

Management Manual for

**Productive
R&D
Scientific, Technical
and Management
Information
Systems**



**FINANCIAL AND ADMINISTRATIVE MANAGEMENT OF RESEARCH PROJECTS
IN EASTERN AND SOUTHERN AFRICA (FAMESA)**

A research and development (R&D) management training network of national R&D institutes, management and development training institutes, and councils of science and technology in Eastern and Southern Africa, based at the International Centre of Insect Physiology and Ecology, (ICIPE), P.O. Box 30772, Nairobi, Kenya

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ICIPE

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FOREWORD

Weaknesses in the management of Research and Development Institutions (R&DIs) in the developing countries is one of the major factors hindering the R&DIs from registering the expected high levels of performance and productivity, and hence achievement of their role in national development. This is understandably so because although the majority of managers of R&D are well trained scientists or technologists they are often assigned managerial responsibilities through promotion without having had opportunity to attend management training courses. A group of R&DI managers meeting at the ICIPE way back in 1982 recognized this problem. They agreed that remedial measures should be taken by establishing a programme to draw curricula and provide driving force in the training of R&D managers in the eight areas identified as critical for proper management of R&D. Hence the Financial and Administrative Management of Research Projects in Eastern and Southern Africa (FAMESA) was born in 1984 under the auspices of ICIPE.

The approach adopted by FAMESA has been to produce training manuals covering each of the eight subject areas. These manuals are subjected to validation by experts in workshops followed by training of trainers in regional workshops held in various institutions which are members of FAMESA Network. Obviously, it is not the mandate of FAMESA to provide for training of experts in management of R&DIs, but to increase awareness and managerial capabilities of incumbent R&D managers. FAMESA manuals therefore address only the basic concepts and issues of R&D management.

One of the eight subject areas identified as critical to successful management of R&D is the **Scientific, Technical and Management Information Systems**. This manual is devoted to this subject. In developing this manual, FAMESA has tried, to the extent practically possible, to avoid loading it with theory which can easily be found in standard textbooks on information science. The manual has been written as a practical tool, addressing real problems faced by R&D managers in the Eastern and Southern Africa region but no doubt with parallels in other parts of the developing world. In order to achieve this, a team of experts visited a number of selected R&DIs in the region and held discussions with R&D managers at various levels in those institutions regarding their experiences and approaches to S&T and management information systems. The manual is also written in such a way that it can be used in workshops as well as in private study. Real-life examples collected during the field visits are presented in form of brief case studies. It is expected that the manual will stimulate discussions and sharing of experiences amongst R&D managers who are able to attend workshops, and that for those using the manual for private study, it will be provocative enough to initiate new but realistic thinking and approach to the management of R&DIs.

The production of the manual was therefore not an easy task. However FAMESA benefitted greatly from contributions of many people and institutions during the various stages of preparation of this manual. FAMESA would therefore like to register its most sincere appreciation to all who in one way or another contributed to the realization of this manual. Particular mention should however be made of the International Development Research Centre (IDRC) of Canada for funding the entire process of production of this manual through their Regional Office based in Nairobi; the team of experts who met for a whole week at the East and Southern Africa Management Institute (ESAMI), Arusha, Tanzania to validate the draft manual; the ESAMI management and staff for their hospitality and facilities for the workshop; Mrs P. Ogada for facilitating production of the manual as FAMESA Coordinator; and Ms Charity W. Mwangi for word-processing the numerous drafts of the manual.

This manual was written by a team of consultants comprising Dr S. Lawani, Director of Information Services, IITA, Ibadan, Nigeria, Dr F.J. Wangati, Agriculture Research and Development Consultant, Kenya, and Mr W.C. Mushipi, Principal Scientific Officer, National Council for Scientific Research, Zambia.

Finally, it is the wish of FAMESA that this manual will find its rightful place and will be utilized fully to enhance the productive capacity of R&D managers through better organization and utilization of S&T and management information.

Professor T.R. Odhiambo

Director

International Centre of Insect Physiology and Ecology (ICIPE)

Nairobi, Kenya

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER I

INTRODUCTION

INTRODUCTION

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CHAPTER I

INTRODUCTION

1.1 Background

1.101 The efficient acquisition, organization, and effective utilization of various types of information are essential and critical to the conduct of the business of every R&D organization. Moreover, the fact that the appropriate packaging and effective transfer of R&D results constitute the *raison d'être* of all R&D efforts cannot be overemphasized. Therefore, the scientific knowledge and technologies generated by an R&D institute must be effectively disseminated to all its clients.

1.102 A survey of 40 R&D institutes in eastern and southern Africa conducted in 1984 by FAMESA identified the following eight areas of major management weakness that should be improved through appropriate training:

- R&D Strategic and Project Planning and Budgeting
- R&D Management Communication Systems
- R&D Institute-Constituency Relationships
- R&D Project Planning, Monitoring and Evaluation
- R&D Facilities and Materials Management
- R&D Personnel Management
- R&D Scientific, Technical and Management Information Systems
- R&D Financial Administration and Management.

To date, FAMESA has managed to produce training manuals on four of the eight topics i.e.

- Strategic and Project Planning and Budgeting
- Facilities and Materials Management
- Institute-Constituency Relationship
- Project Planning, Monitoring and Evaluation.

These **Manuals** have been published and validated and are in use within the region. This, the fifth **Manual** in the series, deals with the area of **Scientific, Technical and Management Information Systems**.

1.103 The fundamental assumptions that have guided the development of this Manual may be summarized as follows:

- (a) An effective science, technology and management information system is central to the success of any R&D activity. In the context of this Manual, R&D is used in the broad sense to include all activities which involve collection and analysis of data leading to improved understanding of scientific and technological principles as well as development of and improvement of technologies and their applications. Such activities may take place in Research and Development Institutions (R&DIs), Universities or in small units usually attached to service organizations. The ability of an R&D institute to identify, acquire, organize, and utilize scientific, technical and management information is of paramount importance to its efficiency and productivity. It can, indeed, be argued that the bulk of the activities in R&D are concerned with information processing and communication.
- (b) The technical environment in which R&D institutes operate is becoming more complex as research operations become more demanding of access to latest information — formal and informal. In the face of this demand, information becomes an increasingly important critical element in decision-making; that is, R&D managers are increasingly dependent on information for their effectiveness and ability to innovate. It is, therefore, mandatory that R&D institutes develop and operate more efficient and responsive information systems.
- (c) It is important that managers of R&D institutes become acquainted with and convinced of the role, organization structure, and potential impact of scientific, technical and management information systems. For the research administrator, such information is useful for priority setting, management evaluations, planning and control operations, appraisal and monitoring of research projects, as well as the evaluation of the overall productivity and impact of the R&D effort.
- (d) Managers of research projects and research institutes tend to be highly specialized in a limited number of disciplines pertinent to the R&D mandate. In general, their fields of expertise do not include information science or information systems. Therefore they need to know more about information systems and information services to enable them understand and appreciate the role of information in the R&D enterprise. This knowledge would additionally help to resolve the problem of linking research, extension and the ultimate users of R&D results.

1.2 Objectives and Coverage of the Manual

1.201 The objectives of this Manual are:

- (a) to provide training material which can be used to improve the knowledge of all levels of R&D managers about integrated information systems for R&D and their management. It is the specific objective to enhance capacity for R&D institutions to organize their information systems as a resource for research, decision-

making, communication of research results to users and in facilitating effective feedback of the constituency requirements needing R&D attention.

- (b) to provide R&D managers with an insight into management information sources and systems and institutional mechanisms required to make full use of these systems.

1.202 **Coverage:** The R&D manager is not expected to be an expert in the technical aspects of actual design and detailed management of information systems. The manager, however, requires some basic knowledge of the various systems, their advantages and disadvantages, potential usefulness and relevance to the specific situation and focus of the RDI, and how the systems can be utilized in the realization of the RDI's objectives. The **Manual** is therefore designed to be comprehensive in scope but to **concentrate more on the basic principles and characteristics of information systems and their management.**

1.203 For these purposes, the **Manual** is divided into the following Chapters:

CHAPTER	I	Introduction
CHAPTER	II	Information in the R&D Process
CHAPTER	III	Sources of Information for R&D
CHAPTER	IV	Information Technology
CHAPTER	V	Processing and Documentation of Information for R&D
CHAPTER	VI	Management Information Systems
CHAPTER	VII	Dissemination of R&D Results
CHAPTER	VIII	Promoting the use of R&D Results
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS		
LIST OF ACRONYMS		

1.204 Each Chapter starts with a statement on the purpose of the chapter, a list of learning objectives and a table of contents. These features will be useful to instructors who are planning the programmes for training courses. The **Manual** may also be used as a stand-alone self-instructional package in which various elements are presented in a way to stimulate and control the pace and quality of learning. Further, the **Manual** is designed for easy adaptation as deemed necessary to guide instructions in a workshop setting.

1.3 Relationship to other FAMESA Manuals

1.301 This **Manual on Research and Development (R&D) Scientific, Technical and Management Information Systems** is the fifth in a series of FAMESA Manuals whose common objective is to enhance the productive capacity of research and development institutes in Eastern and Southern Africa in particular and less developed countries in general. The **Manual**, like the other FAMESA Manuals, takes into account the practical and research experience as well as the expressed needs of research directors, managers, researchers and many individuals engaged in research and development in eastern and southern Africa.

1.302 The coverage and level of presentation of the subject are considered appropriate and adequate for most R&D situations in the region, and it is, therefore, hoped that the

Manual will be adopted widely. However, it is recognized that some individual R&D institutes may find it necessary to make some changes in order to meet specific needs. The **Manual** is designed to facilitate such adaptations. Those responsible for the FAMESA project hope that this **Manual** will be used extensively, and that such use will not only justify the resources put into its compilation, but will also encourage continuing support for efforts to strengthen the management capabilities of R&D institutes in the region by the international donor community.

1.303 In the management of RDIs and the actual planning and implementation of R&D projects, information plays a central role as an input as well as an output. It is therefore recognized that many aspects relevant to the current manual will have been covered in the first four manuals. In such cases, this **Manual** gives only a brief statement and refers the reader to other relevant manuals. For example, the issue of identifying users and their needs is well covered in the **Manual on Institute-Constituency Relationships** and, therefore, a detailed treatment of the subject is not considered necessary in this **Manual**.

1.4 Pedagogical Considerations

1.401 Part of the uniqueness of this R&D management training venture lies in the pedagogical standards adopted for each **Manual**. They derive from experiences in designing, writing and delivering long and short-term training to R&D managers in developing economies as well as familiarity with training materials developed by others in this business. Five particular standards have been applied to the development of these **Manuals**:

- (a) **Mediated and Self-Instructional:** The **Manual** should be amenable to delivery by skilled trainers. But, it must also be in suitable format for self-instruction.

This condition derives from the feeling that needs for training in R&D management are widespread. Therefore, it is wasteful to develop materials which are only meaningful and available to the few R&D managers fortunate enough to be selected for a workshop.

Further, few materials developed for past courses and workshops are practical for review purposes by workshop participants — much less practical for participants to share with colleagues who could not participate in the training.

- (b) **Experiential:** The **Manual** should provide motivation and opportunity for trainees to practice key management technologies through exercises which call for solutions to realistic problems.

Information permeates all fields of R&D activity and managers must therefore be encouraged to share their experiences in the management and use of scientific, technological and management information between RDIs within and between countries. Of course, there is sectoral and socio-cultural bias which may inhibit managers from different R&DIs sharing with and learning from their colleagues.

- (c) **Visual:** The **Manual** should provide visual stimuli for both mediated and self-instructional modes of delivery.

- (d) **Interactive:** The **Manual** should stimulate discussion and guide the process of mutual problem solving, not only between trainees and instructors, but among trainees themselves.

It is hoped that this **Manual** will facilitate interaction between various categories of R&DI managers as all will individually have a great deal to share with each other. One of the long-range impacts of this **Manual** and its companions would be the generation of a worldwide network of R&D managers who actively seek each others ideas and solutions to scientific, technological and management problems they encounter in the course of their work.

- (e) **Empirical:** This criterion stems from the feeling that attempts to transfer information management technology from Libraries and Information Schools or R&DIs in developed countries to R&D managers and institutions in developing countries can be inappropriate and unrealistic. Many management techniques developed in Europe and America simply do not apply in the context of real R&D situations in Eastern and Southern Africa.

The ideas and concepts introduced by the **Manual** must be selected on the basis of real observations about management practices and problems in Third World R&DIs. Further, they must be presented in the same terms.

1.402 Two strategies have been adopted for the realization of the fourth criterion in this **Manual**. First, the **Manual** requires participants to apply the concepts learnt to their own R&DI problems. All participants in training with the **Manual** are encouraged to bring the following materials for this purpose:

- Current statements of their country's science and technology policies
- Any statement of national policy on scientific, technological and management information
- The mandate statement for the institution they represent
- The current organization chart for their institution
- A separate current organization chart for information functions in their R&D institution
- Examples (from their institution) of information brochures and other public information documents, R&D projects and proposals, budgets and such final reports as they may be able to collect.

Many of the exercises in the **Manual** call for the participants to apply management principles to their own R&D institutions. These documents will greatly enhance the value of these exercises and the transfer of sound R&D management principles to real R&D settings.

The second approach is fulfilled through the process used to develop the **Manual**. R&D management curriculum specialists visited a variety of such institutions in several countries prior to outlining the parameters of this **Manual**. Further, they integrated their observations in the body of the text so that trainees can see how scientific, technological and management information concepts relate to the real experiences. Finally, the whole **Manual** was critically reviewed and evaluated by a team of R&D, information and

management specialists from several countries. Their work led to further revisions of the **Manual**.

If these strategies are successful, we expect demand to increase for R&D management training provided by instructors who are trained to use this **Manual**. Further, we expect a growing demand for its use in the self-instructional format.

It is likely that R&DIs will also organize their own training programmes, using the **Manual** as a basis for instruction. In other words, the opportunity exists, through a mechanism like this, for the R&D managers especially in the developing countries to become partners in an effort to make dramatic improvements in the conduct, and ultimately, impact of R&D on national development.

1.5 Instructions for Users

1.501 Introduction: Welcome to the **Management Manual** for Productive R&D. We hope that it will enhance your R&D management skills and be a pleasant learning experience.

1.502 Individual and Group Learning: The **Manual** is designed for either individual or group learning. It is self-instructional for the R&D manager who is studying independently. But it is also amenable to group learning; for use in workshops and other training contexts. It may be used by a manager participating in a large workshop, and then re-used as the manager shares it with colleagues back in the office. It has been designed to make the most learning possible in the greatest variety of formats.

1.503 Exercises: Every now and then you will find exercises which help the R&D manager practise the ideas and concepts being discussed. These exercises may be conducted in a variety of ways: individually in the self-instructional mode; over-night as homework during a mediated workshop; in teams during class time; or even in plenary.

1.504 Instructor(s) Notes: Occasionally some notes to the Instructor(s) are included. These are not mandatory but are designed to help the instructors plan and deliver lectures at workshops, in the mediated mode. If the **Manual** is being used in the self-instructional mode, these notes may be ignored.

1.506 Chapter Guides: At the beginning of each Chapter or part of a Chapter, there are some guiding materials. These give information which will help you plan your study. The first one is simply a title page. The second, however, presents the learning objectives for all the information contained in the Chapter. It will give the user an idea of what he/she should be able to do after he/she has learned all that is in the Chapter.

1.507 The third page is a Table of Contents for the Chapter: Notices of **Session Breaks** may be indicated if it is considered helpful to divide the material into successive workshop sessions.

1.508 Length of Sessions: This **Manual** is designed for workshops that could run for 5–10 days. Some of the Chapters comprise one-day sessions; others may require longer sessions, depending on the pace set by participants and instructor(s).

Basically, half-day sessions are recommended during which new material is introduced. It usually works best to introduce new material in the morning. Then the afternoon is a good time for group exercises and field trips. This takes advantage of the participants' natural tendencies to be more alert and rested in the morning. Regardless, it is recommended that such workshops should include a number of field trips, especially visits to RDIs, so that learning includes as much experience and novelty as possible.

1.509 Instructor(s) should mix as many methods of instruction and exercises as possible in order to maintain the interest of participants. Each of the exercises in the **Manual** may be adapted to a variety of techniques. It is up to the instructor(s) and participants to select those which are more useful and instructional.

1.510 Above all, this learning experience should be enjoyable. It can be made so by adapting the **Manual** to the needs and circumstances of participating R&D managers. The **Manual** is designed with flexibility in mind. R&D managers and instructor(s) alike are encouraged to adapt it to their own needs and interests.

1.511 **Page Format:** This **Manual** is produced in a two-column format.

- (a) The column on the left provides the text for the programme of study. For an instructor, it serves as the basis for lecture and materials for discussions. For the R&D manager, it serves as the basic content for self-instruction or workshop preparation.
- (b) The column on the right, on the other hand, is reserved for notes, prompts and exercises.

Your Notes: Here you may add your own thoughts, comments, questions and notes as you read, listen to a lecture or participate in a discussion. You are encouraged to write such notes on the page. That way your thoughts remain with the textual material; and the combination becomes a more powerful learning tool.

