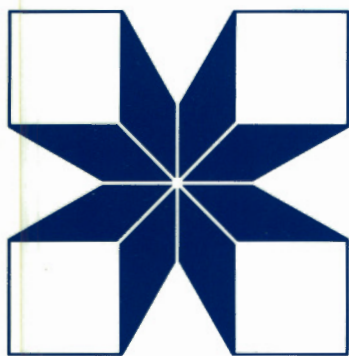


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C A N A D A

UNE STRATÉGIE DU DÉVELOPPEMENT DES RESSOURCES HUMAINES

COMMUNICATIONS DÉCOULANT
DU SÉMINAIRE-ATELIER TENU
À YAOUNDÉ, CAMEROUN,
DU 2 AU 5 FÉVRIER 1988

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Esta serie incluye ponencias de reuniones, informes internos y documentos técnicos que pueden posteriormente conformar la base de una publicación formal. El informe recibe distribución limitada entre una audiencia altamente especializada.

Une stratégie du développement des ressources humaines

Communications découlant du séminaire-atelier
tenu à Yaoundé, Cameroun, du 2 au 5 février 1988

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A HOLISTIC FRAMEWORK FOR TRAINING IN R&D MANAGEMENT

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SUMMARY

This presentation offers a logical framework in which trainers may conceive of mechanisms to further the productivity of research and development (R-D) institutions. It is based not only on an analysis of the subjects and disciplines resident in such institutions ; but also, on the principal responsibilities and characteristics of the full range of people who work in them. Its uniqueness lies in the theme that attempts to improve R-D management must offer subjects to institute personnel who may not have a research or technical background ; and which may not represent what is normally considered either "management" or "research". This paper challenges providers of training in this field to recognize the comprehensive and holistic character of R-D management, and R-D managers.

INTRODUCTION

Thank you Mr. Chairman, colleagues and friends. I would like to use this opportunity to thank the University of Yaounde and the International Development Research Centre for inviting my participation in this Conference. It is exciting to be part of a process which may lead to increased cooperation throughout the region on improving the role of research in resolving Africa's vital human, social and economic problems. I do not think any of us would disagree that research can be a significant instrument for development. But by the same token, I think we would also agree that research has not reached its fullest potential as an instrument for development. And we, in this Conference, are now in a position to do something about that.

As the Chairman announced, my assigned topic is, "Managing and Evaluating R-D Projects". But I have taken some liberties with that theme. I have dropped the word "Evaluating" and added the word "Training". Then I have rearranged the words to yield the theme, "R-D Management Training".

Let me hasten to disabuse you of any notion that I consider R-D project evaluation unimportant or insignificant. On the contrary, evaluation is essential. But it is not well represented in a discussion which tacks it on, as a last step, in an overall management cycle. To my way of thinking, the weakest use of evaluation is in estimating final impacts of R-D. A much stronger use of evaluation is in planning, monitoring and controlling the R-D process itself. In other words, as an analytical tool which is fully integrated with other management processes that are designed to ensure that the R-D project actually achieves its desired outcomes.

The methods and applications of integrated program evaluation are plentiful and worthy of far more attention than we can apply here. Further, the subject of this Conference is "human resource development" in R-D. Therefore, I think it more appropriate to share with you the results of FIT's experiences in R-D management training and, for the timebeing, simply consider evaluation as one equally important element of the total management armamentarium.

Additionally, something must be said about the "D" in R-D. This part of Africa has considerable history and experience in applying research to development

problems. As a number of you have observed these past few days, researchers and laboratories are active in most universities of the region. But a number of you have also observed that very little "D" takes place in these laboratories. Further, that there exist few extension services or field units which are capable of effecting successful transfer of the fruits of research to the ultimate users of new technologies-the urban and rural poor, the illiterate, the sick and the unemployed.

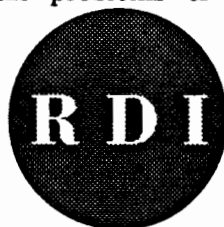
The most significant exception appears in the private, industrial sector in which we occasionally find engineers dealing with production variables associated with an invention ; or economists and managers analyzing market trends. I wish to assert very clearly, at the outset of my presentation that "R" without an equivalent, if not greater, effort on "D" will not further our cause. And, this applies to all sectors. If we cannot sustain and strengthen vital linkages to the ultimate users of results, then those results will remain in laboratories, academic journals and the imaginings of scholars. For purposes of my contribution today, I stress research and development activities and emphasize that all R-D personnel must take full responsibility for the effective management of both of them.

