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DRI PROPOSAL INT7821R

A PROPGSAL FOR  
A REPRESENTATIVE SERIES OF APPROPRIATE  
TECHNOLOGY STUDIES AND ANALYSES

Submitted to:

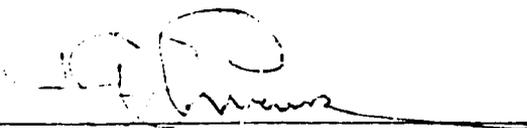
U. S. Agency for International Development  
Washington, D. C. 20523

Submitted by:

Office of International Programs  
Denver Research Institute  
University of Denver  
Denver, Colorado 80208

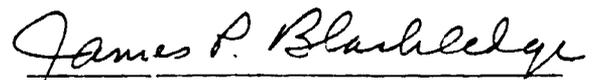
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PREPARED BY:

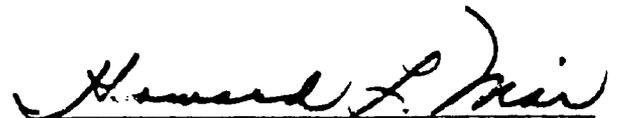


Donald D. Evans  
Assistant Director  
Programs for Institutional Development  
Office of International Programs

APPROVED BY:



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Institute, and Director, Office of  
International Programs



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Director  
Office of Grants and Contracts  
University of Denver

A PROPOSAL FOR A REPRESENTATIVE SERIES OF  
APPROPRIATE TECHNOLOGY STUDIES AND ANALYSES

Description of the Need

The concept of "appropriate," or more recently "light capital,"\* technology has been current in the last few years. These terms refer to the employment in less-developed countries (LDCs) of more-or-less simple technological solutions to largely endemic problems, in which the emphasis is on making maximum feasible use of the local factors of production which are in greatest supply (typically labor) and which require the minimum amount of scarce resources (characteristically capital, especially foreign exchange). It has been observed that in a large number of instances, solutions or partial solutions to indigenous problems are provided through employment of technologies that have their origins in the more developed countries; these may present sub-optimal answers to the needs of the LDCs in terms of making the best possible use of domestic resources in the process of problem solution, process development, product design, resource utilization, etc.

One consequence of these observed conditions has been the establishment of various organizations, the emphasis of which is in activities that will point out the advantages of better-considered technological applications, the devising of more appropriate solutions to LDC problems, and the dissemination of the results of these efforts so that others may benefit from them. Thus, such organizations as the U.K.'s Intermediate Technology Development Group (in which the late E. F. Schumacher was so prominent) and Volunteers in Technical Assistance (VITA) have been organized and have functioned with telling effect for some time. More recent has been the establishment of Appropriate Technology International Corporation, a creation of the Congress of the United States, just now getting underway with the definition and development of its system of operation. Other instances of similar organizations and efforts can be cited in various countries such as India.

One of the difficulties related to the concept of appropriate technology, or the increasingly heard "light capital technology," has been suitable definition of just what is meant by these terms. Perhaps the best discussions of this

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\* For a definition of "light capital technology," refer to Appendix A.

subject appear in Schumacher's now classic work entitled, Small is Beautiful,<sup>1</sup> and in such other definitive works as Owens' and Shaw's Development Reconsidered.<sup>2</sup> Many elaborating short discussions have appeared more recently in the world literature. Perhaps one of the best criteria of the appropriateness of a technological application relates to its relative cost and effectiveness in creating "work places," or new employment opportunities, directly as a consequence of its utilization.

Presently there is some discussion of the tendency to state in at least some LDC quarters that the terms "appropriate" or "light capital" technology equate with the generally discredited phrase "intermediate technology," which connotes in the minds of many a covert effort on the part of the developed countries to foist off on the LDCs various obsolete or obsolescent technologies which have long since been "written off" in the developed countries. This has the effect, presumably, of restricting technological advance in the LDCs to ineffectuality.

Without attempting to further define, or defend, the effects of utilization of such technology transfers, it is observed that there is need for more examples of appropriate technological innovations from within the LDCs which, by general consensus, are considered to have been effective in terms of their overall utility, including their beneficial economic and social secondary effects.