Prompts: You will also find various prompts in the right column. These take many forms; some of them are questions which you should take time to answer. They serve the purpose of providing a review of the textual material. If you can answer all these questions satisfactorily, then you have a good grasp of the material in the Chapter.

These prompts are also helpful to the instructor(s) who may use them as a basis for classroom discussion; they may even be used to develop small group or team exercises.

Each question is located close to the textual paragraphs (in the left column) which provides a basis for answering the question. So if you have difficulty with it, you will have no trouble finding out where to go for help.

Emphasis: The right column is also used to emphasize key points. Sometimes this is done by making a comment, other times it is done with a simple

diagram. But do pay attention; those notes in the right column are like a traffic signal. They direct your travel through this course of instruction; and they regulate your learning.

- (c) **“Case Studies”**: These are brief accounts of real R&DI experiences which illustrate the ideas in the text. They are called **“case studies”** because they represent real situations and are meant to stimulate discussions on the points made in the manual. Names of persons, institutions and countries from which the cases are drawn have been omitted to preserve anonymity. Case studies are separated from the main text so that they do not unduly interrupt the flow of ideas in the text.

1.512 **Definitions**: As with any new material, you will undoubtedly run into new words. Many of them are important for you to learn because they are part of the special language of the subject matter of this **Manual**. We try to emphasize them by using **Boldface** type the first time they appear in the text. That should draw your attention to them. Then, their definitions are usually underscored.

Nevertheless, it is important to note that the usage of terminologies in this **manual** is intended to clarify the key concepts to a lay target audience. As such, definitions indicated may not always conform to rigorous professional definitions and conventions.

Finally, there is a list of acronyms and their meanings.

1.513 **Boldface Text**: Boldface text is used to emphasize key ideas and summary statements about productive R&D.

1.514 **Citations**: Occasionally the text may also bear a person’s name. This is a bibliographical citation. It means that the idea immediately preceding the citation came from another author. The original source of the idea will be found in the **BIBLIOGRAPHY** which appears at the end of each Chapter.

The bibliography contains far more sources than are cited in the text. The additional references are intended for further reading.

1.6 Conclusion

1.601 Good luck and have fun! We live in an information age. What better can one do but to become more familiar with information systems and services? And for those engaged in research and development, time spent in acquiring knowledge of scientific, technical, and management information systems should be accounted as time very well spent, and an excellent investment in productivity.

*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER II

**INFORMATION IN THE
R&D PROCESS**

INFORMATION IN THE R&D PROCESS

Purpose

The purpose of this Chapter is to enable managers of R&D to appreciate the critical role of information at all stages of R&D.

Training Objectives

By the end of this chapter, participants should be able to:

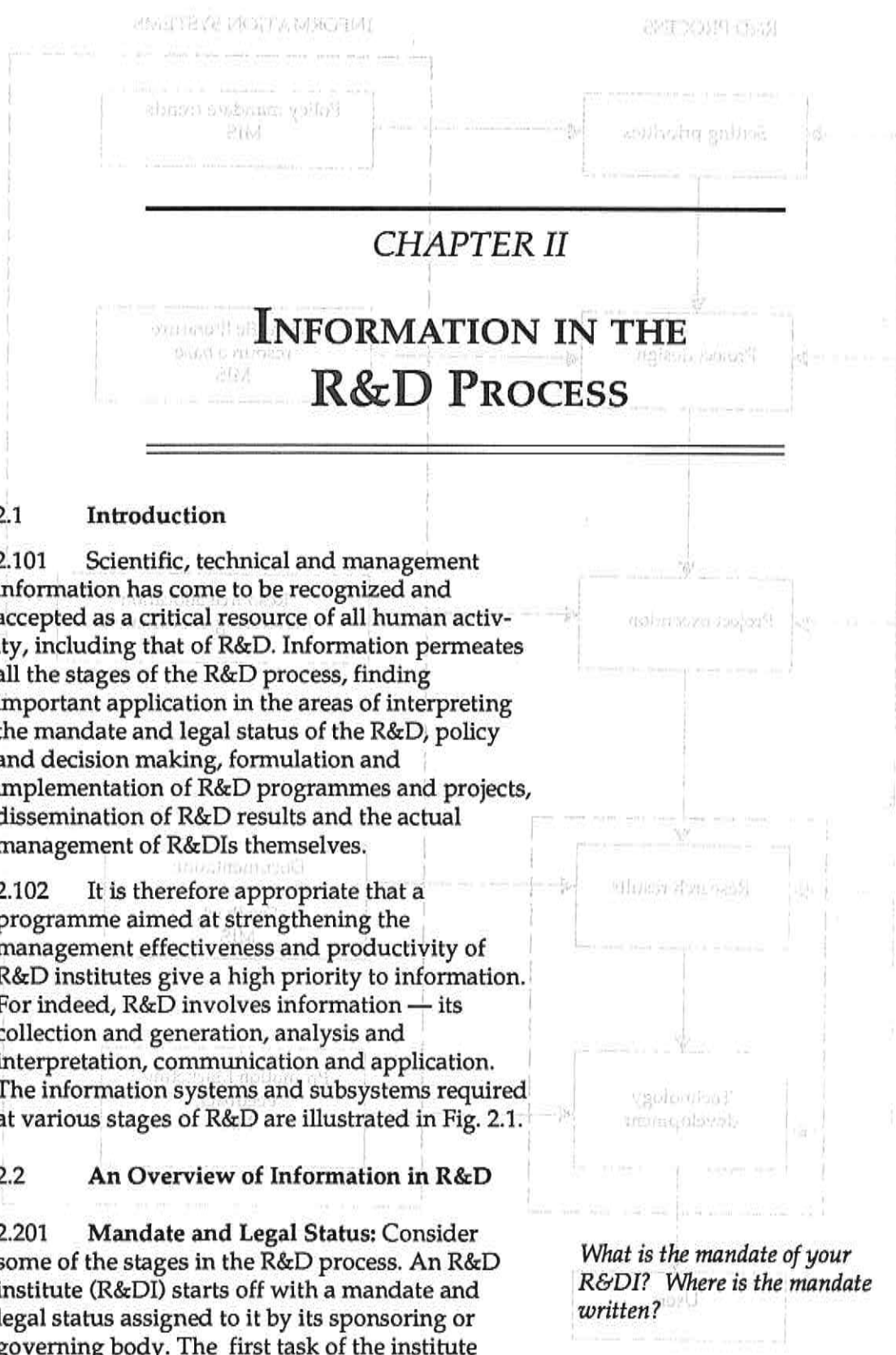
-
1. Appreciate the need for information at different stages of R&D.
 2. Have an overall picture of the subject content of this manual.
 3. Identify sources of technical assistance for the development of the information systems for R&D.
-

INFORMATION IN THE R&D PROCESS

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Fig. 2.1. Information Needs in Various Stages in the R&D Process



2.1 Introduction

2.101 Scientific, technical and management information has come to be recognized and accepted as a critical resource of all human activity, including that of R&D. Information permeates all the stages of the R&D process, finding important application in the areas of interpreting the mandate and legal status of the R&D, policy and decision making, formulation and implementation of R&D programmes and projects, dissemination of R&D results and the actual management of R&DIs themselves.

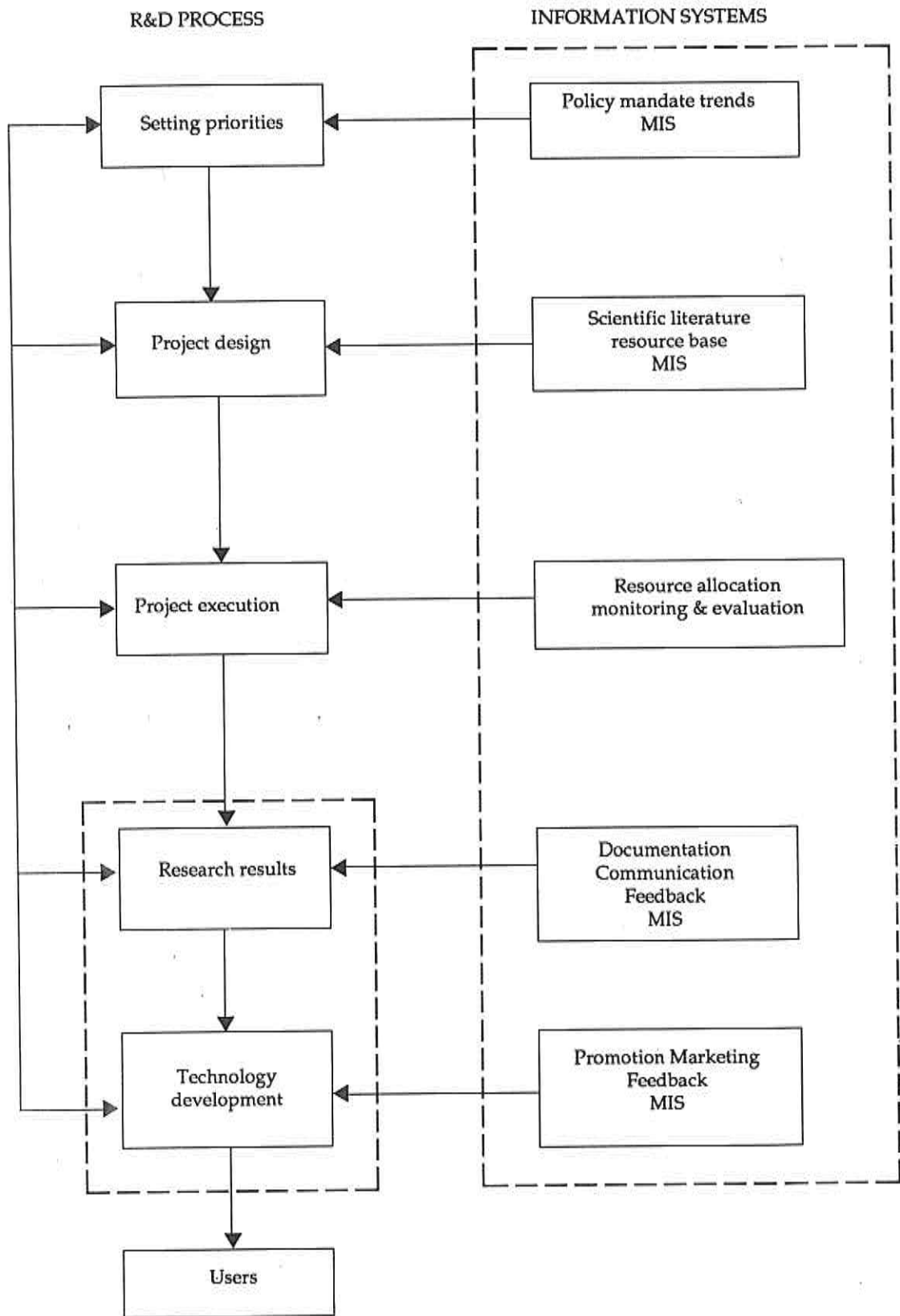
2.102 It is therefore appropriate that a programme aimed at strengthening the management effectiveness and productivity of R&D institutes give a high priority to information. For indeed, R&D involves information — its collection and generation, analysis and interpretation, communication and application. The information systems and subsystems required at various stages of R&D are illustrated in Fig. 2.1.

2.2 An Overview of Information in R&D

2.201 **Mandate and Legal Status:** Consider some of the stages in the R&D process. An R&D institute (R&DI) starts off with a mandate and legal status assigned to it by its sponsoring or governing body. The first task of the institute

What is the mandate of your R&DI? Where is the mandate written?

Fig. 2.1. Information Needs at Various Stages in the R&D Process



managers is to understand clearly the given mandate; and this requires that all information pertinent to that mandate is collected. It is the information about the mandate, legal status that permits the setting of appropriate goals and the development of appropriate strategies for achieving the goals.

2.202 The types of information required for this important stage in the development of an R&D institute depend on the specific nature of the R&D enterprise. In general, they would include elements of the national development plan, national scientific and technological policies, socio-economic and demographic information, activities of any existing organizations in similar industries, disciplines or pursuing related missions. The important point is not the specific types of information required but the fact that information is required, and that information is critical to the process of clarifying the mandate, setting organizational goals, and developing appropriate strategies for any R&DI.

2.203 It is obvious that this exercise must be undertaken at the time a new institute is established. But, it must be stressed that the exercise is not carried out only at the time of establishment. The best R&D institutes review their mandates, goals, and strategies periodically to reflect changing circumstances. And for each review, appropriate information must be collected and studied.

2.204 **Programmes and Projects:** From strategies, an R&D institute moves on to formulation of specific programmes of activities or projects. Clearly, project development must rely on information. One wants to ascertain that a proposed project is not one that would simply "re-invent the wheel"; that is, provide data and information that are already available in the published literature. A review of the professional literature of any scientific and technical field may reveal that several research projects are unnecessary. They turn out to be unwitting duplications of earlier work. And some of such projects may have gone on for many years,

What changes have you observed in your R&DI mandate in the last ten years? Have these changes been written in a policy document?

involving considerable expenditure of human and material resources.

2.205 It should be remarked that needless and unwitting duplications of research are known to occur even within the same organization at different points in time, particularly where staff turnover is high. In other words, failure to search, obtain and use appropriate information for R&D project planning can lead to massive waste of resources. Resources that are so scarce for R&D institutes in Africa. Thus, a good manager must ensure that appropriate literature searches are carried out, and the pertinent literature studied before a project is started.

2.206 It is therefore extremely essential at these stages of problem identification and formulation of programmes and projects that the R&D manager must collect and analyse relevant data and information to ascertain that real important problems (as opposed to perceived or interesting problems) are being addressed. Chapter 3 section 3.2 discusses the types of research information required in the R&D process.

Case Study 2.1: USE OF S&T INFORMATION IN DECISION MAKING

The Case

In the mid 1980s a certain Government in the region established a huge subsidiary parastatal company as one of the measures to accelerate the diversification of the economic base. The subsidiary parastatal company has gone into a wide range of businesses including the establishment of perhaps the largest integrated agricultural production concern in the country. One of the major constraints identified at this scheme was heavy reliance on the use of large amounts of very costly inputs such as chemicals.

In order to ensure economy in the production process, a decision was taken to investigate whether setting up a factory to produce the required chemicals, initially for own use and later for sale, would reasonably reduce production costs or not. Hence, various organizations, both at home and abroad, were contacted for information on large-scale production of these chemicals. The company has

received a lot of information which will be used to make the decision to set up a factory or continue with current practice.

Points to Note

The company decided to collect this information realizing that without it, a wrong decision can be made which in the end would prove to be very wasteful and costly.

Have you encountered such a problem in your R&DI? If you have, describe the circumstances and the final outcome.

Case Study 2.2: RESEARCH DUPLICATION BECAUSE OF LACK OF INFORMATION

The Case

A scientist in the region was engaged in a research project to establish the conditions necessary for domestication and commercial production of a local wild fruit tree deemed to be of industrial importance. One of the parameters to be researched on was soil requirements.

Money was mobilized to travel by landrover to a district where the fruit tree being researched on grew in abundance, in nature, in order to collect soil samples for analysis.

The research team started collecting soil samples at various depths and locations. To their amazement, after hours of hard work, they noticed diggings indicating that someone had already collected soil samples from the area not too long ago. The team continued digging and took their soil samples back to their laboratories.

Before embarking on analysing the soil samples, an information search was mounted to see if they could find results from earlier diggings. The exhaustive, extensive search failed to locate the information. The team had therefore no choice but to repeat the expensive tedious exercise of analysing their soil samples.

Points to Note

In the absence of information, unnecessary duplication of R&D work takes place. This is expensive both in terms of man-hours lost and money spent re-doing the work.

Exercise: What are the advantages and disadvantages of this duplication? How can wasteful duplication be avoided?

2.207 **Setting priorities:** There is always a need, in every R&D institute to set priorities. Not all good projects can be funded. There may not be enough qualified researchers or adequate support staff, or the funds for supplies and the necessary equipment may not be available. Besides, R&D is more productive when available resources are focused sharply on the most important problems and projects that are most likely to lead to the attainment of institutional goals.

Do you have a clear statement of priorities in your R&DI?

2.208 The establishment of the institute priorities should not be done casually. It must rely on concrete information. There are anecdotes about R&D institutes that decide projects on the basis of whether or not the persons who propose the projects are in or out of favour with the institute's director or department head. Of course, such practices will tend to abound where the **information** appropriate for assessing the merits of R&D projects does not exist. It is, therefore, correct to state that **information** is required not only to set the right priorities, but also to guard against arbitrariness in project assessment and evaluation. Readers interested in a detailed statement of this subject should consult the FAMESA Manual on Strategic and Project Planning and Budgeting.

2.209 **Project Implementation:** Information is also a key resource at the stage of experimental design and implementation of an approved R&D project. The researcher must ascertain the choice of the most efficient and cost-effective methodology and experimental design appropriate to the objectives of the experiment. He knows that a methodology he might have learnt at college may no longer be the most appropriate, and he is aware that a wrong experimental design renders any data he obtains invalid or at least suspect. Thus, the most up-to-date professional literature must be consulted. (see Case Study 2.3).