This Conference is enriched by the presence of a number of you from the region's leading universities. As one consequence, many of our discussions on human resource development (HRD) have focused upon ways to improve university organizations, financing and curricula in order to create young researchers in greater quantity and with improved research skills.

For my part, I want to inject a little balance in this discussion by focusing your attention for a few moments on another element of the HRD repertoire. I will not, herein, comment on the development of researchers through the formative regimen of the university system. Rather, I will focus on using HRD processes to improve the outputs of R-D institutions by effecting performance improvements of their managers.

Therefore the unit of observation for my presentation is the single R-D institution(RDI). Picture for a moment, if you will, a circle labeled "RDI":

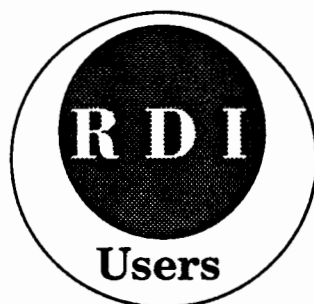
This represents any organization or institution which has the mandate and resources to apply the rigours of science and engineering, economics, marketing and management to the human problems of development. Such an RDI may



operate in the university context. Or it may be a government enterprise controlled through a sectoral ministry. It may function as a parastatal, a private sector organization or an international institution supported by multilateral sources like the UN Food and Agriculture Organization and the World Bank. For purposes of this presentation, we will put all of these forms of organization into our small circle labeled, "RDI".

However, our picture is not yet complete because as we noted in our discussion of the "D" in "RDI", research without vital linkage to the end-users remains academic and makes few contributions to the welfare of the people. Therefore, we have to draw a larger circle around our RDI and label this one "users".

Now examine the picture. It correctly represents the RDI operating within a universe of research users. And it implies that R-D managers must build and maintain linkages between the RDI and the users of research results.



Our picture is becoming more accurate. But it lacks one more important component. This is the national policy environment in which the RDI operates. Each of our countries has a national development plan which specifies priorities for research investments. We have sectoral policies which affect our capabilities to produce qualified research manpower, to acquire technologies from abroad, to create surpluses in the private sector which can be plowed back into product development. Perhaps we are not accustomed to thinking about it at the level of the RDI, but much of our ability to perform is conditioned by a framework of explicit and implicit science and technology policies¹ and national development priorities.

To improve the productive output of our RDIs, R-D managers must begin to shoulder some of the responsibility for influencing the country's national policy environment. Therefore, I will ask you to draw one more, larger, circle around the RDI and label it "policy environment".

Now you should have three concentric circles. At the heart is the RDI. But it operates within a universe of users whose needs condition the work the RDI does, and whose applications provide evidence for the quality of the RDI's outputs.



Further, the RDI and the user environment are equally affected by the priorities and resources ascribed to development needs, and R-D as an instrument for development, by the governments of this region.

This is the holistic framework in which I propose to talk about the substance of R-D management training. In this context training has three important characteristics. I am recommending HRD interventions which are :

- In-service
- Short-term
- Skills-based.

In-service means that the training is targeted upon practicing R-D managers-as opposed to university research students. Short-term means a period more or less corresponding to 10 training days-as opposed to a university term. Skills-based means that the outcomes of training will affect job performance-rather than simply augment researchers' knowledge base.

This kind of training is most often seen in one or more of five formats, as follows :

- Self-instructional
- Single RDI
- Cooperation among RDIs
- National training institution like Ghana's Institute for Management and Public Administration (GIMPA)
- Regional training body like the Eastern and Southern Africa Management Institute (ESAM) in Arusha, Tanzania

My prescription for R-D management training will function equally well in all these formats.

In comments which follow, I have three objectives :

- Define "R-D management,"
- Identify the targets for R-D management training ; and,
- Outline a curriculum framework for R-D management training.

My presentation is entitled, "A Holistic Framework for Training in R-D Management".

NEEDS FOR R&D MANAGEMENT TRAINING

Over the past two decades numerous experts have identified a vital need for sound R-D management practices. They usually base their observations on the assumption that technological development is a factor in the dynamism and productivity of national economic systems.²

The need for sound R-D management pervades all functions, organizations, and individuals engaged in the application of science to the problems of social and economic development. At the policy level, many countries lack the financial environment needed to provide economic support for technical innovation and development. Many lack the infrastructure needed for quality control, standards, patents and proprietary protection. At the level of planning, most national development goals reflect little confidence or support, much less reliance, on the country's ability to generate the scientific and technical breakthroughs needed to further development. Many lack any mention of R-D as a tool for national economic and social development. In fact, too few R-D program or project plans reflect an awareness of the need, much less methods, for transferring technical innovations from the research setting to the production sector.