Such examples, to be useful, should include sufficient attendant information to enable some comparison to be made amongst them, in an effort to determine what their common elements are which may be applied in the conceptualization and planning of programs to achieve such benefits in other LDC circumstances. Consequently, simply a "catalogue" of such examples, without supporting information as to the essential elements surrounding either their success or lack of it, would be insufficient for the purpose. Needed is sufficient information on the origins of the problem, the means by which it was brought to the attention of the solution-finding agent, the methods and problems encountered in reaching its solution, aspects of gaining acceptance of it by the user, and the second-order, economic and social consequences of its employment.

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<sup>1</sup>Schumacher, E. F. Small is Beautiful. New York: Harper & Row, 1973.

<sup>2</sup>Owens, Edgar, and Shaw, Robert. Development Reconsidered. Lexington, Massachusetts: D. C. Heath & Co., 1972, 1974.

It is the thesis of this concept that it would be both possible and useful to identify and adequately describe a sufficient number of instances of such appropriate applications of technology in LDCs, to afford a reference point for analyses and postulation of generalized techniques for arriving at such solutions in the variety of situations that characterize the LDC environments.

#### Purpose of the Proposed Research

The purpose of the research proposed in this paper is:

To develop a sufficient variety of case histories of the application of appropriate or light capital technologies to make possible their comparative analyses for the purpose of deriving a generalized model or theory of the process for developing optimized technological applications, including identification of common problems and difficulties encountered in such processes.

#### Research Method

Fortunately, there are a significant number of institutions dispersed throughout the LDCs which have had broad, "hands-on" experience in the development and application of appropriate technologies--long before such applications were given this particular appellation. These institutions number over 80, and many have been in existence for a sufficiently long period of time to have accumulated significant numbers and varieties of examples of such applications. These research institutions are accessible and, based on current knowledge and experience of the Office of International Programs (OIP) of the Denver Research Institute, are known to be willing to cooperate in a program to develop a representative variety of such cases for comparison and analysis.

These research institutions are not only the sources of appreciable case history information based on their own experience in the generation of technology, but because of being an integrated feature of their respective national scenes, they are well situated to identify other agencies in the country that have been involved in technology generation and application. Thus, they may serve as the means of implementing a search for appropriate technology applications through identification of individuals and other organizations so involved, and the enlistment of their cooperation in the field survey work leading to development of case histories. Another principal advantage of involvement of these institutions is their ability to greatly facilitate

the preparations for and carrying out of field studies based on their language capabilities and general local familiarity.

The USAID Missions in survey countries are also potential sites of appreciable assistance in carrying out field studies--to the extent they are able and willing to facilitate the work. Not only can Missions be sources of ideas for suitable case studies based on their own programs but also could generally support the surveys in various ways in terms of information and, if circumstances permit, modest communication and logistic accommodations. The Missions, of course, stand to benefit by the production of a series of appropriate technology case histories and analyses, because of the importance this subject has assumed in development circles and as a source of ideas about technology for possible implementation in their own areas of responsibility.

In developing useful examples of appropriate technology from a variety of sources, it will be necessary to devise a uniform questionnaire and approach to the problem of eliciting the needed information to ensure that comparative analyses may be made. This is especially necessary if, as is proposed, a number of different individuals will be involved in the collection of the base information for subsequent aggregation and comparative analysis. As mentioned in the section on "Description of the Need," the more important information derived from such a study may well be not the descriptions of the appropriate light capital technologies themselves but, rather, the surrounding circumstances as to how the problem was initially defined, the research approach devised, the problems of gaining solution acceptance by users, and the consequent second-order effects the technology may have had in terms of economic and social impacts.

Consequently, an important aspect of the research will be development of a comprehensive interview procedure and adequate indoctrination of those involved in the field work and in its utilization and reporting. It is anticipated that interviews with users and others associated with the technology outside of the IRI will be required.

DRI's experience in the planning and development of LDC case histories indicates that at least seven full days should be allowed per country. This amount of time is adequate, however, only if advance preparation through local institutions has been well planned and executed. LDC environments typically

can result in dissipation of days of effort simply in the process of identifying and gaining access to potential survey respondents.

It is reasonable to expect one useful case history, in adequate depth, for each country visited. In unusual circumstances, two or even three may result.

The subsequent analysis of the field study results will be performed by an analyst with cogent experience who will involve the surveyors closely in the analysis procedure to assure that uniform and accurate use is made of the data.