Do you think this happens in your R&DI?

Case Study 2.3: VITAL ROLE OF S&T INFORMATION IN PROBLEM SOLVING R&D

The Case

A local authority in one of the countries of the region has among its responsibilities the supply of clean, safe water for both domestic and industrial use. But for many years, the authority had major problems in providing this water because of an aquatic weed growing in the river from which the water is abstracted. A lot of money was spent over many years to try and clear the weed by physical and

chemical methods without success.

A local daily carried a feature article to the effect that scientists, especially in Australia, had managed to successfully and permanently get rid of an aquatic weed from rivers including some in Southern Africa, through biological control. When officials responsible for water treatment and supply got this information, they sent a sample of the weed to the local University for classification. The results of the taxonomic study confirmed the weed to be the same as that referred to in the publication. Contact was made with scientists in Australia and a senior scientist was sent to study and evaluate the situation. In the following weeks, delivery was made of a few hundred of the biological control organism which were introduced in the weed infested river. The organisms are said to reproduce very fast, eat the sea-weed down to the root and then starve to death. At the time the interview was made for this case study, officials were still awaiting and monitoring progress in eradication of the weed.

Points to Note

- By coincidence research results are used because of a pressing problem.*
- If officials had approached an information centre in the country, a literature search would have been done to get this information at a much earlier stage (and money saved).*

2.210 Once valid, reliable data have been collected, they must be analysed and interpreted in relation to the state of knowledge and the objectives of the experiment or the larger project. Again, this can only be done properly by reference to relevant literature. It is only with adequate information that an R&D manager can put his own work into proper perspective. And by so doing, he is able to understand more clearly if and what additional work is required to attain the objectives of the experiment.

2.211 **Summary:** The major points that have been made so far are that:

- (a) Information is critical to the process of determining and clarifying the mandate and legal status of any R&D institute. In many cases, such information would include socio-economic and demographic data and national policy statements.
- (b) Information is needed to translate mandate into institutional goals and strategies. Updated information is required in the necessary process of reviewing periodically set goals and strategies. The types of information used at this stage would include some of those required for establishing mandates as well as information of a purely scientific and technical nature.
- (c) After the process of problem identification, programmes of activities and projects should be formulated in line with goals and strategies. This stage calls for reviews of pertinent and up-to-date scientific and technical literature. The literature review also provides guidance for setting priorities among desirable and potentially useful (or just interesting) projects.
- (d) In the process of implementing R&D projects, there must be constant recourse to, and reliance on scientific and technical information to develop appropriate methodologies and experimental designs, as well as to interpret the results obtained.

2.212 **Reporting:** So far, the chapter has outlined the role of information in the R&D process up to the point at which a research project has been “completed”. The word “completed” must be used advisedly because **no research is completed until it is reported**. Therefore, **reporting or report writing** is an important stage in the R&D process.

2.213 Has information any role at this stage? Definitely yes! One must, however, first ascertain the target audience and have information about its relevant characteristics (educational and professional levels, language etc.). It is also at this reporting stage that one acknowledges the originators of key influences on the work — the authors of the methodologies adopted or adapted, sources of hypotheses tested, authors of earlier relevant research, those who provided special funding, information assistants from libraries and information centres etc. Most of these are pieces of information that one obtains from the scientific and technical literature.

2.214 **Publishing:** Up until this stage, the only information services encountered are the **Library and Documentation Services** or Library and Documentation Centre, whatever name an organization chooses to call it.

At the report writing stage, one encounters the need for another type of information service — **Communication Services, Editorial Services and Illustration Services**. A highly competent researcher is not necessarily a good writer or communicator. Many researchers therefore need the services of editors. Editors help to improve the structure and the language of the report. They ensure consistency in the report and ascertain that stated publication guidelines are adhered to.

2.215 The communication value and usefulness of some reports are greatly enhanced by illustrations; this is the function of draftsmen and graphic artists. A communications office should therefore have photographers and organized collections of photographs (a photo library); such a photo library can be a very useful resource for an R&D institute.

Are you familiar with the word “plagiarism”? What would be the consequences of failing to acknowledge sources of information?

See Chapter 3 for definition of Library and Documentation Centre

*Have you come across examples of this situation or problem?
How easily do such scientists accept their limitations?*

2.216 If one wishes to submit the report to a professional journal, one requires information about the appropriate journals, their editorial practices and specific guidelines, and the addresses of the editors to which manuscripts should be sent. Again, these are pieces of information that a library or scientific and technical information centre provides.

2.217 **Dissemination:** After a research project is concluded and the results published as an in-house report or monograph or as a journal article, matters should not rest there. The management of an R&D institute must ensure that the report, regardless of its form, gets into the hands of as many potential users as possible, either through sale, in exchange or as a gift. In other words, an effective dissemination system must be in place.

2.218 A dissemination system should include a mailing list with addresses coded to facilitate targeted or selective distribution to institute clients and stakeholders. These clients and stakeholders would include individuals that influence the funding of the institute, members of the governing body, those who can assist in promoting the results etc. Of course, the treatment of "classified" or restricted reports would be different.

Who are stakeholders in your R&DI?

2.219 Dissemination of information is discussed more fully in Chapter 7. At this point, it is sufficient simply to indicate that an appropriate dissemination system that is normally organized as part of the R&DI's scientific and technical information services is required, and that its absence would militate against effective dissemination of R&D results.

2.220 The results of R&D may, of course, be a tangible product — a crop variety, a chemical compound, a patentable process etc. Whatever the form of the result is, wide dissemination of information about it is absolutely essential. Without an effective system for dissemination, promotion and marketing of its products, the R&D effort can have no impact on society, and therefore the institute cannot justify its existence. These issues are covered in Chapter 7 (**Dissemination of R&D Results**) and in Chapter 8 (**Promoting the Application of R&D Results**).

2.221 **Conclusions:** It should become apparent from the foregoing that information activities are central to any R&D enterprise. Without an effective information system, productive and relevant R&D is impossible. Moreover, information services are at the core of all efforts designed to ensure that the results of R&D become widely known and utilized and thus contribute to the well-being of society.

Is this recognized in your RDI?

2.222 An R&D institute may be making substantial contributions to society; but influential members of society may not relate such contributions to the particular institute. An R&D institute has to tell its own story to gain recognition; an activity that involves media and public relations as well as production and dissemination of various types of information. All of these imply a strong information division or department.

2.223 The critical and strategic importance of information in an R&D institute must be reflected in its organizational structure. Because information activities are closely related and are most effective when integrated, they should ideally be organized as one of the major divisions or departments of the R&DI.

What do you understand by "integration" in this context?

2.224 Such scientific, technical and management information departments should, of course, be headed by highly qualified professionals just as for the research and development departments. Information is a resource and like other resources — oil, mineral ore, crops — its value is enhanced by processing and proper management. The right processing and management require adequate levels of physical, fiscal and human resources.

2.225 The practice of lumping the budget allocation to information systems and services with "General Services" reflects a lack of appreciation of the central role of information, and explains why many R&D institutes are perceived to be unproductive. There must be a separate information division or department with its own budget. And the budget should be managed by its professional head.

2.3 Types of Information Systems for R&D

2.301 Definition: In their book entitled **Information Systems for Modern Management**, Murdick, Ross and Claggert define System as a set of (interrelated) elements joined (or functioning) together for a common objective. It is clear that for information to be useful, it has to be **organized** into **systems** according to the requirements of various functions. The R&DI is, however an entity and has to use various information systems in order to define and achieve its objectives. We can therefore conceptualize the R&DI Information System, comprising various sub-systems through which the RDI achieves its objectives.

2.302 Management Information Systems: To perform its management functions properly, an R&DI must establish a management information system with at least four sub-systems based on policy and mandate, programmes and projects, resources and trends. The information must be professionally documented and processed to facilitate quick retrieval when required. Chapter 6 of this manual treats the subject of Management Information Systems in detail.

2.303 S&T Information Systems: For any researcher to be able to carry out meaningful work without "re-inventing the wheel", he/she must have access to information relevant to his/her research and in a timely manner. This information is here referred to as **S&T Information**. Detailed discussion on sources processing and dissemination of S&T information is to be found in Chapter 3.

2.304 Application: Although application of the products of R&D is primarily a responsibility of the clients, it is in the interests of the R&DI to do everything possible to promote and accelerate this process. Support for R&DIs is closely dependent on the extent to which its outputs (products) are applied in various economic or social processes and the impact realized from the application.

2.305 The issues of extension, dissemination and marketing of R&D outputs as an aspect of R&D Institute Constituency-relationship are

discussed at length in an earlier FAMESA manual devoted to that subject. The information aspect of these topics were, however, not addressed and will therefore be given a more detailed treatment in Chapters 7 and 8 of this manual.

2.306 The computer and telecommunications technology have found wide application in the processing, storage and organization of information, and have made a profound impact on the handling of information especially in the developed world. Needless to say, the coming of micro-computers in particular, with their high capacities to process and store information and the relatively low capital costs associated with them, should bring about a revolution in the handling of scientific, technical and management information systems in the developing countries. In fact, the application of information technology (IT) is already taking place in the Eastern and Southern Africa region. It is therefore important that R&D managers should appreciate and understand the various information technologies available for handling S&T and management information. Chapter 4 of this manual gives a survey of IT and discusses various areas of its application.

2.4 Sources of Technical Assistance for R&D Information Systems

2.401 In view of the expense and high rate of change of modern information technologies, few institutions in developing countries, especially the African region, will be able to adopt especially computer-based technologies entirely on their own resources. In this section, we will review some of the sources of technical assistance available in this field.

2.402 **Bilateral Sources:** Most countries in the African region have bilateral aid agreements with some of the developed countries. Information technology projects can be incorporated in such agreements in order to facilitate acquisition of hardware, training fellowships and the services of consultants for the design and installation or improvement of information systems.

2.403 Bilateral sources have, however, some disadvantages. They tend to limit the source of technology and expertise to whatever exists in the donor country. An institution may therefore be forced to accept a package which is not necessarily the best available or most appropriate for the institutional needs.

2.404 Bilateral assistance is also subject to political considerations and may be terminated abruptly leaving the half-implemented project in disarray. Such assistance also tends to encourage recipient institutions to opt for very sophisticated systems which only work well as long as donor-support is available.

Have you ever experienced these problems? How would you minimize the risks involved?

2.405 However, on the positive side, bilateral donors are keen to leave in place a system that works and some institutions have been able to acquire and install successful information technology systems in this way.

2.406 **Multilateral Sources:** One of the leading multilateral sources of technical assistance in information technology is the UNESCO General Information Programme (PGI). Although UNESCO does not provide assistance in form of hardware, it can provide valuable information on the advantages and disadvantages of various existing systems, including case studies of experiences in developing countries. UNESCO has also developed the CDS-ISIS computer software which is available to member states free of charge. UNESCO can also provide services of international consultants for design and installation of IT systems provided appropriate funding can be arranged. UNESCO also organizes periodic courses and workshops on IT which are invaluable in on-the-job training of staff.

2.407 Other UN agencies such as FAO, IAEA have developed systems for management of information in their fields of expertise. These agencies are similarly valuable sources of technical assistance for design, installation and management of information systems.

2.408 For experience and training with IT systems in R&D, the best source at present may be

the family of Consultative Group for International Agricultural Research (CGIAR) research centres. Although their resource base is much higher than an R&DI in Africa can muster, there is a lot one can learn from CGIAR Centres regarding integration of various services within the information systems as well as management of the technologies.

2.409 A recent development in information technology within the CGIAR is INFORM, which is short for Information for Agricultural Research Managers. INFORM has been developed by the International Service for National Agricultural Research (ISNAR) from the information and experiences gained in management research and consultancy activities in developing countries. According to ISNAR, INFORM is basically an easy-to-use set of procedures and tools to help managers with their annual programming and budgeting tasks. Its overall aim is to improve managers' decision-making by improving the quality of the information available to them. INFORM includes procedures covering the collection, manipulation, and analysis of information on research content, personnel and funds.

2.410 ISNAR suggests that INFORM is best implemented with the help of micro-computers, but its use does not depend on any specific hardware or software.

2.411 The IDRC has also been heavily involved in the development of computer-based Scientific Information Documentation systems, and organizes periodic training seminars and workshops on the application of these technologies.

2.412 **Non-Governmental Sources:** All reputable agents of computer hardware and software provide manuals, some training, and varying levels of technical support for the products they supply. The best, and usually most expensive, sources of technical assistance for IT are consultancy firms which specialize in various aspects of MIS.

2.413 Expertise in consultancy firms is however usually available to industries and commercial firms which can afford their services, leaving the general fields of library services and R&D which are usually meagrely financed from public funds. These costs should decrease as the number of indigenous computer experts (programmers, analysts) grows within the African Region.

2.414 Another technology with good potential for application in the region is the **Low Earth Orbiting Satellite Technology**: The system which uses radio frequencies to transmit data through a satellite has the advantage that communication of data to or from remote areas can be done with minimal equipment — a receiver and a personal computer. Information and technical assistance can be obtained from VITA (Volunteers in Technical Assistance), based in Virginia, USA.

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER III

**SOURCES OF INFORMATION FOR
RESEARCH AND DEVELOPMENT**

SOURCES OF INFORMATION FOR RESEARCH AND DEVELOPMENT

Purpose

The purpose of this Chapter is to familiarize Research and Development (R&D) managers with sources of information for R&D and the systems and conditions for accessing them.

Learning Objectives

By the end of this Chapter, participants should be able to:

-
1. Understand various types and formats of information for R&D.
 2. Understand various types of sources of information for R&D.
 3. Understand major organizations that distribute information for R&D and their subject scope.
 4. Appreciate various procedures and conditions for accessing information for R&D.
 5. Appreciate the advantages and limitations of various sources.
-

The material in this chapter can be covered in one day.

SOURCES OF INFORMATION FOR RESEARCH AND DEVELOPMENT

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CHAPTER III

SOURCES OF INFORMATION FOR RESEARCH AND DEVELOPMENT

3.1 Introduction

3.101 Chapter 2 of this manual has given an overview of the importance and role played by information at various stages of the R&D process. A brief mention has also been made of some of the major types and formats of information required in R&D activity. This chapter shall take a more detailed look at various types and formats of information for R&D and their sources, i.e. where they can be obtained; it shall look at the methods, procedures and conditions for obtaining or accessing this information, and it shall then evaluate the sources of this information.

3.2 Types and Formats of Information

3.201 There are many types of information and formats in which they are presented. Whereas a given type of information may be presented in more than one format e.g. numerical results may be explained in text, tabulated or drawn as graphs usually such information is most suited to one format of presentation. Before going into detailed discussions of various types and formats of information, it is important to differentiate between the terms TYPE of information and FORMAT of information in order to be unanimous about the context in which the two terms are being used in this chapter.

3.202 Definition: Type of Information: In the context of this chapter, the term "type of information" should be taken to denote a classification of the intellectual contents of a document or any other record based on common characteristics of subject matter and/or purpose for which the information was created.

How else can the phrase "Type of information" be defined?

3.203 It is obvious that any given piece of information will be of a particular type. It is not possible to comprehensively cover all the types of information for R&D in a short section like this one. Hence, only a selection of major types will be dealt with here; the participants are encouraged to think out and refer to literature cited, for other types of information for R&D not covered by this section.

3.204 Major Types of Information: The type of information that one may need in the R&D process will always depend on the stage or activity one is engaged in. In most cases, more than one type of information may be required at any given stage or activity in the research and development processes. Here are some of the types of information and the stages or activities in the R&D process associated with them.

- **Policy Information:** When an institution is established the purpose and mandate for its creation will be found in the policy statements of the authority creating such an institution. It is, therefore, very important that the management must be familiar with its policy in order to correctly interpret the RDI mandate and purpose and hence the programmes and projects which should be accommodated.

The major types of information required at this stage are the relevant Acts of Parliament establishing the given institution; survey and consultancy reports on the establishment of the institution; some kind of a charter review and evaluation reports which may from time to time amend the mandate of the organization, and national development plans.

Give other types of information on policy.

What would happen to a manager with no access to policy information?

What documents do you consult for your R&DI mandate?

- **Programmes and Projects Information:** In formulating programmes and projects, one

must have information contained in national development plans in order to ensure that proposed activities are in unison with the development aspirations of the nation. It is also important to identify real problem areas falling within the mandate of the institution. Conference proceedings and reports of seminars and symposia will usually have recommendations for action on problem areas. Reports from socio-economic research projects and surveys, consultancy mission reports and annual reports of other organizations also indicate problem areas which may need attention. In order to avoid unnecessary duplication and to aid in the design and choice of methodology, the manager of R&D must have information on past and on-going projects. For this he/she needs to consult relevant directories, abstracts, indexes and bibliographies, and must be assisted with the procurement of substantive information from journals, reports, books etc.