Vast resources are spent on R-D. But little of it is productive in furthering the ends of national development. In fact, from the economic point of view, the output of significant results seems to be small in relation to the input of resources. Further, few of those scientifically interesting results have any significant economic or social impact on the country.³ Not all of these problems can be overcome by the judicious application of the principles of management. But improved R-D management can go a long way toward that end.

2 Brandao, Guilherme, "The Brazilian Experience in S&T Planning", in Rustam Lalkaka and Wu Mingyu, ed, *Managing Science Policy and Technology Acquisition : Strategies for China and a Changing World*; UNFSSTD, New York : 1984.

3 Woodward, F.N., "The Management of R-D Institutes in Asian Developing Countries"; in Lalkaka and Mingyu, Ibit ; Chapter Fifteen, pps.127-137.

HOLISTIC INTERPRETATION OF R-D MANAGEMENT

"R-D management" means many things to many people. Most definitions commence with fairly generic recitations of the principles of management, as follows:

...the establishment of organizational objectives, the permanent monitoring of their validity, the identification and creation of opportunities for their achievement, and the anticipation of problems associated with their definition and solution... (all) carried out through planning, organizing, directing, monitoring and controlling decisions.⁴

The addition of "R-D" as a qualifier of "management" adds, however, vital qualities to the meaning of the word. This is because the character of R-

D work is unique. The "R" in "R-D" represents a range of activities which draw on the resources of highly trained and creative people. The "D" also provides a purpose or focus for the management activity. Including it in the definition of "management" reinforces the importance of transferring new technologies from the laboratory to the work place. That has to be as much a concern of the scientist, as of the government policy maker or the production executive. Consequently, we define "R-D management" as follows :

R-D management : the efficient and effective marshalling, allocation and control of human, material and financial resources in a manner which perpetuates a creative environment in which research and development activities may be used to focus on priority national development problems.

This definition has five significant elements. The "efficient and effective marshalling, allocation and control..." is a phrase which focuses on the principal elements of management. Allocation and control are familiar activities for most research managers. Marshalling, on the other hand, bespeaks the need to acquire resources for R-D purposes. It is something which researchers must be taught to keep in mind when they write research proposals or report on research results. Further, R-D institute leaders must be prepared to marshal resources through their representational and planning duties. It certainly fits in the purview of a R-D management curriculum.

"...human, material and financial resources..." encompasses any and all resources which are needed to carry out research and development activities. Without resources, there can be no R-D activities to manage.

⁴ Swaminathan, M.S., Critical Elements in Managing Science and Technology for Development, Proceedings of the Panels of Specialists of the United Nations Advisory Committee on Science and Technology for Development ; Held at Kuwait, 8-11 January, 1983, and Tunis, 6-9 April, 1983; United Nations, New York : 1984

The phrase, "...creative environment..." refers to the special character of the R-D enterprise itself. It is basically a very creative endeavour. Researchers are, hopefully, creative people. Further, research managers will testify that it requires special understanding and management skill to maintain an institutional environment which fosters and directs that creativity without stifling it.

"...research and development activities..." refers to the fullest range of tasks and operations needed to effect an adaptation of science for the enhancement of development. They are usually technical in nature. Indeed, they may well not be fully understood by research managers. Yet, they are the purpose and end-product of the R-D enterprise. Hence, they play a vital role in this definition of R-D management.

Finally, "... priority national development problems..." reinforces the ultimate purpose of R-D and research management. It focuses on the "D" in "R-D". It emphasizes that all scientific and technical researches which are conducted under this rubric are designed to reduce economic and social hardship for a nation, region or even continent of people.

In other words, "R-D management" means far more than the three principal words which comprise the label. It includes national development issues and priorities and encompasses technology users and consumers-most of whom may not be technical people. It incorporates social and cultural phenomena which influence the relationship between R-D institutes and manufacturers or farmers. It encompasses the country's financial infrastructure, policy makers in all sectors, the international scientific community and foreign affairs.

Targets for R-D Management Training

Defined so broadly, "R-D management" could be used to refer to the widest variety of R-D managers. It requires that those who focus training in this arena, reconsider the targets for their assistance.