The following institutions and countries are proposed as possible survey sites:<sup>\*</sup>

Central American Institute of Industrial Technical Investigations  
(ICAITI)--Guatemala City

Institute of Technical Studies (IIT)--Bogotá, Colombia

Institute of Mining and Metallurgy (IIMM)--Oruro, Bolivia

Dominican Institute of Technology (INDOTEC)--Santo Domingo,  
Dominican Republic

Escuela Superior Politécnica (ESPOL)--Guayaquil, Ecuador

Laboratorio Técnica de Uruguay (LATU)--Montevideo, Uruguay

Institute of Technical Studies (IPT)--São Paulo, Brazil

Royal Scientific Society (RSS)--Amman, Jordan

National Research Center (NRC)--Cairo, Egypt

Laboratoire Central--Tunis, Tunisia

Appropriate Technology Development Center (ATDC)--Kumasa, Ghana

East African Industrial Research Organization (EAIRO)--Nairobi, Kenya

Pakistan Council of Scientific and Industrial Research (PCSIR)  
--Karachi, Pakistan

Council of Scientific and Industrial Research (CSIR)--New Delhi,  
India

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<sup>\*</sup> Not all will necessarily be visited; this will depend on making satisfactory preliminary arrangements leading to a productive field study situation.

Ceylon Institute of Scientific and Industrial Research (CISIR)  
--Colombo, Sri Lanka

Singapore Institute of Standards and Industrial Research (SISIR)  
--Singapore

Applied Scientific Research Corporation of Thailand (ASRCT)--Bangkok

Laboratories of LIPI--Indonesia

Korea Institute of Science and Technology (KIST)--Seoul, Korea

National Institute of Science and Technology (NIST)--Manila, Philippines.

The research will include an extensive review of the related literature and development of an appropriate bibliography.

### Staffing

The project will be organized and directed by Donald Evans, with the assistance of Laurie Adler, who will be responsible for questionnaire development, coordinating report preparation and dissemination, and organization of a presentation, in Washington, of the study results.

The field studies will be conducted during scheduled visits to the respondent institutions by these OIP staff members (biographic information appears in the appendix):

Laurie Adler  
Donald Black  
James Blackledge  
Eric Ericsson  
Donald Evans  
Milan Racovic  
Richard Roberts

### Reporting

The report of the proposed research should have wide receptivity and usefulness in view of the importance being assigned to the concepts of appropriate, light capital technology. The timely appearance of the study preliminary to the 1979 UN Conference on Science and Technology for Development (UNCSTD) will provide an opportunity to utilize it in connection with this signal event in the consideration of the relationship of technology and development. It is proposed that 5,000 copies of the report be acquired by AID for use in conjunction with the UNCSTD and for other appropriate distribution.

The Westview Press of Boulder, Colorado, which has an extensive experience and title list relating to development subjects, is willing to enter into an agreement to provide the 5,000 copies, at cost, in return for the opportunity to publish the study and promote it as part of the publishing house's regular activity. The estimated cost of each copy is \$3.50, for a total of \$17,500. DRI will supply edited copy and suitable illustrations to Westview, who will undertake the production of a quality, soft-cover book of approximately 250 to 300 pages.

#### Time Required

The project will require eight months for completion from date of institution.

#### Funding Required

Required are funds for the staff time and travel to carry out the field studies, plus the necessary time for analysis and reporting to be carried out at OIP in Denver, Colorado, and in Washington, D. C., and for publication of the research report (see following budget). Some of the cooperating IRIs will require funding to meet their costs of data collection and preparation, staff time, etc.