- **Trends:** Another type of management information necessary for the R&D manager is that of trends. In some R&DIs, there are very good managers but who are always behind time. The results of this kind of negligence can be quite disastrous. For example, young, brilliant and ambitious members of staff will get easily frustrated and this can lead to undesirable turnover of highly trained staff. Secondly the institution will lag behind in equipment procurement and may continue trying to solve old problems in the face of new, more urgent priorities, or new problems with out-of-date technologies and methodologies.
- **Primary Literature:** This type of information consists of original publications as found in journals, books and grey literature. This type of information enables the researcher to know what has already been done and helps him keep up-to-date with developments in his field of activity.

How else can one identify problem areas?

Is duplication always a waste of resources? Discuss.

What other consequences could face a manager who does not keep in touch with trends?

- **Grey literature:** This type of information needs emphasis. This term is used to describe the unpublished information in files and other internal documents. This is a valuable source but very difficult to access. Efforts should, however, be intensified to collect and document such information. See case study 3.1 below.

Case Study 3.1: EXPERIENCE IN THE ACQUISITION, PROCESSING AND UTILIZATION OF "GREY LITERATURE"

The Case

One of the major challenges in scientific and technological development is documentation and access to the large volume of unpublished information otherwise known as "grey literature". This information is in many forms — raw data, internal cyclostyled reports, consultancy reports, draft papers which are never published etc. The sheer bulk and often disorderly nature of such information discourages potential users and documentalists alike and researchers may ignore such sources altogether. One of the major projects undertaken in the region to organize and document "grey literature" is the Agricultural Documentation Centre (ADOC) of the Ministry of Agriculture in one of the countries of this region. The objective of ADOC is to collect, process, store and make available all relevant information relating to Agriculture.

ADOC seeks out relevant documents from research and extension services, classifies and stores the information in both hard copy and microfilm, and publishes directories, bibliographies and abstracts of this information in various formats. The most

comprehensive is the Agricultural Abstracts — Cumulative retrospective series — which includes sections on personal author index, corporate author index, programme and project index, subject index, and abstracts. An essential aspect of the ADOC information processing system is computer application which lists and sorts the information in standardized worksheets and facilitates publication of the information in various formats. ADOC has been able to make extensive use of AGRIS and AGRINDEX to expand its access to literature.

Outcome and Points to Note

The ADOC, which was originally funded by external donor has been quite successful and is now fully institutionalized within the Ministry of Agriculture. However, the enthusiasm of ADOC staff is adversely affected by shortage of funds, breakdown of equipment and very low demand for information especially from local researchers. The project has also moved from active search for literature to reliance on goodwill that those in possession of such information will forward copies to ADOC. The number of documents reaching the centre has therefore decreased.

Questions for Discussion

- (a) How could interest in and sustainability of an information system such as ADOC be built up and maintained. Indicate the possible role of both information sources and users in the management of such a system?*

- **Resources Information:** After a manager of R&D has worked out his programmes and projects, he will always find that it is not possible to implement all of them because of limitations in resources. He may, therefore, have to consolidate projects or give them some order of priority and implement only those which resources permit. Resource information is thus another type of information required by managers of R&D. Three types of resources on which information must be sought are personnel, finance and materials. Resource information for R&D is treated in more details in chapter 6: 'Management Information Systems' of this manual.
 - **Bibliographic Information:** This type of information consists of titles with summaries of original publications produced over a period of time and in a given subject. Usually author and subject indexes and a classified contents page are provided to facilitate locating bibliographies or abstracts of interest.
 - **Scientific Directories:** Under this type will be found such publications such as current/ on-going research projects; directories of experts, directories of organizations, Union lists of periodicals and Union catalogues. The first three directories can provide useful information on research in progress, other scientists with similar interests and organizations with programmes and
- (b) *What incentives can a research manager give to his research staff to increase their interest in using local data bases?*
 - (c) *Is it necessary to keep both hard copy and microfilm versions of each publication in an institution such as ADOC?*
 - (d) *How can information personnel improve the use of information in R&DIs?*
- Give advantages and disadvantages of bibliographic information.*

equipment needed for a researcher's work. This information is very important in enhancing collaboration in research and sharing of facilities. The Union lists of periodicals and Union catalogues give information which can help in locating the library or information centre where a cited journal can be found.

List other types of scientific directories you are aware of.

- **Field Notebooks:** As a general rule, researchers record their observations in field notebooks during both laboratory work and field trips. These notebooks contain very important research information in form of basic raw data and general observations. To an R&D manager the importance of raw data should not end with the completion of a project or report.
- **R&D Internal Reports:** Internal reports of an R&DI contain very important information on projects carried out by the institution. In addition to methodologies used, results, conclusion and recommendations, they usually also give proposals for future work.
- **Statistical and Socio-Economic Information:** An R&D manager needs statistical and socio-economic information not necessarily as direct input into his project but as a basis for decision making. Statistics can be used to reveal the magnitude of the problem and hence give justification for carrying out a research activity. Socio-economic information can also be useful to an R&D manager by helping him/her understand the national development goals of his country and the proposed programmes and resources allocated.
- **Monitoring and Evaluation Information:** The process of monitoring and evaluation has been covered in the manual on R&D Project Planning, Monitoring and Evaluation. The R&D manager must be provided with monitoring and evaluation reports to enable him/her have an idea of what other independent people think about the RDI he/she belongs to, its interpretation of policy and

Who generates this type of information?

mandate, programmes and projects and impact on national development. Such information is important to an R&D manager in reviewing and evaluating research programmes and projects so that they are up-to-date with the current philosophy of the R&DI.

- **Patents and Legal Information:** This type of information is very important in R&D work but unfortunately most R&D managers know very little about it and rarely make any use of it. **Patents** contain information on technology which is ready for exploitation. Patent information is available from a well-organized international network called, World Intellectual Property Organization (WIPO) and its regional offices and from national patent registration offices. Knowledge of patent information rules etc. is also important for an R&DI which may wish to protect tangible results.

How can a researcher use patent information?

As regards legal information an R&D manager should be specially conversant with contractual law. Upon completion of a project which culminates in exploitable output, the R&DI can sell it to industry for commercialization. In such a case an R&D manager may be required to draw-up the basic contract outlining the conditions under which such technology may be transferred.

What are the dangers of an R&D manager not being conversant with contractual law?

From time to time, an R&D manager may be commissioned by industry to carry out R&D activity on their behalf, either to improve current processes and products or help discover new lines of production. The R&D manager should be able to draw on legal advice to be able to negotiate conditions of contract which do not prejudice or compromise the interests of the R&DI.

3.205 **Format of Information:** For the purpose of discussions here, this term may be taken to mean the classification of information based on common characteristics of physical and/or logical presentation.

3.206 Major Formats of Information: Having surveyed the major types of information important for R&D, here are some of the formats in which this information may be presented. There does not exist a one-to-one relationship between the type of information and the format in which it is presented. An author will decide the most suitable way of presenting his information. In fact, as has been stated earlier, one type of information may be found in two or more formats. It is understood from the definition of format at the beginning of this section that there are physical and logical (structural) aspects to the way information is presented, and hence to its formats. This shall look at some physical and logical formats of presenting information.

E.g. information may be presented as graphs (structural) on microfiche cards (physical). Give more examples.

3.207 Physical Formats:

- **Paper format:** For a very long time paper has been the traditional physical format of presenting information. The information may be written by hand, typed, duplicated, photocopied or printed. Most of the material presented in paper form will be left loose leaf, bound into a book, monograph, journal, pamphlet or in a chart form. Even though many other physical formats have evolved, paper still remains a major vehicle of carrying information. The major problems associated with this format of presenting information are that paper is bulky and heavy and reproduction in large quantities is expensive. On the other hand, paper format has convenience of use and can be transported and stored under fairly harsh conditions.
- **Microform:** Another physical format of presenting information is the microform. There are two commonly used types of microform: Microfilm and Microfiche. In microfilm information is stored on a long, thin roll of film, each frame carrying a page or two. On the other hand a microfiche is a sheet (card) of film carrying a simple matrix of frames, each frame carrying a page or two. In either case, pages are commonly reduced by a factor of 12, 24 or 42. It is possible to put very easily a document of about 130 pages on

Can you think of other advantages and disadvantages of paper format?

Compare microfilm with microfiche.

Compare and contrast microform to paper form.

one roll of microfilm or one card of microfiche at a reduction of, say, 24. The lettering are small on microform so they must be enlarged and projected on some kind of screen using microfilm or microfiche readers. Some of these readers have a facility to print paper copies of microform and are called reader-printers.

Why are reader-printers better than simple readers?

- **Computer based media:** Another physical format of presenting information is the computerized format, commonly appearing as magnetic tapes, discs and diskettes and laser impressed diskettes like Compact Disk - Read Only Memory (CD-ROM). For early models of computers, information was carried on paper tapes or cards made by punching small holes in the pattern recognizable by the computer.

A more detailed discussion of computer based formats is contained in Chapter 5: 'Information Technology'.

- **Slides, films and videos:** Information can also be presented in these three other physical formats. Usually the information is that which records events, experiments etc. These formats are useful for information meant for augmenting lectures and conference and seminar presentations. For slides, it is possible to synchronize the slides to run simultaneously with a tape recording, giving audio commentaries at appropriate intervals.
- **Other formats:** There are many other physical formats for presenting information which have not been discussed here. The phono record, cassette tape and photographs warrant mention here.

3.208 Logical Formats:

Under this category, one can mention structured textural formats, tables, graphs and charts.

- **Textural formats:** This is the most common format in which information is elaborated in normal language. However, the author, publisher or editor of the publication will

give the information being presented a suitable structure.

- **Tables and graphic formats:** These formats are usually used together with the textural format. They are used to present figures or show trends of given parameters.
- **Charts:** Charts are also a structural format of presenting information. In most cases, charts are used to show processes or structures of organizations, and as illustrative materials.

Can you find more examples of logical formats?

3.3 Sources of Information

3.301 This chapter has so far discussed several types of information and ways in which they may be presented. This section concentrates on a review of the major sources where such types of information may be found. The sources discussed include libraries, documentation and information centres, archives, international information systems, commercial vendors, networks, clearing houses, professional societies, and the invisible college. All these may be institutional, national, regional or international.

3.302 **Components of an S&T Information System:** It is important for an R&DI to establish a well coordinated information system responsible for the acquisition, production and organization of various types of information. It would therefore be useful to visualize a working model of an information division in an R&DI before presenting a description of various sources of information for R&D. There are no fixed rules as to what the structure of a research information system should be. Components of the system may be created according to the various types of information, as separate entities or combinations of two or more.

3.303 Here then is a brief description of major sources of information for R&DI:

- **Libraries:** One of the major sources of various types of information is the libraries. For the manager of R&D, academic and special technical libraries will be of high relevance in locating information. In

What other types of libraries are you aware of? What information do they contain that would be of interest to the manager of RDI?

libraries, a researcher will be provided with full-texts of the information required in some of the formats discussed above.

- **Documentation and Information Centres:** These information sources will usually exist together with libraries, providing specialized but complementary information services. Such information sources will usually not stock primary but secondary literature. At these sources, the user can be provided with bibliographies, abstracts and addresses which may help him to get original information from a library or other sources. In most cases, staff of these centres will be able to assist the user procure substantive information. Examples of national centre include the Information Services Unit of NCSR, Lusaka, Zambia and KENSIDOC of Kenya; region centres include PADIS of ECA and ARSO based in Nairobi. Some National Documentation and Information centres in developed countries e.g. NTIS in the USA and VINITI in the USSR provide services all over the world. See case studies 3.2 and 3.3.
- **Archives:** The term archives has a dual meaning in that it denotes both the institution in which public or institutional records of no immediate use are sent for systematic preservation and future reference, and to the relegated, old underutilized records of historic, academic or legal importance which may have important information for future use. Most governments in the world and a growing number of organizations have established archives for the preservation of their "inactive" records. For many national archives, deposit laws are enacted obliging any person or institution producing published works to make a copy available to the archives.

How would you use a bibliography or an abstract? Give more examples of national and regional documentation and information centres in Africa.

Microfilming and other information technology have found wide application in archives because of the large volumes of records they have to preserve for posterity and reference.

**Case Study 3.2: CONVERSION
OF A LIBRARY INTO
DOCUMENTATION AND
SCIENTIFIC INFORMATION
SERVICE**

Up to 1970, a certain Documentation and Information Centre (DIC) in the region was run as a specialized scientific library offering most of the conventional services expected of such a library.

Since 1970 the DIC initiated projects and services not normally found in a conventional library. Firstly microfiche and microfilm equipment were acquired to enable the DSIC to exploit information available in these formats. Cameras and other equipment for preparing the same were also obtained, but have never been put to any real use. With time, all this equipment has become malfunctioning and obsolete. However, a new microfiche reader has been acquired with British Council assistance. (Two smaller microfiche readers are still in use).

Secondly, a current awareness service was started in which staff of DIC photocopied and circulated photocopies of contents of pages of journals to alert users of the latest literature available in the library. In addition, "international" abstracts and indexes were scanned and relevant information extracted and compiled in a "Survey of Scientific Literature".

In 1976, new activities were started including publication of a local journal of Science and Technology, documentation of locally produced literature in a concise form, and publication of abstracts. The DIC has also compiled the Union List of

Scientific and Technical Periodicals; Directory of Scientific Research Organizations and Directory of Scientific and Technical Personnel. The Union List is in the process of being updated. The DIC further provides literature search services, document delivery service and has a strong publication exchange programme with local and overseas organizations. Recently, the DSIC has acquired a microcomputer and software being used in computerizing most of the databases currently existing in printed format. The DSIC has also a budget to acquire a second microcomputer and a Compact Disk-Read Only Memory (CD-ROM) player in order to enhance services.

During 1991, the responsibilities of the DIC were expanded to include the editorial and typesetting offices and photographic, graphic and printing services.

Question for Discussion

What should be the role of DIC in a National Information System?

Case Study 3.3: ESTABLISHMENT, MANAGEMENT AND OPERATION OF A SCIENCE AND TECHNOLOGY INFORMATION SYSTEM

The Case

Most R&D and training institutions maintain technical libraries and in some cases information documentation activities. There is, however, no referral centre or system whereby one can be guided on sources or location of scientific information. The National Council for Science

and Technology therefore embarked on a project to establish an S&T information centre. The main function of this centre is to promote compilation and publication of directories to S&T information held in various libraries and to establish a referral system whereby users can be guided and assisted to locate the information.

The centre was started within the NCST secretariat. Activities of the Centre are guided by a Council Committee on S&T Information which includes librarians and documentalists in charge of major scientific libraries. It was expected that as the system develops, computers will be introduced to facilitate faster access to information as well as compilation of bibliographies and directories to meet needs of specific S&T sectors. The management even hoped that at a later stage on-line access would be possible. In order to facilitate production of sectoral information directories a number of libraries and documentation centres have been given the role of Resource Centres. These Centres are expected to produce directories relating to their sector e.g. Medical, Industrial, Agricultural etc.

Outcome

The idea of a referral centre for S&T information has been well received at policy level and the centre is included specifically in the Five Year National Development Plan. At the institution level progress has been slow due to a number of factors, but a good start has been made in acquiring published directories and a few bibliographies have been produced. The Centre has also

played a major role in sensitizing the Government machinery on the need to institutionalize the referral system and to intensify training of personnel at all levels.

The first difficulty encountered in the establishment of the Centre was to convince the constituent libraries that the Centre would not usurp or duplicate their role. This fear was eventually alleviated through in-depth consultations but then a second issue arose — the responsibility to finance the creation of information directories at the individual library and Resource Centre levels. The third major difficulty was that of re-orienting library staff from their basic role of library maintenance to that of suppliers of scientific information. The latter role requires special training in information science and information technology. It turned out therefore that there were no staff suitably trained and motivated to embark on the new venture. The fourth difficulty was the introduction of computer technology in the system. A few computers were provided through donor grants but the requirement for highly trained computer programmers and operators to install, adapt and operate even the simplest documentation programmes was highly underestimated. Major investments have been made in training staff for the system, but most of them have left the service for the more lucrative private sector. The Government has upgraded some of the posts and created an establishment which would enable the Centre to operate as an independent institution. No effort has been made to publicize the service to the public until a sufficient

number of qualified staff are available at the centre.

Points to be Noted

- (a) *With good planning, patience and sensitization of the institutions concerned, it is possible to convince the government to improve the status and financial support for scientific information and documentation systems.*
- (b) *Availability of trained staff is likely to remain a major limiting factor in the development of S&T information systems.*

Exercise: From the experience in the above case study, develop a project proposal for the establishment of a central S&T referral information system in your country. What committee structure would you institute for general guidance, control and support of such a system?

Questions for Discussion

- (a) *How can a S&T information referral centre be organized to promote optimum utilization by those who need the service?*
- (b) *How could the resource centres in such a system be encouraged to produce information directories?*

- **Government Departments:** These institutions are also a very important source of information for R&D. Most government departments will have shelves of local reports both in published and unpublished form, often disorganized and unknown to users. This disorganization poses a big problem in retrieving information from these departments. In addition, government bureaucracy and secrecy and confidentiality of information may militate against easy access to information in government departments.

*What types of information would one find in government offices?
How can it be accessed?*

- **Regional and International Information Systems:** Another important source of information for R&D are information systems belonging to regional and international organizations. On the African continent such organizations as ECA, SADCC and PTA have well established information services. The United Nations Family has several specialized agencies which have excellent information services. Most of these information systems provide their information free of charge, a major advantage in the face of poor funding for information services in R&DIs.