Training in R-D management should be targeted on research managers. But that word can refer to many kinds of people. Does it include the ministers of industry or agriculture ? What about cabinet-level people in planning and resource allocation ? Is it limited to the directors and deputy directors of R-D institutions ? What about their department heads ? Does it include the scientists themselves those who propose, conduct and report on the status of R-D institution- those who maintain and operate specialized research facilities or equipment ; those who manage accounting, personnel information and printing operations.; or those who interact most directly with the eventual users of new technology ?

It is easiest to define three classes of people who would benefit most from R&D management training :

- Strategic managers
- Researchers
- Support staff⁵.

Strategic managers give the R-D enterprise a sense of direction. They bridge the vital gap between the nation's research capability and its development goals and priorities. They select research and development programs to receive scarce resources ; plan the general direction of the R-D enterprise ; appeal to government and other funding sources for support ; and ensure that R-D institutional mandates are fulfilled. They are, therefore, a most important target for R-D management training which focuses on their role. Here is an operational definition of this category of R-D manager.

Strategic managers : those research managers who are primarily responsible for directing the whole R-D activity through :

Ensuring that the R-D activity coincides with national development priorities;

Collecting the human, material and financial resources needed to carry out R-D projects and programs; and,

Establishing the fundamental rules and standards by which all institute research activities will be managed.

⁵ Special thanks are extended to Professor Jacques Marcowich of the University of Sao Paulo for contribution the rudiments of this idea.

Strategic managers include those officials in ministries of planning, or budgeting offices, whose purview includes (but is not necessarily limited to) the development goals and financial resources for R-D. Many of them may not have any direct affiliation or experience with scientific or technical pursuits. Indeed, many may be surprised to consider their participation in an examination of R-D management. However, others may operate in close proximity to R-D activities. These would include R-D institute directors and their deputies managers concerned with obtaining allocating and controlling financial and other R-D resources.

Some of these strategic managers may have no technical background. Others may have graduated to strategic management levels from the ranks of technical researchers. In the latter case they would have the added capability of comprehending the technical elements of the enterprise they direct. Often these types of managers have difficulty, however, focusing on strategic matter and delegating their concern for technical matters.

Another class of R-D managers is called researchers. These too, may operate at many levels in a country's scientific and technical infrastructure. Some may simply be laboratory assistants who have a minimum of technical training or experience. Others may be R-D project leaders ; or they may even direct a portfolio of R-D projects.

The most significant characteristic of researchers is their technical specialization and responsibility. Most of them come to the enterprise from academe where they learned the requirements for basic research. Few of them on the other hand, will have learned or experienced, the principles and practices of sound management. This group of R-D management training participants is operationally defined as follows:

Researchers : those research managers who are primarily responsible for the output of R-D activities and organisation through:

Bringing specialized technology to bear on the resolution of national development problems;

Proposing, conducting and reporting the results of research projects; and,

Furthering the technical productivity and capability of R-D organizations and people.

Researchers focus, almost exclusively, on matters of scientific or technical nature. They are usually responsible for a well defined, and limited, range of technical activities. They look to strategic managers for an overall sense of direction and the resources needed to conduct their work. And, they rely on a wide range of support personnel to help them conduct that work.

Support staff comprise the third class of participants in R-D management training. These people never have sole responsibility for strategic or technical decisions. Rather, they have the job of helping the other two classes of R-D managers fulfill their responsibilities. They include laboratory assistants and technicians responsible for such things as documentation and information, scientific instrument repair and maintenance, statistics and data analyses, publications, and the like⁶.

Support staff may have a management background—like accountancy or purchasing. Or, they may have some training and experience in scientific areas—like statistics or laboratory maintenance. But they are distinguished by the fact that their role is usually limited to a few duties which are needed to support the functions of researchers and strategic managers. They are operationally defined as follows:

Support staff : those research managers who are primarily responsible for supporting strategic management and research activities by:

Collecting, combining, analyzing and interpreting information on all R-D operations;

Converting R-D policies to management systems ; and,

Facilitating the relationship between strategic managers and researchers.

These are the principal distinctions among all people most directly involved in managing the R-D enterprise. Consequently, comprehensive R-D management training must offer increased capability and more effective job performance to each of them.

⁶ Abdel-Rahman, I.H, "Issues in R-D Manpower Development", in Swaminathan, *ibid.*, pps.25-28.

A TOPICAL FRAMEWORK FOR R&D MANAGEMENT TRAINING

Training in R-D management must include subjects and formats which are useful for all three classes of participants. Some subjects may be more relevant to one group. But the whole package must provide comprehensive coverage in order to reflect the real integration of R-D management functions which is expected of all three groups in an R-D institute.