Estimated Budget

1.	<u>Staff time</u> *		
	Professional		
	26 person-weeks (5 days each) @ \$1,900	\$49,400	
	12 person-weeks @ \$870	10,440	
	Secretarial		
	10 weeks @ \$350	3,500	
	<b>Total Staff Costs</b>		<b>\$63,340</b>
2.	<u>Defense Base Insurance</u>		
	\$14,800 in salaries (4.65 person-months) @ \$8.75/ month/\$100 of salary		1,295
3.	<u>Fees for Cooperating IRIs (estimated)</u>		12,000
4.	<u>Per Diem and Incidental Travel Fund</u>		
	Per Diem:		
	Amman--7 days @ \$62	\$ 434	
	Bangkok--7 days @ \$42	294	
	Bogotá--7 days @ \$40	280	
	Cairo--7 days @ \$58	406	
	Colombo--7 days @ \$35	245	
	Guatemala City--7 days @ \$41	287	
	Guayaquil--7 days @ \$45	315	
	Jakarta--7 days @ \$56	392	
	Karachi--7 days @ \$72	504	
	Khartoum--7 days @ \$73	511	
	Kumasa--7 days @ \$78	546	
	Manila--7 days @ \$40	280	
	Montevideo--7 days @ \$37	259	
	Nairobi--7 days @ \$49	343	
	New Delhi--7 days @ \$48	336	
	Oruro--7 days @ \$22	154	
	Santo Domingo--7 days @ \$42	294	

\* Staff time includes base salary + 16% vacation/sick leave + 19% fringe benefits + 86% institutional overhead.

São Paulo--7 days @ \$68	\$	476	
Seoul--7 days @ \$54		378	
Singapore--7 days @ \$50		350	
Tunis--7 days @ \$54		378	
Washington, D. C.--20 days @ \$35		700	
	Total Per Diem		\$ 8,162
<b>Airfares:*</b>			
6 trips, Denver-Washington, D. C. @ \$300	\$	1,800	
Latin America (6 countries) @ \$1,300		1,300	
East Asia (4 countries) @ \$1,800		1,800	
North Africa-Middle East (3 countries) @ \$1,300		1,300	
South Asia (3 countries) @ \$2,200		2,200	
Sub-Saharan Africa (4 countries) @ \$1,900		1,900	
In-country travel (LDC surveys)		2,000	
	Total Airfares		\$12,300
	Total Travel		\$20,462
<b>5. <u>Report Preparation</u></b>			
Graphics and compositing	\$	1,000	
Miscellaneous materials		1,000	
Reproduction (5,000 copies @ \$3.50)		17,500	
	Total Report Preparation		\$19,500
<b>6. <u>Communications Expense, Immunizations, Duplicating Costs, and Miscellaneous</u></b>			
			\$ 1,403
	Total Estimated Project Cost		\$118,000

\* Where other AID-supported activities are coincident, it may be possible to cost-share transportation expense, in which event these estimates--which assume no such saving--will be on the high side.

## APPENDIX A

## APPENDIX B

LAURIE NOGG ADLER, Research Associate, Office of International Programs,  
Denver Research Institute, University of Denver

EDUCATION

B.S., Marketing, School of Commerce, New York University,  
1971  
M.S.S., Graduate School of Librarianship, University of Denver,  
1975

PROFESSIONAL EXPERIENCE

November 1977 - present      Denver Research Institute. Responsibilities include: information-gathering activities for projects and ongoing programs in industrial research institutes in developing countries; technical processing in information automation; proposal preparation; integration of information-gathering processes within the Office of International Programs; marketing research and analysis; publishing assistance.

April 1976-present      Assistant Director, University of Denver Publishing Institute. Coordinates and administers Institute activities within the University

1972-1977      Market Researcher and Evaluator, Consolidated Marketing Service, Inc. Researched, compiled and evaluated data for market analysis--mostly real estate demographics and feasibility.

April 1977      Compiler, Keystone Center for Continuing Education. Executed detail of Fortune 500's largest industrial companies for mailing list.

October 1976-February 1977      Project Coordinator and Researcher, Western States Arts Foundation. Compiled directory of funding sources available to Native Americans in the Arts. Organized library collection.

September 1971-September 1977      Research Assistant, Genesis, Inc. Worked with various aspects of design and marketing to expedite client problem solving.

July 1972-November 1972      Researcher, Samsonite Corporation, Toy Division  
Organized information from secondary resources on the pool-toy market.

July 1972-September 1977      Most of the above positions as well as many other short-term assignments were performed under the name of Research Resource.

PUBLICATIONS

Native American Arts and Culture: a Resource Directory,  
Western States Arts Foundation, Denver, 1977.

Book reviews have appeared in The Denver Post and The Los Angeles Times.

LANGUAGES

English (native), reading knowledge of French.