For example, INFOTERRA of UNEP is an excellent source for environmental information; INIS of IAEA for atomic and nuclear information; INFODOC of ICRAF for agroforestry information; IITA and AGRIS of FAO for Agricultural information; and PADIS of ECA for socio-economic information.

The following Case studies 3.4. and 3.5 are examples of two International Information Systems, and Case Study 3.6 an example of a Regional Information System.

**Case Study 3.4: INIS—
INFORMATION SERVICE
SYSTEM**

INIS, the International Nuclear Information System, is a scientific and technological information unit of the International Atomic Energy Agency (IAEA) based in Vienna, Austria.

INIS operates on a decentralized system in which liaison officers at designated National Focal Points (NFPs) have the responsibility of submitting input published in their country to INIS Headquarters at IAEA and also for dissemination of the information in their country. The INIS Headquarters hence have only the responsibility of processing the information and merging it into the INIS computer database and its

counterpart the INIS ATOMINDEX, a printed version of the database. The merged output product is then sent to member states for use in dissemination. Members to INIS also include international organizations.

The INIS database consists of abstracts of literature published on atomic and nuclear science and technology intended for peaceful purposes only. It has several indexes including the author, subject, corporate, conference, report, standard and patent number indexes. The INIS Headquarters does not collect actual publications of all the material reported. Only abstracts and indexes are kept in the database. However, there is a clearing house (library) which collects what is called non-conventional literature i.e. documents not easily available in conventional channels. These are kept on microfiche.

Auxiliary information in the INIS ATOMINDEX index includes ways and costs of procuring documents corresponding to selected abstracts. An individual with a problem, will send his request to the INIS Liaison offices in his country or international organization. The ATOMINDEX will then be searched to locate relevant abstracts. The user will then study the abstracts and choose those for which he requires substantive information. The Liaison Officer will then follow the procedure indicated in the INIS ATOMINDEX to procure the requested documents.

Case Study 3.5: INFOTERRA — A REFERRAL INFORMATION SOURCE

INFOTERRA, an information system of the United Nations Environmental Programme (UNEP), is a worldwide referral information network on environmental information. The INFOTERRA is headquartered at the UNEP offices in Nairobi, Kenya.

Essentially, INFOTERRA consists of the Programme Activity Centre at the headquarters, one National Focal Point (NFP) in each participating member state and several sources of information identified by the NFP in each member state. In addition to member states, international organizations also belong to INFOTERRA family. The sources of information include national organizations, special sectoral sources (SSS) — i.e. organizations specialized in a given aspect of environmental information — and international organizations. INFOTERRA system does not collect and organize substantive environmental information as such. Its database consists of a Directory of sources of Environmental Information and its indexes. The directory consists of profiles (addresses, functions, types of services etc.) on sources of environmental information as identified by NFPs etc. The criteria for being a source are simply willingness and ability to provide relevant information.

Each NFP etc. is required to provide a list of sources to INFOTERRA which in return compiles the directory and indexes, and sends back to each NFP etc. a complete set of this product. Upon receiving a query,

the NFP will search the directory and provide to the client a list of addresses which have the relevant information and are able and willing to share it. A focal point may of course contact the source on behalf of the user. For NFPs in developing countries lacking computer facilities, PAC can provide a certain number of searches each year free of charge.

Points to Note

It can take a long time between sending out a query and receiving the actual information.

Receiving actual information depends on ability of provider, time to compile it being a major factor if source is not an information centre.

User has a wide range of sources to choose from.

Users can develop direct contacts with their colleagues.

Some users may not follow-up on addresses.

Information overload may arise.

Discussion

Compare and contrast Case studies 3.4, 3.5 and 3.6.

What would you recommend for your country?

What are the cost/benefits of each system?

Commercial Vendors: There are also sources of information for R&D which operate on purely business/commercial lines. In general these information sources provide secondary type of information and the user has to follow up for substantive information through libraries or by direct contact with the information provider. These types of sources are usually very broad based and make a very good coverage of information for R&D. Examples of this type of source are Chemical Abstracts Service and Institute of Scientific information both of the USA. The British Library — Document Supply Centre of the UK however provides substantive information in response to bibliographic requests.

The Invisible College: This source is the grouping of peers and colleagues based on personal cognizance and contact. It comprises the informal network of managers of R&D who have similar professional interests. This is a very important source of information for R&D but one which is usually taken for granted. When an R&D manager needs information, very often they will approach a colleague. In this way such colleagues form an invisible network, an important source of information for R&D.

What limitations are there in getting information from commercial databases? See further discussion in chapter 5.

Which source of information do you usually approach first?

Do you belong to any invisible college? What problems may arise with information from colleagues?

How reliable would information from an invisible college be?

Case Study 3.6: A REGIONAL SCIENTIFIC LITERATURE SERVICE

The Case

A major handicap to research in Africa is inadequate access to scientific literature, especially current journals. Communications are also often so difficult and unreliable that establishment of well-stocked central libraries does not solve the problem. In an effort to alleviate this problem a Scientific Literature Service was established in 1967 to serve agricultural research and educational centres.

This service entailed establishment of high capacity photo-copying facilities at the well equipped regional Library. From this centre, researchers were supplied with copies of content pages of current journals from which they could request specific articles to be photocopied. After a year, 14,000 pages of photocopied articles were being supplied monthly to 134 research centres, 102 of these on a regular basis. The whole project was initiated with donor funding with the expectation that local funding would be found to sustain it.

Outcome

The Literature Service turned out to be one of the most successful experiments in distribution and sharing of scientific literature in the region. By the mid-seventies, even very remotely sited research stations had built up impressive collections of journal articles relevant to their work, and improvement in quality of research was evident. The situation, however, changed drastically when regional cooperation collapsed amongst the countries and the donor withdrew from the project. The status of the Regional Research Centre and its library also changed from regional to national and the other countries now had to use foreign exchange to subscribe to the service. This proved difficult and the regional aspects of the service collapsed. Even at the national level, resources could not be found to maintain journal subscriptions and demand for the service has declined substantially.

Points to Note

There are some lessons to be learnt from this project:

- (a) Access to Scientific Literature can be made efficient, economical and effective through a system of information sharing.*
- (b) Sharing of Scientific Literature should be a long-term commitment backed by allocation of resources to ensure continued subscription to journals or central access to external data bases. Donor funding should be seen as a temporary facility.*
- (c) The information sharing system should be institutionalized so that resulting collections of valuable literature do not become personal property of individual researchers.*
- (d) A cost should be imposed right from the beginning on users so that their demands are tempered by priority needs.*

Questions for Discussion

- (a) What are the legal requirements of Copyright Laws in your country?*
- (b) How could an information service like the one described have been operated without infringing copyrights?*

Draw up an administrative and management structure for a national scientific information service based on cost-sharing. How should such a system be financed to ensure sustainability?

3.4 Major Distributing Agencies of Information on R&D:

3.401 There are many agencies engaged in the distribution of information for R&D all over the world. Some of the information sources discussed in section 3.3 above, do play a dual role of being information sources and distribution agencies of their own publications. Most of the United Nations Agencies, for example, do play this dual role. In this section, we shall briefly describe some major agencies distributing information for R&D.

- **Government Departments:** Many Government Departments are active in R&D and have very strong publication programmes. Such departments as Agriculture, Water Affairs, Mines, Geological Survey and Meteorology may be taken as good examples of government departments actively engaged in R&D. When they produce a publication, they will usually distribute it to sister organizations both at home and abroad on exchange basis or as a gift. Government Printers are established in most countries where government publications may be purchased.

- **Non-Governmental Organizations:** Many non-governmental organizations both within the region and abroad are playing a major role as distributors of information. Their information is normally available free of charge or upon becoming their member. Some examples of NGOs active in this area include Kenya NonGovernmental Organization, African Centre for Technology Studies, PANOS Institute of the UK and the International Federation of Library Associations.
- **Publishers:** All over the world, including the African region, publishers are major distributors of information for R&D. In some countries in the region, these publishers have agreements with publishers overseas to reproduce their publications and distribute them locally. Unfortunately, local publication of information in R&D is still very weak in Africa; and, except for school texts, local publishers are not very strong distributors of information for R&D.
- **Book Agents:** Book agents form a very important link in the chain of distributors of information for R&D. Book agents are actually book sellers who will have entered into contract with a publisher to sell books, journals etc. on their (publishers) behalf. Book agents are more widely used in the purchase of library stocks because they will usually represent many publishers and hence have a wide range of material for sale. A library would have a great difficulty if it were to order books etc. from individual publishers. In terms of pricing, book agents are quite reasonable because they live on commission agreed upon with the publishers.
- **Book Sellers:** Although book sellers are also an important group in book distribution, they differ from book agents in that they do not have contracts with publishers. Booksellers purchase materials from publishers, book agents, R&DIs and any other sources for the purpose of reselling. It is therefore most likely that booksellers will be more costly

Contrast and compare publishers, booksellers and book agents as distribution channels for R&D information in your country.

than publishers and book agents as a source of information.

3.5 Procedures and Conditions for Accessing Information

3.501 If information cannot reach its intended audience, then the whole exercise of publishing it is of no serious consequence. There are many standard ways and conditions of accessing information for R&D, but every information source will set up its own requirements.

- **Publicity:** First and foremost, it is the duty of an information source to publicize itself, its resources and services to its intended audience. In this way, users will be attracted to make contact with the source. Some ways in which this may be achieved include publishing and distributing an in-house magazine; regular announcements of new additions to the information source through the compilation of acquisition lists; distribution of brochures elaborating facilities, services and information resources, and by holding open-days.
- **Terms of Access:** Libraries, documentation and information centres will have established procedures and conditions for accessing their resources. The general rule is that an interested reader will be required to become a member of the library and obtain membership and borrowers cards. This will entitle him to the services, facilities and resources of the library. Chapter 7 'Dissemination of R&D Results' addresses some issues of information services. Very often, it is possible to obtain information for R&D free of charge from United Nations Agencies and other international and regional information systems if one can show that the information being requested would not be used for profit. It is helpful if the request is done through the local library.
- **Complimentaries:** In many cases, it is also possible for a library to get complimentary copies of a publication from the organization

How else can an information source publicize itself?

What methods are there for accessing information for your library?

responsible for its intellectual content; and to obtain reprints from the authors of journal articles.

3.502 As regards sources of information for R&D, publications can be obtained from distributors through several ways. Five such ways are briefly discussed here.

- **Purchase:** Most libraries and information centres will, on an annual basis, assess their requirements and arrange to buy books, journals and other documents from publishers, booksellers and book agents. Since most materials for R&D have to be imported, these institutions are facing great difficulties in securing their orders.
- **Exchange:** If an institution has a reasonable publishing programme, it is possible to enter into a publications exchange programme with selected institutions both locally and overseas.
- **Gifts:** To complement the two methods described above, the institution can embark on a vigorous campaign to solicit donations and gifts from various organizations. Most foreign missions will assist in identifying organizations making donations in their countries.
- **Depository:** Many organizations, especially those belonging to the United Nations, to Non-governmental organizations and international organizations will usually be looking for suitable organizations to serve as depository libraries in their countries. Once an agreement has been entered into, such libraries receive publications free of charge, but must in turn disseminate the information as widely as possible. UNESCO, ICRAF and CISRO are examples of organizations providing this facility.
- **National Focal Point:** Some organizations wishing to extend their activities, including information services, identify suitable partner institutions to serve as National Focal Points

What are the disadvantages of depending on donations and exchange programmes?

Are there any NFPs in your country? What do they do?

or Liaison offices. A selected institution will be supplied with all available literature, including that for R&D, and be given the responsibility of disseminating the same as widely as possible. Here INFOTERRA of UNEP, INIS of IAEA and INTIB of UNIDO may be given as good examples.

3.6 Advantages and Limitations of Various Sources of Information

3.601 The various sources of information discussed in the foregoing sections will certainly have their own strengths and weaknesses in playing their role as sources of information for R&D. This section addresses some issues pertaining to advantages and limitations that these sources may have.

- **Advantages:** One of the major advantages of the sources discussed in this chapter is that if a client identifies material dealing in his subject area of interest, he is likely to find the information he requires in one central place instead of having to move from place to place. Besides, these sources will probably have good contacts with other institutions and colleagues so that information that may not be readily available in their centre can be procured elsewhere.
- Secondly, these sources can be used as referral centres, i.e. they can redirect the user or his query to the source that has the ability to provide the information being sought.
- Thirdly, most information sources discussed above have professional staff and provide specialized information services. They are therefore able to retrieve and repackage the information in more professional manner than would most managers of R&D on their own. Lastly, some of these information sources are processing their information in a very special way either manually or by machine. They can therefore provide a much faster and efficient service.

- **Limitations:** This, of course, is not to say that it is all roses. Far from it! These sources also operate under very harsh conditions especially in developing countries where poor economies are militating against the provision of better information services.

One of the major limitations is that resources allocated for the operation of these units are generally inadequate. This situation adversely affects the acquisition of library stocks, facilities and equipments; which in turn makes it very difficult to meet user needs.

Where these sources of information for R&D are part of a larger organization, they will probably be accorded a very low priority status. Hence they will usually not be considered very favourably in matters of staff recruitment and training, expansion of facilities, entering the new information technology age, and so on; with a concomitant result that staff will be frustrated and services offered may remain at inadequate level.

How can a manager of R&D influence resource allocation to his library?

What proposal would you make for improving services at your Library?

How does the status of your library stand?

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER IV

INFORMATION TECHNOLOGY

INFORMATION TECHNOLOGY

Purpose

The purpose of this Chapter is to familiarize R&D managers with the major technologies for information processing, storage, retrieval and dissemination.

Training Objectives

By the end of this Chapter, the participant will be able to:

1. Understand the characteristics and future prospects of the major technologies for information processing, storage, retrieval and dissemination.
 2. Appreciate the applications of the various information technologies.
 3. Assess the advantages and limitations of specific information technologies for the major R&D information activities.
 4. Appreciate infrastructural and other constraints to the use of information technologies in the setting of sub-Saharan Africa.
 5. Appreciate the Human resources — (personnel, training) requirements for Information Technology.
 6. Understand organizational and management issues connected with information technologies.
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INFORMATION TECHNOLOGY

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CHAPTER IV

INFORMATION TECHNOLOGY

4.1 Introduction

4.101 Information technology (IT) may be described as the process used in the collection, storage, retrieval, processing, dissemination and use of information. The various scientific, engineering and other technological and management disciplines which are used in these processes are now referred to as "informatics", a term which originates from the French word "informatique". This word has become more prominent in information science and policy since the invention of the electronic computer.

4.102 It is, however, important to recognize that computer-based technologies are only one type of information technology. Information technology has advanced and spread rapidly since the late 1970s and early 1980s. This has been due to two main factors. First is the coming together of computer and telecommunication technologies. And second, the increased design efficiency, size reduction and cost reduction based on advances in microelectronics (chip technology).

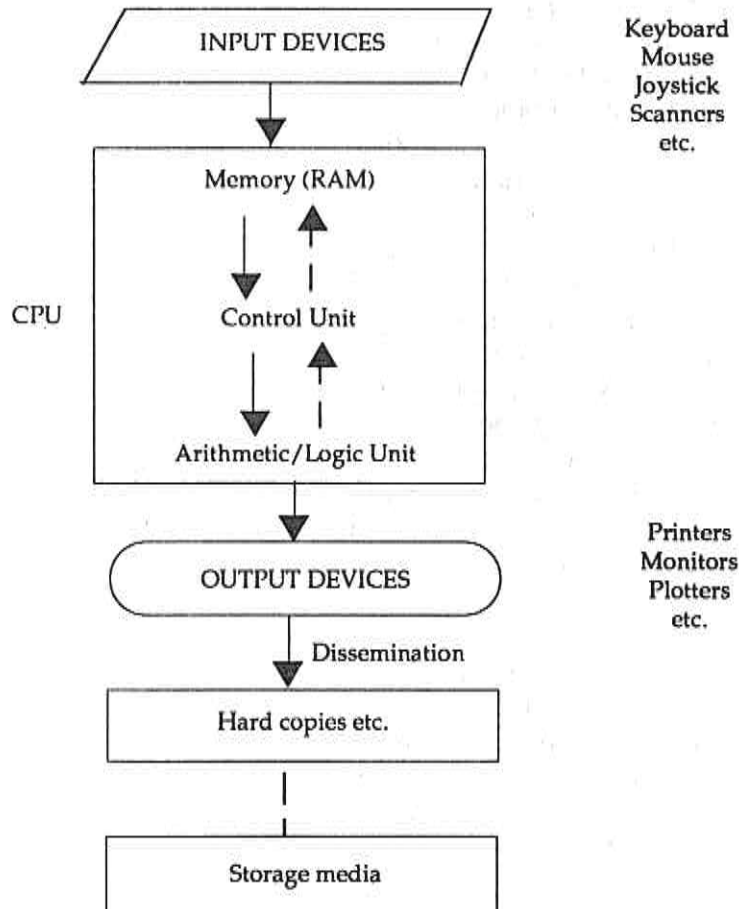
4.103 Since this manual is intended for managers of R&D, the contents of this chapter will be confined to brief descriptions of various information technologies of potential use to R&D institutions, areas of application and factors to be considered in choice of technologies. The main emphasis will be put on computer-based IT.

