn-around time for cargo vessels. More development work is needed to design

and establish container systems suited to particular countries and groups of countries.

(33) Containerization is particularly advantageous in underdeveloped areas because of frequent transshipments where there are gaps in the transport system. Rail systems can be utilized more effectively when containers rather than costly rail cars are used for storage. Containerization can also simplify freight rates by providing a tariff per mile per container, regardless of contents. Substantial gains would be realized by replacing the confusion and paper work of the present complex commodity rates.

Other Necessary Conditions

(34) The effective use of available science and technology cannot be realized unless organizational, financial, and administrative innovations accompany the implementation of scientific discoveries. Whatever the planners' decisions, and however ideal they may prove to be from the standpoint of technology, transport performance will be poor if organizational arrangements are poor.

(35) If transport facilities are to operate efficiently we will need to know more about the present organization, financing, and operating techniques of the transport function in underdeveloped areas and the advantages and disadvantages that administrative experimentation has revealed. We need to know what the organizational requirements for an effective transport system are, and how the necessary integration is to be achieved between transport and planning commission objectives. It is also important to gauge the role to be played by the private sector, the relevance of economic regulation, and the possibilities of international and regional cooperation for transport operation. All these are essential factors which must be explored if the institutional arrangements are to keep pace with technological potentials.

(36) Methods of financing transport facilities are likewise important to the effective use of transport, for financial policies have an important bearing on the choice of transport facilities, their design and condition, and the volumes of traffic using them. We need to understand why most of the world's railways are in financial difficulty, how railway rate policies can influence development, and what approaches might be taken to alleviate the financial crises typical of the transport sector. It is already clear that the terms of financing affect the rate of technological developments and therefore especially careful study should be given to the financial policies followed by the foreign aid agencies.

(37) And finally, we should not fail to take advantage of what is already technologically possible from a failure to communicate the information we already have. There is an untapped wealth of information in the experience of foreign assistance programs and international lending agencies over the past decade. But few efforts have been made to make the information available in a systematized way. Transport investments of various types under different circumstances have been made, but there are no careful analyses of the results that followed these investments. The need for such an undertaking is clear if we are to take advantage of the lessons offered by past successes and failures.

A World Program of Research and Development

(38) What is needed above all is a world-wide program of research and development aimed at the advance of understanding and the exchange of knowledge and information with respect to transportation and its role in development. Our knowledge of how best to overcome the drag of poor transport in poor countries is still primitive, and an organized effort needs to be made to hasten the promise of technology.

(39) There is need for a number of international focal points, regional centers throughout the world, dedicated to a better understanding of the relation between immobility and poverty. The task, to be shared by both developed and newly developing countries, is to marshal the facts already available, to analyze the wealth of knowledge that experience has provided, and to stimulate scientific discovery and applications of known scientific and technological advances to the solution of transport problems.

(40) In the United States the Agency for International Development has made a beginning by its support of a five-year research program in Washington at the Brookings Institution. This program is concerned with the relation between transportation and the achievement of higher levels of living. This effort is dedicated to a fresh view of the role of transportation in development—to designing a total strategy that will provide not only the mobility and accessibility required to achieve higher levels of living, but also the maximum economic and social byproducts that transport investment can provide.

(41) A number of institutions and scholars will be asked to join in the task of advancing our limited knowledge of the role of transport in the development process, and in so doing to assist in determining the most effective application of existing transport technology and the most important goals for further scientific inquiry. The program is also designed to help new nations to avoid the mistakes that the developed countries have made, to share with others the successes that economically advanced countries have experienced, and to direct research efforts to the discovery of better institutions and better methods of overcoming the barriers to transportation that stand in the way of higher standards of living.

(42) This is a small beginning to a very large undertaking. The scope and importance of such a program of research call for simultaneous efforts on the part of all the countries of the world. The challenge that the transport sector poses for the scientific community and for the United Nations is one that cuts across the entire development field. The results of an effectively organized research and development effort can supply important clues to the whole process of economic growth.

In conclusion:

(43) The most effective use of technology in transport is not being realized because we are looking at transportation too narrowly, rather than looking at the ways in which transport can contribute to the realization of national goals. For this reason we have failed to make the maximum use of transport technology as part of the strategy of development.

(44) The scientific and technological advances that can contribute to the solution of transport problems are not to be found in the field of transport alone. Many of the sessions at the Geneva Conference that appear to have no direct relation to transport may prove to have the greatest significance for resolving transport problems. These include the possibilities of new sources of energy, new methods of energy distribution, new approaches to processing and preserving food, and new possibilities for substituting communications for transportation. In many cases it will be as important to minimize avoidable transport as to supply new facilities.

(45) Much of the failure to use the fruits of science and technology effectively in the transport sector is due to the comparative lag in financial, organizational, and administrative innovations that are needed to accommodate the forward thrust of scientific innovation.

(46) These are the essential ingredients of a total strategy for mobility. Until they are all included in the effort to improve the mobility of the underdeveloped countries the full promise of science and technology will remain unrealized.