RONALD P. BLACK, Assistant Director, Programs for Management Development,  
and Senior Research Scientist, Office of International Programs, Denver  
Research Institute, University of Denver

#### EDUCATION

B.S., Chemistry, Millsaps College, 1958  
U.S. Department of Agriculture, Southern Utilization Research and Development  
Fellow, Thermodynamics, Tulane University, 1958-1960  
Ph.D., Chemistry, Massachusetts Institute of Technology, 1964  
Recipient of Minnesota Mining and Manufacturing Company  
Fellowship and National Institute of Health Fellowship

#### PROFESSIONAL EXPERIENCE

- 1974-Present      Denver Research Institute: Dr. Black's major functions include: transferring management skills internationally and developing the management capabilities of staff and executives of R&D organizations in addition to directing all such activities conducted by DRI; analyzing the processes of international transfers of industrial and agricultural technology, as well as the processes whereby intermediate technology is designed, developed, adapted, and commercialized in less developed economies (LDE); and structuring research institute programs aimed at uplifting the status and living conditions of segments of LDE populations, which have underprivileged positions in their societies. Dr. Black has worked, since 1974, with the Applied Scientific Research Corporation of Thailand in the area of management and institutional development. Representatives from Mahidol University, Preserved Food Organization, the National Social and Economic Development Board, the Office of Agricultural Land Reform and the Asian Institute of Technology are among the Thai organizations participating in management development programs directed by Dr. Black.
- 1970-1974      Senior Systems Analyst      Stanford Research Institute (SRI).  
During this period, Dr. Black served as science and technology policy advisor to the Secretary General of the National Research Council (NRC) of Thailand; directed a joint SRI/NRC team that developed the system currently utilized for measuring Thailand's scientific and technological potential; directed joint SRI/Thai Military Research and Development Center team that conducted information feasibility study and then developed a major data bank of geographic, administrative and socioeconomic research-generated data.
- 1964-1968      Scientist, Analytic Services Incorporated. Dr. Black conducted analyses in Southeast Asia of U.S. operations there that were aimed at aiding national level U.S. policy-makers in decision-making; and conducted studies of the process of technological innovation in the civilian public sector of the United States.

- 1964 Consultant, National Academy of Arts and Sciences. Dr. Black conducted an analysis of the probable societal, economic, and regional effects of placing a major National Aeronautics and Space Administration facility in a rural region of the United States.
- 1964 Postdoctoral Fellow, Massachusetts Institute of Technology. Dr. Black conducted research into the effects of rotational energy on high-energy complex nuclear reactions.

SCIENTIFIC HONORARY SOCIETIES

Society of Sigma Xi, Phi Kappa Alpha

PUBLICATIONS

Approximately 30 publications encompassing the fields of management development, technological innovation, feasibility studies, science policy, and chemistry. List available on request.

JAMES P. BLACKLEDGE, Associate Director, Denver Research Institute,  
and Director, Office of International Programs, Denver Research  
Institute, University of Denver

### EDUCATION

B. S., Chemical Engineering, University of Utah, 1948  
M. S., Metallurgical Engineering, University of Utah, 1949  
Completion of coursework toward D. Sc., Colorado School of Mines, 1957

### PROFESSIONAL EXPERIENCE

1949-Present                      Denver Research Institute. Associate Director of the Denver Research Institute (19 years), administrative responsibility for and control of contractual negotiations and agreements with sponsors, personnel selection and policies, budget and internal expenditures, overall management of research operations (e. g., space, equipment, support personnel). Other responsibilities include long-range research planning, new and promotional contacts with sponsors. Principal investigator on NASA project to identify, modify, and apply aerospace-generated or aerospace-augmented technology to the solution of problems or improvement of processes in the private sector of Latin America; principal investigator of project supported by USAID to conduct a comparative analysis of industrial research institutes in developing countries with particular emphasis on interaction between the institute and the industrial sector; principal investigator of program supported by USAID to provide management and technical assistance, especially designed short-term management and technical training courses, and industrial project-oriented grant assistance to selected IRIs in several developing countries in Asia, Africa and South America; principal investigator of USAID-sponsored project concerned with methodologies for strengthening LDC IRIs to interact more effectively with the contiguous public and industrial sectors; involved in inter-American technical assistance, including social and life sciences, economics, law and engineering providing mechanism for consulting, exchanges of students and faculty; working knowledge of 80 research centers in approximately 30 countries in Latin America, Far East, Middle East, Africa, Asia. Previously Head of DRI's Metallurgy Division (8 years), where responsible for the growth of the Metallurgy Division from two to forty people and from no projects to well over \$1 million worth of contracts; established a completely modern research facility and obtained funds from a variety of sources to provide equipment valued in excess of \$700,000; created the Graduate Metallurgy Program leading to the M. S. and later the Ph. D. degree in physical metallurgy.