4.2 Overview of Major Information Technologies

4.201 Information technologies differ in both complexity and application. They range from simple technologies such as photography (see microform described in chapter 3), cards, calculators, slides, video films, photocopiers, printers, duplicators, telephones, telexes, and faxes to the more complex computer-based technologies. Although the utility of the simpler technologies should not be under-estimated, it is important for the R&D manager to be acquainted with the faster and more versatile but more complex computer-based technologies which are increasingly becoming accessible.

4.202 Computer technologies are usually classified in terms of processing capacity of the computer hardware. Information flow in a computer system is illustrated in Fig. 4.1.

Fig. 4.1. Configuration of a Computer System



There are three main categories of computer hardware:

- **Mainframe Computer:** This denotes a powerful computer hardware with a Central Processing Unit (CPU) capable of doing several jobs at once. Access to mainframe computer is usually through computer terminals (work stations). Mainframe computers are designed to handle large quantities of data and usually require dedicated, air conditioned facilities.
- **Mini Computer:** This term is usually applied to computers whose capacity and price is less than that of a mainframe but more than that of a micro computer. This category of computers is, however losing meaning as the processing capacity usually associated with minis is now available in micro-computers. Mainframe and mini computers are normally required to control a variety of operations in large organizations and are ideal for time-sharing applications.
- **Micro Computers:** These are computers in which the functions of the CPU are controlled by a Microprocessor chip. The usual version of micro computers is the desk-top computer which is also referred to as a Personal Computer (PC). A microcomputer comprises three units: a CPU, a Monitor (display screen) and a Keyboard. Data and programmes are fed into the CPU and operations controlled manually through the keyboard or automatically through diskettes. Micro-computers have become available in highly portable forms such as Lap-top or even pocket versions. In this type of computer, the CPU, monitor and keyboard are housed in one unit. Modern microprocessor technology has produced lap-top computers which are light (Less than 3 kg), and as powerful as the desk-top computers. Further reduction in size is associated with reduced functions due to the smaller visual display screen, number of keys which can be accommodated on a small keyboard, and the size of internal hard disk

drive which can be accommodated. External disk drives have been developed for use as peripherals in order to improve data handling capacity of small micros.

4.203 Computer Inputs: Data is entered from the outside world into computers through input devices such as keyboard, mouse, scanner or light pen. The mouse works by positioning a cursor (pointer) on a command on the screen. Clicking on the mouse button causes the command to be executed. There are Optical Character Recognition (OCR) and image scanning machines which can "read" printed or typed information but their speed and accuracy are still inadequate for routine conversion of massive documents. Scanners work similarly to fax, sending whole documents into the computer memory. They are very important inputs for graphics and text especially for large and complex documents.

4.204 Computer Outputs: The printed text is still the preferred mode of presentation of most information. Electronically controlled printers have therefore been developed in order to reproduce text, tables of figures, graphs, maps and diagrams generated by computer analytical programmes.

4.205 There are many types of printers in the market differing mainly in typeface (quality of print), speed of printing, ability to draw line diagrams (plotters) and of course price. Technologically, the main differences between printers are the printing process and the type of print-head installed in the printer.

Although most computer software can now accommodate different types and makes of printers, it is important to ensure that printers are compatible with the computer software in use in an organization.

- **The impact daisy wheel:** In this system the characters projecting from the daisy wheel are positioned automatically and impacted on paper over an ink ribbon in the process of printing. The resulting typeface is of good quality and printing speeds of up to 30 characters per second are possible.

- **The impact dot matrix:** In this system, a series of pins located on the print-head are ejected and impacted on paper over an ink ribbon electronically to form a series of dot matrices corresponding to the various characters. The number of dots forming each letter can be regulated electronically to produce either draft or letter-quality print. The number of pins on a print-head may vary between different makes of dot matrix printers. Products of dot matrix printers are rarely of a quality acceptable for direct publication.
- **Ink jet printers:** This type gives higher quality typeface than dot matrix but is more expensive.
- **Laser printers:** These printers are the most versatile but they are expensive. They produce a typeface as good as that of solid type. Laser printers are used to produce high quality final text for correspondence or desk-top publishing. In the laser printer, the page to be printed is composed electronically by computer, scanned and transferred to paper using lasers in a process similar to photocopying. That is why the consumables in a laser printer are toner cartridges and drums.

4.206 Compact Disk (CD)

CD-ROM: A more recent innovation in data storage is the Compact Disk (CD). The Read-Only Memory version (CD-ROM) uses the digital audio CD system for storage and retrieval of machine-readable information. CD-ROM has the advantage of reliability, permanence and durability and is free from problems of demagnetization. The CD-ROM cannot be copied and therefore enhances protection of data. A single disc has the storage of up to 600 megabytes, the equivalent of 275,000 pages of text.

Experience shows that CD has much longer shelf-life than microform and that CD images come out clearer than the original. It is also easier to locate information on CD than on microform. CD-ROM

can be used with almost any size of computer. Since the major databases are now available on CD, a CD-ROM facility is in many cases a good investment in R&D Library services.

Exercise: How would you determine the real need for CD-ROM technology in your institution?

4.207 Other output devices include monitor screens, TVs, diskettes, and tapes.

4.208 **Networks:** A number of computers can be connected with cables to form local (LAN) or wide area (WAN) Networks which facilitate exchange of data at high speed. Such systems facilitate data entry at different locations and can be used for complex operations such as computer conferencing, sharing of information and sharing of resources such as printers, discs and databases. If such a system is envisaged within an organization, it is essential that all software be compatible.

4.3 Applications of Computer-based IT

4.301 The main applications of computers in R&D activities are concerned with acquisition, storage, analysis, presentation and communication of data. Computers can also be programmed to control the frequency of measurements and to detect malfunctions in measuring systems. Automated analytical instruments remove a lot of drudgery in routine procedures and increase accuracy of data.

4.302 Computers have proved especially useful in statistical analysis of data, preparation of reports and creation of databases for management of large volumes of experimental data.

4.303 **Word Processing:** Word processing has become one of the major applications of computers since the advent of the micro-computer. A word processor is simply a computer programme that accepts input text and formats it automatically on a page. Essentially, it presents the user with a typewriter environment to work in without needing to know how it is programmed. The ease of editing and the preservation of documents between changes allows almost anybody to produce a decent letter, report or manuscript. Indeed with a word processor, only modest typing skills are necessary for increased productivity in the R&DI. It has been observed, for example, that 40–60% of the time of an active research scientist is spent on processing of research and management information. Any technology that helps raise efficiency in this segment of a researcher's work must surely raise overall efficiency and allow more time for research. Word processors are therefore a productivity tool in R&D.

4.304 **Desktop Publishing (DTP):** DTP is the use of advanced word processing software that incorporates many of the features of typesetting. It is used to design and produce documents which are visually ready (called camera-ready) for professional printing. DTP allows multi-column designs, multiple type-faces (fonts), graphics, indexing etc. It can therefore be used to prepare such documents as newsletters, magazines, journals, books, brochures, pamphlets, forms, and calendars etc. DTP has thus brought much of the typesetting and editing function into the R&D manager's range of control. It has therefore made it possible to manage the origination (writing, inputting, designing, typesetting, editing, proofreading) of an institution's products much better with particular reference to accuracy, quality and timeliness.

4.305 **Databases:** The large volumes of data collected in R&D processes can be stored in databases which greatly facilitate retrieval and analysis. A good example is that described in Case study 4.1.

Example: This manual was "desktop published" in the ICIPE's publishing division (called ICIPE Science Press) using a Macintosh II computer with a laser printer. The writers and editors worked closely with ICIPE Science Press staff until the manual was ready to go to press.

Describe any databases you have established within your RDI.

Case Study 4.1: USE OF A DATABASE SYSTEM IN THE MANAGEMENT OF SEED STOCKS AND RELATED INFORMATION

The Case

One example of R&D database is that used in one of the countries of the Eastern African region for the marketing of high quality seeds of trees developed. A major factor in the success of this undertaking is the systematic documentation of a large number of parameters leading to identification of superior or "plus" trees in the breeding programmes. This information facilitates accurate description of parentage of such trees and hence stability of the desirable characteristics associated with the tree. As information has accumulated in the 50 years breeding programme, the original well designed manual system of recording seed acquisition, stocks, trials etc. has proved laborious and access to data increasingly difficult. This is due to changes and shortage of staff and need for cross-referencing a large number of separate data files. A computerized data base has therefore been developed with the objective of eventually covering all the thousands of data units currently in the manual files as well as future records.

Outcome

In view of the complexity of the exercise, the first priority was given to installation of a data management system for seed stocks available for sale. Information on origin, quality of seed, recommended planting environment, resistance to disease and pests and availability of seed for sale has been successfully

computerized. The system which was originally designed for main frame computer has also been adapted for use in micro-computers, which are cheaper, can accommodate a greater variety of software and are more amenable to decentralization and portability. The next objective is to develop a standardized procedure for inputting production data derived from the various experiments and trial plantings.

Points to Note

Progress achieved in this project demonstrates the benefits and viability of a computerized database developed to meet specific institutional needs. In order for such a system to be really valuable, it should endeavour to provide as much of the information as possible to assist decision making in the widest range of problems.

Success of this project also shows that it is possible to use locally available skilled personnel who are more experienced and sensitive to local needs and availability of facilities.

A computerized data base should be preceded by a well-designed manual system of data or information documentation which has gone through a period of testing and improvements so that the desired outputs are well documented.

Conversion from manual to computer-based systems should be gradual and phased according to specific needs and objectives.

Exercise: Can you identify specific experimental procedures or data management needs in your R&D institution which could benefit from computer applications? What technologies do you think would be appropriate for such application at the present stage in your institution?

4.306 There is now a large number of commercial databases providing ready reference to published information on virtually any major branch of science and technology. Some of the well-known databases of interest to R&D are the CABI International database covering agricultural and biological subjects, CARIS and AGRIS of the Food and Agriculture Organization of the United Nations (FAO), Dialog, Science Citation Index, Chemical Abstracts, and INFOTERRA of United Nations Environmental Programme (UNEP). Most of the databases can be accessed directly (on-line) through controlled computer codes but CD-ROM versions are being marketed and may be less expensive and more convenient to RDIs because they can be used on-site.

Exercise: What databases does your institute currently subscribe to? To what extent do you think subscription to the databases has been cost-effective?

4.307 Computerized Libraries: The main functions of a **library** or information centre are to acquire various forms of published information, to document and store the information in conveniently retrievable forms and to avail the information to users in formats tailored to user needs. Each of these functions requires specific tools which in turn require suitable technologies for their creation and operation.

The traditional library system comprises information in form of books, periodicals etc. which are displayed on shelves. The user is guided to the location of each document by a system of directories, bibliographic catalogues and card catalogues which contain varying amounts of information on the document concerned.

However, as the library collection of documents increases, the need may arise to computerize the library system. In computerized systems, the information normally kept in separate printed

directories, catalogues and cards is stored in computer memory and may be accessed by the user directly through a computer terminal.

Such systems can also be used to speed up creation of user-specific bibliographies and current-awareness information bulletins for users located far from the library itself. A further advantage of computerized library systems is the possibility of on-line information search and retrieval.

Exercise: Describe the system currently in use for information storage and retrieval in your institute's library. What aspects do you consider would benefit from introduction of computer technology?

4.308 Creation of computer programmes for management of library information systems is, however, a complex exercise. A number of organizations have therefore invested heavily in this field and one would be advised to try these programmes before embarking on in-house programme design.

The CDS/ISIS, which stands for Computerized Documentation System/Integrated Set of Information Systems, was developed by UNESCO in 1985 and has since been updated. The software package is based on the ISIS originally developed by the International Labour Organization (ILO). The system allows users to keep the library database current through updating of the master and other files and to search for and retrieve

information through use of search terms. Information can also be sorted and printed using a variety of formats and data exchange is also possible through ISO format.

The Canadian Selective Dissemination of Information (CAN/SDI) technology has been incorporated in CDS/ISIS making the system even more versatile. The CDS/ISIS can be installed in libraries with IBM and IBM-compatible micro-computers. An internal computer memory (RAM) of at least 500K bytes is required for the operation of the system.

4.309 On-Line Searching of Databases that is accessing databases in interactive mode is obviously very attractive especially to scientists who are at the frontier of research and who therefore must keep abreast of the latest published information.

Experience shows, however, that this process is both expensive and often frustrating especially if one has to use non-dedicated communication lines. Considering the poor state of telecommunications in the African region, it is doubtful whether R&D institutions will be able to sustain access to databases on-line in the near future even if such facilities appear to work within donor-aided projects.

4.310 Data Capture: Scientists are, often frustrated by the usually slow rate of manual data recording and subsequent entry in computer systems and the errors which creep in necessitating complex quality control of data. It has, however, been observed that most experimental parameters can be coded, recorded and even transmitted in digital form. Technologies have therefore been developed for direct "logging" of experimental data (data-capture) in formats which can be collated and analysed directly in computer systems without manual intervention. Survey questionnaires can also be coded and marked in such a way that the information in them can be retrieved and computerized automatically.

4.311 Data Analysis: R&D activities involve assignment of numbers as measures of various attributes in experiments or surveys. In all cases,

What do you understand by "installation" of a programme? Do you have CDS/ISIS facility in your RDI library? If so, has it made any difference?

manual statistical analysis of these data becomes a time-consuming process and has often to be repeated in order to reduce chances of computation errors. The development of electronic equipment ranging from simple hand-held calculators to highly complex computers has however greatly revolutionized data analysis. A lot more data can now be analysed extremely fast and hypotheses can be continually tested as information is accumulated.

Microprocessor technology has now reached a level where most of data processing facilities required in normal scientific work can be adequately performed on a desk-top or even lap-top computer.

4.312 Telemetry: Telemetry is the process of transmission of data from the sensor to recording and analytical facilities located away from the sensor. The information may be transmitted via cable or microwave communication links as in the case of satellites. Telemetry is often used to transmit meteorological data from sensors located in inaccessible areas.

4.313 Remote Sensing: This term is used to describe technologies for obtaining information on an object or system without physical contact. The main tool for this technology is a camera or any sensor which can respond to energy radiated or reflected by the object or system of interest. Such energy can be sensed from a variety of "platform" ranging from a hand-held camera to aerial platforms such as aeroplanes and floating balloons and even satellites operating outside the earth's atmosphere.

Remote sensing has acquired a prominent place in information technology since the development of multi-spectral radiation scanners which can operate from aircraft or artificial satellites placed in orbits around the earth. These instruments are able to translate radiation sensed from land and other objects on the earth surface into images which portray the nature of the objects. Computers have greatly increased the speed and accuracy of imagery data transmission, analysis and interpretation.

What problems would you expect with telemetry in your environment?

Certain types of remote sensing require Government approval. Can you list some of the technologies and applications which would fall under this category?

The main application of **remote sensing** in S&T institutions is for acquisition of data on the distribution of major earth resources such as water, vegetation and certain minerals. This information has come to be known as Geographical Information System (GIS) and has proved particularly useful and cost-efficient in monitoring weather and other changes resulting from desertification, deforestation and other environmental phenomena. Computer-based GIS is a powerful tool for construction of databases, as well as storage, maintenance, retrieval and analysis of data and preparation of maps etc. GIS information should, however be closely guarded since it can be used for espionage or military purposes.

Remote sensing can also be used to monitor effects of drought, pests and diseases on field crops.

Acquisition and processing of satellite and other remote sensing information is, however, an expensive process and is best done through pooled resources. The African countries have therefore established the Regional Centre for Services in Surveying, Mapping and Remote Sensing. The Centre, which is located in Nairobi, provides centralized (pooled) facilities for acquisition, storage, analysis and dissemination of remotely sensed GIS data to member countries. The Centre also provides training and consultancy services to member countries.

Exercise: List major areas of research in your institution where remote sensing technology can be applied. What facilities would you require at your institute in order to make full use of such data?

4.314 **Teleprocessing:** This is a form of information technology in which a data processing system utilizes communication facilities. An example of this technology is computer **time-sharing**. This system has the advantage that major computing jobs can be queued and executed automatically as computer time becomes available thus maximizing the use of the central computer-processor. The major requirements for this technology are a terminal, a modem and a communication facility.

Teleprocessing through centralized main-frame computers and the associated inconveniences of time-sharing is therefore only necessary or cost-efficient in large organizations or institutions which rely on large internal databases.

4.315 **Computer Graphics:** An important development in computer technology is computer graphics. The technology facilitates creation of maps, diagrams, graphs and other pictorial forms which help to illustrate complex messages. Graphics technology has also found good utility in industrial design where effects of changes in design of items or machinery can be reproduced and evaluated on paper without having to make the item itself. This process is called Computer Aided Design (CAD).