We propose nine elements for any R-D management training curriculum. Each element represents a cluster of topics which relate well to each other. They all derive from incountry needs assessments, conversation with R-D managers, the proceedings of international meetings on this subject and R-D management training experiences of FIT. The nine principal elements and their attendant subtopics are listed below :

- **Science and Technology Policy Environment for R-D**
 - Role of S&T Policy in R-D management
 - National Development Goals and R-D Policies
 - Policies on Imported or Indigeneous Technology
 - Economic Environment for R-D
 - Human Resource Development for R-D
 - National Technological Policies
 - Non-technological Policies
- **Strategic and Project Planning and Budgeting**
 - Productive R-D for National Development
 - Organizing for Productive R-D
 - Planning for Productive R-D
 - Budgeting for Productive R-D
 - Proposing for Productive R-D
 - Monitoring and Controlling R-D
 - Evaluating the Productivity of R-D
- **Commercializing the Results of R-D**
 - Assessing User Needs for New Technology
 - Assessing Production Requirements
 - Assessing Market Potential for New Technology
 - Determining Product Characteristics
 - Calculating Capital Requirements and Financing Costs
 - Price Distribution and Marketing
 - Dissemination, Patents and Licensing
 - Extension Service Role in Commercializing R-D
- **R-D Management Communications**
 - Institute Advocacy and Representation
 - External, Constituent Communications R-D
 - Planning and Managing Public Relations
 - Internal, Management Communications

Writing Research Proposals
Writing and Presenting Research Results
Disseminating R-D Information

- **Institute-Constituency Relations**
 - Institute Advocacy and Representation
 - R-D Client Needs Assessments
 - Utilization-Based Research Management
 - Institute Extension Services Management
 - Marketing Research Results
 - Research Dissemination, Patents and Licensing
- **Project Planning , Monitoring and Control**
 - Principles of Monitoring and Control
 - Time Performance
 - Cost Performance
 - Technical Performance
 - Role of Planning in Monitoring and Control
 - Project and Institute Control Systems
 - Developing a Control Strategy
- **Facilities, Materials and Inventory Management**
 - Planning Facilities and Materials Management
 - Purchasing and Acquisition of Materials
 - Supply Storage and Retrieval Systems
 - Inventory Controls
 - Maintenance and Replacement of Equipment
- **Personnel Management**
 - Personnel Job Descriptions
 - Key Task Analyses
 - Personnel Recruiting Practices
 - Supervision and Decision-Making Methods
 - Motivation, Incentives and Rewards
 - Personnel Performance Evaluation Systems
 - Human Resource and Career Development
 - Personnel Policies
- **Scientific, Technical and Management Information Systems**
 - Socio-economic and Demographic Information
 - Scientific and Technical Data Systems
 - Information for R-D Planning
 - Information for R-D Monitoring and Control
 - Accessing External Information Systems
 - Developing Internal Information Systems
 - Managing Information Systems

The first element, **Science and Technology Policy Environment for R-D**, is designed to inform R-D managers about the critical relationship between what transpires in the R-D institute, and national policies affecting the full range of development issues. R-D managers have to realize how national policies, for example those on foreign exchange, affect pressures to import technologies or develop them in R-D institutes. They have to recognize the role of national educational policies on the production of researchers and technicians. Above all, R-D managers, most of whom work within the confines of R-D institutes, must recognize and take active responsibility for their own role in influencing the emerging S&T policy environment in their nation.

The second element, **Strategic and Project Planning and Budgeting**, focuses on the processes of converting grandiose research and development goals into practical R-D programs and projects. It demonstrates the vital linkage between real project-level research activities, and long-range institute-level goals and objectives. It presents methods for managing resources so that these linkages are maintained. In effect, it also overviews most of the principal components of management, i.e., planning, organizing, monitoring, controlling and evaluating.

The third element, **Commercializing the Results of R&D**, emphasizes the purpose of R-D, viz, the resolution of significant social and economic problems. It defines R-D managers' responsibilities for knowing the technology needs of their "clients" in the productive sector. It provides tools for determining the client-based characteristics of new technologies which are needed, and will be utilized, in the marketplace. It introduces vital systems to protect the integrity of new technologies while at the same time making them available for general application.

The fourth element, **R&D Management Communications**, presents the full range of communications issues. It commences with institute advocacy and representation to government officials and the public by senior managers. It concludes with research proposal writing and presentations of research results by researchers. This element must offer a standard communications model-thereby providing participants with a tool for analyzing their own R-D communication problems.