**1969-Present** Management Consultant to Instituto Centroamericano de Investigacion y Tecnologia Industrial, Guatemala, in areas of management philosophy, organization, promotion and public relations, total cost recovery and fiscal controls, operational procedures.

### PROFESSIONAL ACTIVITIES

Consultant to Federal University of Rio Grande do Sul, Brazil, for establishment of post-graduate engineering program.

President, Colorado Partners of the Americas with Minas Gerais, Brazil, involved in identification of and inter-organizational agreements in areas of agriculture, education, health and preventative medicine, and business and investment opportunities, 1968-1972.

Member, Advisory Panel to USAID Committee on Science and Technology in Latin America.

Member, Board of Directors, Volunteers for International Technical Assistance (VITA), 1970 to date.

Member, National Academy of Sciences-National Academy of Engineering Committee on Development of International Industrialization Institute.

Member, U. S. National Academy of Sciences Panel on "Management Training Programs for Technological Institutes in Developing Countries."

Member, Executive Committee, World Association of Industrial and Technological Research Organizations (WAITRO), 1974 to date.

Consultant to the Subcommittee on International Cooperation in Sciences and Space, Committee on Science and Astronautics, U. S. House of Representatives hearings on the International Science and Technology Transfer Act of 1974, H. R. 14242.

Consul for Guatemala (1972 to date).

ERIC ELKINS ERICSSON, Senior Industrial Specialist, Office of International Programs, Denver Research Institute, University of Denver.

EDUCATION

B.A., Physics, Kansas University, 1949  
Licentiate, Economics, University of Stockholm Graduate School,  
Sweden, 1947  
Doctorate, Literature, Sorbonne, University of Paris, 1951

PROFESSIONAL EXPERIENCE

October 1977-  
Present                      Denver Research Institute. Responsibilities include: assisting industrial research organizations in developing countries in the formulation of policies and procedures based on experimental technology transfer projects to determine viability of alternatives for public and private sector utilization; conducting rural development programs in developing countries which stress small-scale industry development, appropriate technology, labor-intensive economic activities, and training programs in development techniques and methodologies in these areas; performing industrial economic feasibility studies in science and technology in the areas of innovation and application to developing nations, including market research for the establishment and improvement of operating practices and evaluation of manufacturing facilities, construction projects and service organizations; participating in team effort of managerial and technical specialists in industrial development assistance programs to developing country industrial research institutes/centers.

1972-1977                      Executive Director, America International Technical Consultants, Inc., Emporia, Kansas. Development of industry in evolving countries. Activities included: Development of farm hand tools, project Rwanda as Director of Forge and Blacksmith School with French Language syllabus; rural development project in Tunisia as agro-industrial advisor; rural and agro-industrial project in Haiti involving alternate energy development; integrated agro-industrial development projects in Central America.

1969-1972                      Senior Industrial Advisor, UNIDO, Central America, Panama, and British Honduras (including work in New York, Vienna, Geneva, and Mexico). Responsibility for all United Nations industrial development projects, contracts, funding, and professional UNIDO personnel. Projects included: textiles, leather, refineries, agro-industrial, cooperatives, solar salt, R&D institutions.

1969-1969                      Private Enterprise Officer--Africa, Department of State, Agency for International Development. Development and implementation of AID projects.

1966-1968 Senior Industry Advisor, USAID, Tunisia

1965-1966 Manager for Africa, Honeywell International. Responsibility for marketing and technical development.

1960-1965 President, Controles Honeywell, SACI, Buenos Aires. Responsibility for corporate subsidiary development and management for operations in Argentina, Uruguay, and Paraguay with spin-off activities in Chile, Brazil, and Venezuela.

1956-1960 Sales Engineer and Account Executive, Honeywell International. Industrial instrumentation and air conditioning controls systems design and sales in world markets from Honeywell divisions at Philadelphia, Minneapolis, and New York.