4.316 **Expert System (ES):** This is a computer system which operates by applying an inference mechanism to a body of specialist knowledge in a given field. ES is a component of artificial intelligence (AI) intended to perform functions normally carried out by a human expert on specific fields. An ES should be capable of reasoning and justifying the basis of its conclusions.

4.317 **Management Information Systems:** The main technological requirement in **management information systems** is to increase speed and accuracy of information retrieval for decision making.

Do you agree? What other reasons would cause review of MIS technologies?

A lot of developmental effort has gone into computerization of management information systems. The resulting range of commercial software (programmes) for management of

accounting, supplies, personnel and assets functions is available to R&D managers and can be easily adapted to individual institution needs and circumstances. MIS are fully covered in Chapter 6 of this manual.

4.318 **Computer-based Communications:**

Computers have also found many applications in the field of communications. They are used to store, to process and to feed or receive information into or from communication systems according to pre-programmed instructions.

4.319 **Telex:** Is a world-wide teleprinter service which facilitates transmission of messages between points which have dedicated Telex links. The message typed into the machine at one end is consolidated and transmitted at high speed to the destination where it is transcribed and printed automatically. This system has the advantages of avoiding the busy telephone lines, is more economical and ensures accuracy since the message is recorded automatically. Messages can also be received any time of day or night.

4.320 **Facsimile (Fax)** systems enable a user at one location to scan a document and have an identical (facsimile image) document appearing at another location that has compatible Fax machine. An advantage of this system is that it uses normal telephone communication lines. It is, however, advisable to use a dedicated line since a Fax message would be lost if it was interrupted by normal telephone conversation.

Another advantage of Fax is that many suppliers have come to accept a signed Fax order as a legal basis for financial transactions, thus facilitating urgent ordering of supplies.

Fax technology has now been expanded to allow direct communication between personal computers (PC). This involves installation of a Fax Board in the PC which facilitates documents still in electronic mode within the PC to be transmitted or received.

Use of Fax boards is, however, of limited advantage in library information systems unless

the library distributes regularly word-processed documents to a regular group of subscribers on-line.

4.321 **Electronic Mail (E-Mail):** Although Telex and Fax are sometimes included in the general description of E-mail, the "E-mail" is increasingly being restricted to specialized computer-based communication systems. Thus one can have separate contact numbers for Telephone, Telex, Fax and E-mail.

Electronic mail and Fax have also good potential for libraries where their utility is mainly in inter-library loans, information enquiries and communication with suppliers.

The necessity to install Telex, Fax and E-mail in R&DI MIS should be determined by the size of the organization, geographical distribution of its service centres and the efficiency of the national telecommunication systems. An institution may also find it economical to instal such facilities if it has to make frequent and urgent communication with other institutions overseas.

4.322 **Teleconferencing:** This is a two-way interactive meeting of small groups of people over short or long distances. Permanent facilities are usually required at each location, the basic equipment being audio communication, video, graphics and facsimile. Computer conferencing operates in a similar way, but it is limited to participants viewing a document appearing on their computer screens and keying in their comments on the terminal.

Teleconferencing is only cost-effective where regular or frequent meetings between participants in distant locations are necessary. It must also be realized that the personal interaction which plays a major role in the success of meetings is difficult to create in a teleconferencing situation. Technological problems can also seriously interfere with the conduct of a teleconference.

4.323 **Packet Switching** is an advanced computer-based data communication system which is now becoming available in the African

region. The system is designed to increase capacity of transmission lines and reduce transmission time by splitting messages into small fixed pieces (packets) each with a destination address. The "packets" are then transmitted and reassembled automatically according to the addresses on the packet with minimal distortion. This facility will become increasingly useful as RDIs develop networks of collaborative research involving frequent exchange of large quantities of data.

4.4 Constraints to the Use of Information Technologies

4.401 However desirable and cost effective information technologies may appear, there are major constraints which influence their adoption in an organization. These constraints may be divided into three categories — infrastructural, financial and personnel.

4.402 **Infrastructure** includes buildings, power supply and telecommunications. Although modern computer-based technologies are less demanding in terms of air-conditioning, they are still highly sensitive to dust, mould and extreme temperatures. An institution planning to install such technologies should therefore have available office space which is reasonably free of dust and which is shielded from extreme fluctuations of temperature.

One way of alleviating this problem is to install the equipment in a special computer room. Although this tends to inconvenience users, problems associated with misuse are minimized.

R&D managers are also advised to design "intelligent buildings" which can easily accommodate requirements of IT such as Network cables.

The computer based technologies also require either reasonably stable main electricity supply or voltage regulators. Back-up generators and Uninterruptable Power Supply (UPS) units may also be needed if total power failures are frequent and prolonged. Fluctuations of voltage may result in loss of data or serious damage to equipment.

Reliable telecommunication facilities are mandatory in the case of on-line information systems and transmission of data. Although items such as desk-top computers are considered portable, great care is needed in transportation of such equipment on rough dusty roads.

4.403 Financial: Like other organizational inputs, information technologies have their costs in terms of financial outlay for purchase, installation, operation and maintenance. In all cases varying degrees of reorganization of procedures and re-training of staff are mandatory and these can cause considerable disruption of routines within the organization.

It is therefore essential that adequate evaluation be carried out on the actual need and applicability of a particular information technology before such technology is adopted. In this section we will review briefly some of the major functions within R&D institutions in terms of information technology needs and hence the applicability of various IT.

In spite of the downward trend in the price of computer hardware, the initial investment still requires considerable financial outlay especially where a main frame computer or a network of microcomputers has to be installed at various points within the organization.

Since the hardware has to be imported, availability of foreign exchange for purchase of equipment, spare parts and software and access to foreign data bases can also be a major constraint to successful introduction of computer based technologies.

Vendors of computers and associated technologies go to great pains to convince buyers that the systems they sell are almost fool-proof and that all a potential user requires is a few lessons on the basic principles and techniques. The reality is, however, usually quite different and many institutions have ended up with systems which are hardly used due to lack of suitably trained personnel.

Exercise: Have you come across this problem? How was it eventually resolved?

4.404 **Personnel:** Computer-based technologies are still relatively new in the African continent and the basic skills in their use have to be learnt at the workplace through re-training.

Even if computer operators can develop a reasonable degree of proficiency within months, an important resource which is usually lacking is a cadre of well trained computer programmers and systems analysts. This cadre is needed to develop or adapt software to the specific needs of the organization and to re-programme the systems should they break down due to equipment or operator failure.

List institutions in your country where computer personnel can be trained.

The third cadre of personnel which is still lacking is trained and experienced technicians who can diagnose and correct malfunctions in hardware.

4.405 **Utility Computers** including Expert Systems are an aid rather than a substitute for managerial skills in decision making.

4.406 **Other constraints** to use of IT include national regulations governing licensing of cross-border data flows and even use of remote sensing and telemetry.

4.5 Organization and Management of IT

4.501 **Procurement of IT Hardware and Services:** This is usually a difficult process. Once

an institution has decided to change the existing information technologies, it is faced with the difficult problems regarding first the choice of appropriate technologies; second the inexpensive and most reliable source of the technology and third, the timing of introduction of the technologies.

4.502 It is at this early stage that the manager requires the services of consultants who are knowledgeable in both theory and practice of IT. It is essential to ensure that even if this expertise exists within the institution, the experts are not tied up financially with vendors of various technologies.

4.503 One would also ensure that whatever system or technology is recommended, quotations for supply of hardware, software and services are received from as many suppliers as possible. The technical specifications of the job should be well documented. This would enable an independent panel, which should include the institution's management team, to select the most appropriate technologies and sources of supply.

Why would the R&D manager be unwise to lease the entire process to the computer experts?

4.504 It is also highly desirable for the manager and his senior staff to visit institutions which are operating or have tried the selected technologies in order to gain information on the experiences with both technology and the vendors.

4.505 The following questions should be answered before a final decision is made:

- (i) How long has the technology been in use?
- (ii) How much information can the technology handle and at what speed?
- (iii) What calibre of staff is required to operate the system?
- (iv) Does the technology require special materials e.g. specially sensitized paper, which are not produced locally?

- (v) How reliable is the system under normal use? An indication of down-time since the technology was installed and any weak points would be useful indicators.
- (vi) How often are new models of the equipment being released? What happens to services (e.g. spares) for the older model?
- (vii) Can the hardware and software be upgraded to increase capacity or traded-in?
- (viii) What services (repairs, preventive maintenance training) does the supplier provide?
 - free of charge
 - at a cost (service contract)
- (ix) How reliable is the supplier? Timeliness of response, number and quality of staff, and guarantees on equipment are useful indicators.

Once a decision has been made to acquire a particular technology, the manager should insist on a supply contract which should include:

- Terms of purchase (price inclusive of taxes, freight and costs of installation and testing).
- Delivery date.
- Manuals to be supplied with the equipment.
- Installation time and guarantees.
- After-sale Services, updates and trade-ins to be provided by the supplier.

Exercise: How would you ensure that a supply contract is legally binding? How much testing would you consider adequate for contractual purposes?

4.506 Manpower Development for IT: While some of the information technologies like the telephone, telex and Fax are relatively simple to operate, most systems which are computer-based require a much higher level of training for personnel who operate them. The following points should be helpful in manpower development:

- The first step in development of manpower for IT systems is to select and recruit persons who have the basic qualifications and aptitude for the various tasks. Analysts and programmers should have a strong background in mathematics, a good temperament, ability to absorb new technologies quickly and a flair for innovation in organization and methods of handling data. Systems operators should be able and willing to handle large quantities of data accurately. A flair for neatness and concentration is a good indicator of persons suited to such tasks.
- Ensure that IT staff receive regular on-the-job training. Information technologies are changing very fast and short-term seminars, workshops and refresher courses should be programmed to acquaint the staff with new developments.

-
- Managers of computer-based information system should have at least a masters degree in information or library sciences. Such training enables them to work with other function managers in the organization in determining the needs for various levels of technology and with the computer experts in designing appropriate packages of technology to meet the management needs.
 - Analysts and programmers should have similar training and at least a diploma in computer science. At the time of writing this manual, there are extremely limited opportunities for formal training in information or computer sciences and technology in African universities. Most of the formal training for this cadre has therefore to be carried out in overseas universities at high cost.
 - Computer technicians should have specialized training in the maintenance of micro-electronic systems. Modern computers are based on micro-processor chips which are sealed integrated circuits. These chips are assembled on integrated circuit boards each of which has a specific function. The main skills requirement for technicians is therefore ability to diagnose the problem and its source and to replace the faulty circuit boards. This type of training is provided in polytechnics leading to certificate or diploma in electronics.
 - Computer operators are required to be proficient in following the hundreds of instructions contained in a computer programme for entering and retrieval of data according to various formats required by management. Training for such personnel ranges from two or more years in a polytechnic to a few weeks for basic skills in specific fields such as word processing. Training of computer operators requires a lot of hands-on practice and is therefore best carried out either at the place of work or on day-release basis.

Motivation of Staff should be a major concern for R&D managers. It is evident from the foregoing discussion that the recruitment, training and retention of personnel is a major organizational and management consideration in the implementation of information technologies, especially those involving use of computers. This task is made even more difficult by the novelty and rapid growth of computer-based technologies and the number of organizations competing for very limited pool of trained manpower. Problems of retention of IT experts in RDIs will however persist until a large pool of experts has been developed. In the interim, R&DIs can alleviate the problem by sharing available resources. An institution is therefore only able to retain such staff if they are **highly motivated**.

Experience however, shows that in addition to training and a reasonable level of remuneration, a major and often more important factor in motivation and retention of staff is job satisfaction. For technical personnel, the greatest source of job satisfaction is challenge and recognition for achievement.

Within R&D setting, challenge can be enhanced by allowing IT managers, analysts and programmers to spend some of their time studying and experimenting with new ideas even if these are not immediately required for implementation. Such exercise becomes even more meaningful if it is carried out jointly with researchers or other function specialists in the institution and the results are published in newsletters or appropriate journals.

Another strategy may be to allow the specialist staff to provide consultancy services to other institutions, the resulting revenue being shared between the personnel concerned and their employer.

4.507 **Management of IT:** Information technology requires an efficient **management structure** within the institution. Such a structure should provide for clear lines of responsibility in decision making regarding systems design, allocation of hardware, acquisition of software and maintenance of both hardware and software.

4.508 Where computer facilities are centralized through either location of hardware or time sharing on a mainframe computer, it is usually necessary to put the entire system in a computer unit under a computer manager.

4.509 The computer manager should have a team of programmers, analysts, operators and servicing technicians who are able to handle most of the problems which do not require specialized facilities.

4.510 The seniority of the computer manager should be such that his/her technical expertise and authority will be respected by all senior staff, including scientists, within and outside the institution. As a member of the top management team of the organization, the computer manager should be consulted on all matters regarding information technology, including choice of hardware and software and training of staff.

4.511 Within R&D setting, it would be helpful to encourage participation of the computer manager in design of experiments. Acknowledgement of his/her input in the institution's publications would also encourage a high degree of cooperation with the research staff.

4.512 Further discussions regarding the organization structure for information technology are to be found in Chapter 6 on MIS.

Exercise: How would you proceed to integrate computer applications in your RDI? Are there any disadvantages associated with integrated systems?

4.513 **Research in IT:** Many of the problems of maintenance of IT in the African region are related to environmental conditions. Managers of R&D should therefore encourage, wherever possible, research into factors which reduce service life and causes of down-time of IT hardware. Research should also aim at the establishment of IT industry on the continent.

4.514 **Obsolescence of Technologies:** The Concise Oxford Dictionary defines the word "obsolete" as "disused, discarded, antiquated". According to this definition, an obsolete technology is one that is no longer useful and has therefore to be discarded or only preserved for historical record. A technology should therefore be considered obsolete not because a newer technology has been developed, but because the existing technology can no longer do the job it was expected to do adequately or the nature of the job has changed so much that the technology is no longer relevant.

4.515 Technology can therefore be rendered obsolete through management decisions involving change of systems, lack of staff, spares or special materials required for the operation of the technology. A good example of the latter is a generation of copying machines whose technology was based on specially sensitized paper. These machines were rendered obsolete when the manufacturers of the special paper ceased to do so. Similarly, many machines are lying idle or discarded in institutions due to lack of spares.

4.516 Choice of information technologies in particular should take fully into consideration the likelihood of the technology being rendered obsolete through monopolistic controls on the basic inputs. Collapse of a monopolistic agency usually results in obsolescence of the technology dependent on it.

4.517 Although there is as yet no agreed standardization of computer technology, manufacturers of hardware are increasingly adopting IBM systems in order to benefit from the larger market of IBM computers and hardware. IBM-Compatibility is therefore an important issue in choice of computer hardware.

4.518 Losses through obsolescence can also be reduced to a limited extent by stocking a supply of vital components, but it is better to adopt a long term strategy in design of information systems and to select equipment which can be modified to accommodate increased output or new uses. This is particularly important in choice of computers where preference should be given to hardware which is more versatile e.g. incorporating "expansion slots" which can be used to expand "memory" or accommodate "modems" for multi-user or on-line communication systems.

4.519 It is, however, difficult to avoid a form of "built in" obsolescence in most machines, including computers. This is the limited working life of a machine, which is determined by specific characteristics or quality of material or technology used.

4.520 The best ways of coping with built-in obsolescence is through choice of technology with proven reliability, full utilization of equipment to ensure maximum return for investment made, and forward planning which should provide for programmed replacement of hardware and the associated re-training of staff.

Exercise: Would leasing rather than outright purchase of hardware solve problems of obsolescence?

4.521 Managers should, however, recognize that with all wisdom and planning, the world information systems are inter-dependent and access to data-bases and world literature will be determined by factors outside the influence of the institution. It is therefore essential that the management keep up-to-date with technological developments worldwide and create a reserve fund which can be used to maintain compatibility of information technologies within the institution and those of both its clients and sources of information.

4.6 Some Common Terminologies Used in Information Technology

Information Technology is full of words which have been coined to describe certain processes and facilities. It would be useful to list a few of these terms — sometimes referred to as computer jargon — here since R&D managers who understand them will find it easier to follow the text and discussions and to communicate with Information Technology experts. There are many more terms used in Information Technology whose meaning can be found in computer dictionaries.

1. Access time the time a computer takes to carry out a command to get stored data.
2. Applications a set of computer package programmes written to do a particular job or a number of specified jobs.
3. Artificial A branch of computer science dealing with programmes written in logic. Use of AI has produced Expert Systems which contain knowledge or expertise.
4. Back-up copies of data kept (on tapes, disks, etc.) for contingency purposes.

- These are used in case there is accidental loss of data in the computer.
5. Batch processing a process in which all data and programmes are assembled as a single set or batch to facilitate single run through computer.
 6. Bit a word derived from Binary Digits 0 and 1. A bit is the smallest unit of information which can be stored in computer memory.
 7. Byte a set of 8 bits representing a character (letter, number, symbol) in a computer memory. Kilobyte (or Kb) is 1024 bytes, i.e. about one thousand megabytes (or Mb) is $1024 \times 1024 = 1,048,576$ bytes, i.e. about one million.
 8. Chip an integrated assembly of micro-circuits designed to control the basic operations of a micro-electronic device e.g. computer.
 9. Databank A collection of a firm's data. The data can be in files, folders, on computers, etc. No structure is envisaged in a databank.
 10. E-mail Electronic Mail. This is mail communicated through computers.
 11. Floppy disk a flexible disc with magnetic coating on which computer information can be stored. Also referred to as a diskette.