Institute-Constituency Relations embodies many topics included in other curriculum elements. But it places them all in the context of an R-D institute principal audiences those people and organizations who are interested in the plans, products or processes of R-D. The principal intent of this element is to increase R-D manager's awareness and sensitivity to interest and constraints those for whom R-D should be a service. It must be couched in terms of a model for the participation of institute constituents in the R-D management process.

More than any other, this element is designed to offer managers tools for stimulating demand-pull for R-D.⁷

Project Planning, Monitoring and Control provides tools for application of these select management processes to specific R-D projects. It also, however, links individual project control systems to those needed by managers who are responsible for a portfolio of projects, or for the output of the whole institute. It concludes with a presentation of alternative project control strategies which are applicable to a variety of management styles.

The seventh element, **Facilities, Materials and Inventory Management**, focuses on the physical infrastructure which supports R-D activities in any institute. It offers principles, standards and real tools for increasing the efficiency and quality of management in these areas. Most R-D institutes and managers reflect on the poor maintenance and status of physical plant, facilities, equipment and materials. Many complain that it is a necessary condition of developing economies. But many times this problem relates to poor management decisions on technology choice and resources allocation. This training element is designed to stimulate the kind of improved management which is vital, particularly in countries where physical resources are limited.

Personnel Management applies management principles to the human resources in an R-D enterprise. It too, provides standards, forms, formats, criteria and other tools which will improve the effectiveness with which R-D staff are recruited, selected, directed, evaluated and enriched through their work experience.

The last elements, **Scientific, Technical and Management Information Systems**, relates to earlier ones on communications and institute-constituent relations. But it focuses particularly on systems which may be applied to improve the quality and efficiency of information exchange throughout the R-D infrastructure. This element deals with information needs which are intrinsic to the R-D institute. But it also provides tools for managing information flows between the institute, other institutes, client groups and the S&T world at large.

Quite obviously, subtopics among some of these elements overlap. That is necessary. But, all three classes of research managers would not be interested in all elements of this framework. In fact, given the array of subjects and managers, it becomes possible to distinguish three possible tracks for R-D management training. They are represented by the following matrix :

⁷ For a discussion of the marketing concepts of demand-pull vs. supply-push, in the context of R-D see the work of Dr. Charles Weiss of the World Bank, e.g., "Economics Policies and the Development of Industrial Technology," in *R-D Institutes and Local Industry Interaction : An International Perspective*, by the World Association of Industry and Technological Research Organization; edited by Moses D. Mengu; Jutland, Denmark :1987

CURRICULUM Elements	Classes of R-D Managers		
	Strategic Managers	Researchers	Support Staff
Science and Technology Environment for R-D	X	X	
Strategic and Project Planning and Budgeting	X	X	
Commercializing the Results of R-D	X	X	X
R-D Management Communications	X	X	X
R-D Institute-Constituency Relations	X	X	
R-D Project Planning Monitoring and Control	X	X	X
R-D Facilities, Materials and Inventory Management		X	X
R-D Personnel Management		X	
Scientific, Technical and Management Information Systems		X	X

This matrix is not intended to reflect any exclusive qualities of the topical framework for R-D management training. In fact, the Xs in the cells would probably be placed differently by different experts. The point of the matrix is to demonstrate the kind of program flexibility available with discrete elements in a topical framework like this. In fact, we suggest that training in this field will have very little impact unless it offers the full range of subject which comprise the whole system of R-D management, to the full range of R-D managers responsible for it.

In summary, R-D management incorporates a range of management activities that are designed to perpetuate a unique environment in which creativity can be systematically wielded to resolve abiding social and economic problems. The managers of R-D are distinguished, not so much by technical skill and training, as by their function in the R-D enterprise itself. Some of them have principal responsibilities for setting the pace and direction for R-D. Others are mainly responsible for the technical work. A third class provide administrative and technical support to the first two groups of managers. But all of them need R-D management training.

R-D management training has to incorporate curricula and topics which help managers build and maintain the vital linkages between the RDI and the ultimate user of research and new technologies. It has to strengthen R-D managers' capabilities for influencing the direction and focus of national development policies and plans. Some of these may reflect directly on the country's science and technology policies. Others, may have only an implicit relationship to science and technology, but they may, at the same time, have a direct bearing on the country's resources for R-D. As a consequence, effective R-D managers are those who can comprehend the holistic character of their enterprise, and who have the tools to influence it at all levels.

Thank you.