Previous: Professional staff, Battelle, Columbus, Ohio; U.S. Foreign Service, Embassy/Madrid, Consulate General/Dakar, Embassy/Paris; Quality control inspector Gustin-Bacon, Kansas City; Surveyor, Post Engineers, Camp White, Oregon, and Ft. Lewis, Washington; farmer; hardware; blacksmith.

#### MILITARY

1944-1946 USNR "Eddy" Electronics Program V-6, Aviation Petty Officer.

#### PROFESSIONAL ASSOCIATIONS

Senior Member Instrument Society of America  
Owner member Kansas Farm Bureau

DONALD D. EVANS, Assistant Director, Programs for Institutional Development, Office of International Programs, Denver Research Institute, University of Denver

### EDUCATION

B. Sc., Mechanical Engineering and Geology, Ohio State University, 1952  
M. B. A., Industrial Marketing, Miami University, 1960  
P. M. D., Business Management, Harvard Business School

### PROFESSIONAL EXPERIENCE

- 1973-Present                    Denver Research Institute. Management and institutional development programs for industrial research institutes in developing countries, including organization and participation in management development and training programs in these countries and the U. S. as well.
- 1962-1973                    Member, Corporate Staff, Battelle Memorial Institute, Columbus, Ohio. During this period at Battelle, involved as Manager of Battelle Institute Ltd., London, a \$3 million per year research subsidiary; Resident Manager of the Korea Institute of Science and Technology Project, Seoul, Korea, where he participated as a principal in all aspects of the feasibility study, planning, organizing, development and construction/equipping of the Institute--acted as KIST Trustee representing Battelle on frequent occasions; Research Technical Economist involved in techno-economic research projects and industrial-marketing program management; and Project Development Representative in the Department of Metallurgy.
- 1960-1962                    Lecturer, Miami University, Oxford, Ohio. Lectured at graduate and undergraduate levels on industrial marketing.
- 1955-1960                    Market Supervisor, Armco Steel Corporation, Middletown, Ohio. Liaison with R&D and development engineering to relate new products to construction and consumer goods markets and development and execution of marketing programs.
- 1953-1955                    Lieutenant, U. S. Navy.

Member of various professional societies related to development, science and political affairs in both the U. S. and Europe.

## MILAN RADOVIC

Senior Research Engineer, Denver Research Institute, Denver, Colorado 80208  
Telephone: (303) 753-2185

### Education

Civil Engineer and Economist, University of Belgrade

M.S., Management and Industrial Engineering, Columbia University, New York

Graduate studies in economics, University of California, Riverside; public administration, Carleton University (Ottawa); organization, management and EDP, Federal University of Rio de Janeiro.

Professional Engineer license, State of California

Fluent in French; working knowledge of Spanish, Portuguese, and Italian.

### Experience

in 1952: Jr. Engineer, Louis Breguet aircraft works, Velizy, France.

1953-1958: Project Engineer, Ramseyer and Miller, Inc., New York, project planning and management; marketing, investment, industrial management reports; techno-economic studies for iron and steel industries in U.S. and abroad.

1958-1965: Manager, Master Planning and Proposals, Aerojet-General Corporation: long-range planning; production planning and control; methods improvement; section administration.

1965-1975: Senior Systems Economist and Project Manager, Stanford Research Institute, Menlo Park, California: program management; techno-economic and socioeconomic research and studies; marketing study of Peruvian industrial products; management consultant for the Brazilian National Housing Bank; project leader for planning-programming-budgeting in a Canadian ministry; relocation of an international organization headquarters; study of investments in Guam; transportation of Arabian Peninsula countries; study of a public health program; highway safety research; civil defense program study.

1975-1977: Consultant to insurance companies (Risk Analysis and Research Corporation, San Francisco, California); consulting engineer (W.A. Wahler and Associates, Palo Alto, California); studies and research organizations (Western Geothermal Agriculture, Palo Alto, and Georgia Institute of Technology, Atlanta) and professional associations (Black Businessmen's Association of Los Angeles); operations and systems analyses, market studies and marketing; economic study of geothermal energy use for agriculture; appropriate technology transfer to developing countries; development of small industries and handicrafts. Lecturer, business organization and management, MBA program, San Jose State University, San Jose, California. Board Director, World Knowledge Bank.

Since 1977: Senior Research Engineer, Denver Research Institute, managing technical assistance programs in Brazil and Colombia; including a food processing project in the State of Sao Paulo and improvement of brown sugar rural manufacturing facilities in Colombia; village-level food processing

RICHARD S. ROBERTS, JR., Office of International Programs, Denver Research Institute, University of Denver.

### Education

Doctorate (1962) and License (1959), international economics and political science, Graduate Institute of International Studies, Geneva, Switzerland.

B.A., Yale University. (Political and Economic Institutions).

### Professional Experience

1978 - Senior Industrial Economist, Denver Research Institute.

1975 - 1977 President, International Management Development Institute, New York. Overall executive responsibility plus marketing, design, staffing, organization, evaluation--and some teaching--of custom-tailored overseas management training seminars in the public and private sectors in developing countries, primarily in Africa.

1974-1975 Fellow, Center for International Affairs, Harvard University.

1968-1974 Assistant Representative, The Ford Foundation, North Africa (Tunisia, Algeria, Morocco). Program management responsibility included project identification, planning, monitoring, advising, reporting and evaluation in a range of fields including agriculture, management, population and public administration.

1967-1968 Social Sector Economist, Robert R. Nathan Associates, with the National Planning Council, Government of El Salvador. Studies on which Education Chapter of 1968-1972 Plan was based and special studies related to technological innovations in education and to requests for bilateral and multilateral foreign assistance.

1965-1967 Project Specialist (Advisor), The Ford Foundation, with Human Resources Development Center, Regional Planning of Aswan Project (of the Government of Egypt); advisor to the Director on the planning, implementation and supervision of studies and pilot projects related to human resources development in the region.

1963-1965 Economist, Stanford Research Institute, Behavioral Sciences Research. Studies of management decisions to automate (project leader), of small and medium industry in Peru, of special topics for A.I.D.'s "Advisory Committee on Private Enterprise in Foreign Aid", among others.

1961-1962 Economist, International Labor Office, Management Development Branch, Geneva. Country analyses of economic, political, social factors relevant to management development work; other research related to technical assistance in the management training area.

### Other

Trustee, International Management Development Institute, Inc., ---  
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study for Pakistan; gur, oil seed and rice bran production and marketing;  
manpower development plan for an electro-mechanical industries complex in  
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## House of Representatives

Remarks of Representative Clarence D. Long

### DEFINITION OF LIGHT CAPITAL TECHNOLOGY

Although a number of amendments have been enacted into law requiring emphasis on "light capital technology" in foreign aid programs, there is still a great deal of confusion over what the term "light capital technology" means.

Light capital technology should not be regarded as "primitive," "low," "unsophisticated," or "obsolete" technology. Rather it is technology economical of capital. Producing a light capital technology that works, is culturally congenial, and is economic can require ingenious design and careful field testing.

Light capital technology should not be regarded as synonymous with inefficiency or high cost. On the contrary, if done appropriately, it should represent the least-cost solution by combining factors of production according to their relative scarcities, economizing on capital wherever capital is scarce and expensive and labor abundant and cheap.

Labor intensiveness is a necessary condition by which to define light capital technology, but it is not a sufficient condition, since even primitive or labor wasting technologies are labor intensive.

Light capital is not defined by dividing the total cost of a project by some total of beneficiaries, especially where it is difficult to identify these beneficiaries and to measure their individual benefits. It is defined by a small amount of capital investment per worker using the capital, and preferably by small projects that can be managed by small entrepreneurs.

A useful approximation of light capital technology is \$100 per worker employed. The \$100 figure is intended to be an order of magnitude, rather than a precise figure. A few light capital technologies will be more costly than \$100, but many others can be found that will be much cheaper: a one-shot seeder in Honduras for \$20; a family grain storage bin in El Salvador for less than \$60. Any cost appreciably larger than \$100 per worker tends to soak up so much capital in helping a relatively small number that no capital would be left to help the great majority. For a cost of \$100 per worker would mean that \$100 billion would be required to finance the employment and increased production of the world's one billion working poor---a far larger sum of money than would be available for economic development even over a number of years. Therefore, any standard on an order of magnitude greater than \$100 per worker deprives us of any hope of reaching a significant proportion of the world's poor.

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