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12. Flowchart a diagram showing the sequence of events within a system. Certain symbols are used in flowcharts as follows:
- terminal box — depicts start or end of an operation.
 - input/output box.
 - action or process box.
 - decision box.
- sequence of activities or flow of information is shown by direction of arrows linking the boxes.
13. Hardcopy computer output printed on paper.
14. Hard disk a rigid magnetic disc which is installed in computers to hold data and programmes.
15. Hardware items of equipment which go to make a computer system.
16. LAN Local Area Network. A network of computers in a small area like a building or campus.
17. Micro literally very small. Used as abbreviation for a microcomputer.
18. IBM International Business Machines. This is the world's biggest manufacturer of computers.
19. IBM compatible these are computers (usually PCs) which are compatible to IBM machines.

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20. Modem derived from Modulator/
Demodulator Electronic
component which converts
digital computer signals
into analogue sound
signals and vice versa.
21. Online Situation input and output
systems are directly
connected and ready to
transfer data to or from a
computer.
22. Optical disc A disc (similar to audio
CD) storing data in digital
form. Information is
written and read by a laser.
These discs are usually
written once and read
many times. They are very
good for archival purposes.
23. Peripheral an item of equipment e.g. a
printer that can be
connected to and controlled
by a computer.
24. RAM Random Access Memory.
This is a form of computer
memory which allows any
part of it to be read or
written directly (random).
RAM is mainly the
computer memory. The
size of RAM determines the
capacity of a computer
since it determines the
amount of programme
instructions which can be
stored in the computer.
25. ROM Read Only Memory.
Computer memory which
holds information or data
permanently allowing only
reading but no writing of
additional data.

26. **Software** written program which are used to instruct a computer how to perform various functions.
27. **Time-sharing** a computer system which is used by many people at the same time, that is, they share the time. The user access to the computer (usually a mini or main frame) is through a terminal.
28. **WAN** Wide Area Network. A network of computers spanning a wide area (even continents). Such networks use telecommunications like telephones, satellites, etc.

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INFORMATION SYSTEMS*

CHAPTER V

**PROCESSING AND DOCUMENTING
INFORMATION FOR R&D**

PROCESSING AND DOCUMENTING INFORMATION FOR R&D

Purpose

The purpose of this chapter is to introduce managers to R&D to the principles and methods of identifying, selecting, acquiring and processing information for R&D.

Learning Objectives

By the end of this chapter, participants should be able to:

1. Appreciate the need for organizing information for R&D.
 2. Understand the methods of identifying, selecting and acquiring different types of information for R&D.
 3. Understand methods and techniques for processing of information of R&D.
 4. Discuss procedures for the compilation of certain reference sources for R&D.
 5. Understand different types of information retrieval systems.
 6. Appreciate facilities and environmental conditions for storage and preservation of information for R&D.
 7. Appreciate professional qualifications and skills required for organizing information for R&D.
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PROCESSING AND DOCUMENTING INFORMATION FOR R&D

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CHAPTER V

PROCESSING AND DOCUMENTING INFORMATION FOR R&D

5.1 Introduction

5.101 Over past decades, and especially since World War II, there has been an exponential increase in the production of information. Today, there is so much information in the world that the term Information Explosion has been coined to illustrate this phenomenon. In a study conducted by the Chemical Abstracts Service of the USA, it was concluded that the volume of information doubles every seven years. There are many factors that have contributed to this state of affairs, but one can speculate that Research and Development is one of the major factors.

What other factors do you think have contributed to the growth of information?

5.102 With information for research and development growing at an exponential rate, it is not possible to imagine that managers of R&D can be able to successfully look for the information they require and at the same time find time to carry on with their work. It is not imaginable even for a well established institution to be able to collect all the information needed for its users. However, it is not difficult to envisage the amount of confusion that would reign if all this information was not systematically documented, processed and stored.

5.103 As a result of the sheer volume of information and the need to be able to access that single piece of literature which responds to a user's need, several methodologies and techniques have been evolved and are being used for the

identification, organization and management of information. This chapter, looks at some of these systems without which trying to find a document would be a nightmare. The chapter also discusses several reference sources of information which can be created within an R&DI and the kind of manpower required to operate the information system of an R&DI.

5.2 Identification, Selection and Acquisition of Information for R&D

5.201 Every individual or institution in any field of endeavour has a need for information. These needs can be quantified and articulated in fairly specific ways. Where this is done it is possible to identify particular information to acquire for an R&D institution or indeed for a manager of R&D. In a library or information centre, this process accomplishes the identification, selection and acquisition of information.

Have you ever had to quantify your information needs? What format did you use?

5.202 A library of an R&DI must have a clearly articulated acquisitions policy setting out parameters against which to judge suitability of material being acquired. Such a policy may take into consideration the subject scope of the R&DI, mandate and programme of the R&DI, sharing of information with other R&DIs, availability of equipment for information services and any other factors.

5.203 **Identification:** To guide the identification of materials, library staff make book and journal announcements from publishers available to their patrons. Library tools like the **Ulrich's List of Periodicals**, and **Books in Print** can also be used. In addition, patrons are advised to be on the lookout for important publications listed in References, Bibliographies, Selected Lists for Further Reading etc. of documents they may be using. These lists help in identifying material for acquisition. The titles so identified, augmented by library staff proposals can then be scrutinized to ensure that they do not already exist in the library. The list is then compiled in some order of priority ready for the process of selection. During the process of identification, one should be aware of material published in microform and computer based media e.g. electronic journal.

How do you identify publications intended for acquisition in your RDI?

What criteria would you use in listing of publications requested in order of priority?

5.204 **Selection:** At institutional level, selection of information (or publications) can be done in two ways. Either the library can invite its patrons to suggest what they need, or the library staff can do the selection on basis of knowledge of planned activities. In the latter case, library personnel must consult with the R&DI staff to ensure that the selection would satisfy their needs, get further suggestions and put the selected material in order of priority. Selection of information material is a very important exercise because of the high costs of reading material, inadequate funding for libraries and the need to ensure that the material acquired would be relevant to the programmes of the institution. In most cases, the two methods are used together.

How do you respond to library requests for proposals? Compare and contrast the two methods of selection.

5.205 The various methods of acquiring information for R&D have been briefly mentioned and discussed in Chapter 3, 'Sources of Information for R&D' of this Manual. In this subsection the basic procedures involved in this activity are elaborated.

5.206 **Acquisition:** It may be desirable, at this point in time, to decide which publications will be acquired and which of the methods discussed earlier on will be used. It is advisable that top priority journals, books, abstracts, indexes and reports be purchased if there is doubt about getting them through exchange, donation or otherwise. Once this decision has been made, one should ascertain the possible sources and obtain quotations. When all this has been done, all the information should be passed on to those responsible for the purchase of library materials in the R&D institution.

- **Purchase:** When orders have been placed, the officer-in-charge of acquisition should expect a response within a certain period of time. If this does not happen or if documents start arriving with missing issues, it is important to make immediate follow-up by sending reminders to the suppliers.

When purchasing books, it may be a problem to secure foreign exchange from the local Central Bank for placing orders outside the

country. Usually, the local UNESCO office will be of assistance by accepting the local currency in exchange for UNESCO dollar coupons. Most publishers, booksellers and book agents will accept the coupons as mode of payment. However, it is advisable to confirm with the suppliers before-hand if they would accept UNESCO coupons.

Donations: For documents listed for acquisition as donations or gifts, standard forms are available from the donor agencies which should be completed and submitted. Examples of such donors are the British Council and the Third World Academy of Sciences. Other institutions, however, may simply be contacted with a formal letter requesting a donation.

Exchange: For documents expected to be obtained by other formalized channels, e.g. exchange, one would expect the partners to automatically send the publications. However, it will not do any harm to draw their attention to publications of particular interest to the institution and to publications not received.

In section 3.5 of chapter 3 of this manual, other methods of acquiring information are discussed. They include depository, national focal point and complimentaries. Readers are encouraged to refer to this section. Case study 5.1 demonstrates the use of these methods.

Have you experienced such problems in your country? What do you think should be a long term solution?

Case Study 5.1: ACQUISITION OF LIBRARY COLLECTIONS

The Case

A certain Documentation and Information Centre has among its responsibilities the acquisition of library materials (including books, journals, reports, abstracts, indexes etc.). Like most libraries in the Eastern and Southern African Region, this library has over the last decade been faced with great difficulty. Whereas by 1990 the local currency allocation had increased by nearly thirty times compared to the

1975 levels, purchasing power of this currency had decreased so much that the 1990 allocation could buy only half the library materials compared to 1975. Some of the major factors precipitating this situation were the soaring prices of imported materials, falling prices of exports; falling rate of exchange of the local currency.

In order to alleviate this problem, the Centre has taken some steps to acquire some of its materials through alternative means. First, the Centre has established a strong gift and exchange of publications programme with nearly 120 organizations, both national and international. Under this arrangement, the Centre exchanges its publications for those published by sister organizations elsewhere. In addition, some organizations make a continuous donation of their publications to the Centre.

Second, the Centre is a deposit library and a national focal point of some organizations thereby receiving their publications free of charge. In return, the Centre disseminates the information received to users in the country, and plays the role of liaison office, respectively.

Third, the parent R&DI regularly undertakes research projects funded by donor organizations e.g. IAEA, IDRC, UNDP. In some cases the projects do include a component for the purchase of documents relevant to the project. These materials become property of the R&DI at the end of the project and are deposited in the library.

Fourth, the Centre makes earnest appeals for book donations from such organizations as the British Council, the Third World Academy of Sciences and the American Cultural Centre.

Last, the Centre has a good document delivery system when a particular book, journal article or report is identified by the user. The Centre makes good use of resources of local libraries, reprints from authors and complimentary copies from "kind" organizations. In addition, the Centre makes use of the resources of the British Library Document Supply Centre in the UK and the National Technical Information System of the USA. The Centre keeps British Library coupons and UNESCO coupons for urgent requests.

Points for Discussion

- *What are the disadvantages of acquiring publications by means other than purchase?*
- *What is the experience in your R&DI with the procedures outlined in this case study?*

5.3 Cataloguing and Classification

5.301 As the publications are received by the library, they must be arranged in some logical order. If this is not done, the library staff and their patrons will soon get overwhelmed by volumes and volumes of publications and retrieving a particular book, report etc. will become progressively more and more difficult.

5.302 In earlier days, documents in libraries were arranged by such physical characteristics as colour and size. Obviously, such arrangements would not be very useful to somebody looking for a FAMESA Manual on Scientific, Technical and Management Information Systems or indeed for a book written by J.K. Moolak.

Give limitations of arranging library material by physical characteristics. Can you think of a situation where such an arrangement would work?

5.303 It was, therefore necessary to develop more logical ways of processing documents. As a result of these efforts, various methods of cataloguing and classifying publications were evolved. The following paragraphs briefly discuss the two concepts, cataloguing and classification.

5.304 Chapter 3, 'Sources of Information for R&D', discussed the logical and physical ways of presenting information. In treating documents so that they can be arranged in a sensible way, there are the physical and intellectual approaches to description of documents. These are referred to as cataloguing (physical) and classification (intellectual).

- **Cataloguing:** The process of cataloguing a document is aimed at uniquely identifying that piece of literature as a physical entity. One could say that cataloguing is like giving a descriptive name to a document. There are several parameters that are used to achieve this identification. The major ones are the Title, Name(s) of Author(s), Imprint, Size, Pagination, Illustrations (if present) etc. All this information is presented in a catalogue in a logically ordered sequence. There are rules and guidelines which must be followed in cataloguing documents; the most commonly used being the Anglo-American Cataloguing Rules (AACR).
- **Classification:** Whereas the objective of cataloguing is to identify a document as a unique physical entity, the classification process relates to the intellectual content, i.e. it brings together documents covering similar subject areas. After classifying a document, it will belong to one particular "class" if it is written on a specific subject, or to two or more "classes" if it touches on several subjects.

There are rules and guidelines which must be followed during classification. Examples of standard classification schemes include Library of Congress (LC) and Universal Decimal Classification (UDC). When the subject area(s) of the contents has been determined, the schemes named above, and

many others are used to assign a unique alphanumeric or purely numeric classification number to represent the subject.

To help the Librarian in determining subject areas in a consistent manner, several tools have been developed giving proposed subject headings. Examples are the **Shears List of Subject Headings** and **Medical Subject Headings (MESH)**.

Discuss advantages of classifying information.

5.305 As a general rule, cataloguing and classification are applied in the organization of published books and other monographs.

5.306 Cataloguing and classification can also be done using a computer. An example of this is the use of MARC tapes of the Library of Congress. For each publication, several cards will be generated to indicate title, authorship and subject. A corresponding classification will also be indicated on each card. The cards can then be arranged in alphabetical order in the Library Catalogue, sorted according to the parameters mentioned above. The classification number will be indicated on the actual document using a sticker and the books on shelves arranged in ascending order of these classification numbers.

5.307 **Types of Catalogues:** There are many ways of presenting library catalogues, each presentation denoting a type of catalogue. Major types of catalogues commonly found in libraries and information centres are described in this subsection.

- **Card catalogue:** It consists of stiff cards (12.5 x 7.5 cm) each bearing a single entry of cataloguing. The cards are housed in a special cabinet.
- **Book catalogue:** This type is produced in well bound book form, each page carrying several entries from different documents.
- **Sheaf catalogue:** This is a catalogue of paper slips which are held in loose-leaf binders.

Other types of catalogues that may be found in libraries and information centres are those whose entries are put on microfiche or microfilm and on computer media.

Library catalogues can be classified, i.e., entries sorted according to title, subject, author and any other category. Under each category the entries are arranged in alphabetical order. On the other hand, catalogues can be unified, in which case all entries will be arranged in alphabetical order irrespective of categories.

5.4 Abstracting and Indexing

5.401 The discussion on Cataloguing and Classification has shown that these processes are applied to published types of literature acquired by the Library. Abstracting and Indexing, however, applies to all types of documents as long as they meet the scope of the abstracting journal. The scope is usually a subject area e.g. Tuber crops, or Entomology; Geographical e.g. Zambia or East Africa; or a combination of the two e.g. Agriculture in Malawi or Tropical Agriculture.

5.402 Abstracting and indexing are highly technical activities requiring special communication skills and understanding of the subject matter being treated. Information specialists working at this level must be very highly qualified and preferably have a good subject background. Where such personnel are not available, use must be made of subject specialists in the R&DI.

5.403 The purpose of an abstracting service is not to collect the documents that have been processed; but rather to create a tool which brings together and in a concise form, all publications issued within the pre-determined scope, irrespective of where such publications may be physically located. This concept is called Bibliographic Control.

5.404 An abstracting service is therefore a very important activity for any nation in order to document all its publications. In the next section, abstracting and indexing are shown as one way of

Example of an abstract and example of an index page corresponding to this abstract.

creating an Information Storage and Retrieval System.

5.405 There are many abstracting services that cover information on a worldwide basis. The concern in this manual is the kind of abstracting which may be done for bibliographic control of national information.

5.406 **Abstracting:** Abstracting is the preparation of summaries or extracts of original documents without distortion or interpretation of the original meaning. There are many types of abstracts but the ones most commonly used are the descriptive and informative abstracts.

- In a descriptive abstract, the abstractor simply outlines the major elements of the document, e.g. objectives, method and results. On the other hand, in an informative abstract the abstractor gives more detailed information on the subject matter of the document. The process of abstracting starts with the selection of documents falling within a defined scope.
- A decision must therefore be made on the type of abstract to prepare. In general, long articles, books, reviews and very short articles are processed as descriptive articles; Research reports, chapters of books and more subject specific documents are processed as informative abstracts. Some documents will carry author abstracts. The abstractor must always evaluate these and modify them if necessary.
- The next stage is the preparation of a bibliographic entry of the abstract. This includes the title and author of document; affiliation (where work was done); for journal articles and chapters of a book, the title of the main publication must be given, imprint, volume and issue etc. This information is important for locating the original document. This is then followed by the abstract. At the end of the abstract, it is helpful to indicate the physical location where the original document can be found.

What other types of abstracts are you aware of?

Why should author abstracts be evaluated?

5.407 Indexing: In order to facilitate the location of abstracts, they must be indexed. An index is a list of terms and phrases selected and structured in such a way that they reflect the subject content of the abstract or document being analysed. The entry number or page number corresponding to an indexed item is given against the terms to facilitate its location. This type of index is called the subject index. Other types of indexes include the author index, geographical index, patent index, conference index etc.

- A lot of research has been directed into developing software and techniques through which abstracting and indexing can be done by computer. The process of abstracting using computer has not been very successful. However, there are many computer programmes which can be used to generate indexes (see Case study 5.2).

Case Study 5.2: PRODUCTION OF SCIENTIFIC ABSTRACTS

The Case

The production of the Scientific Abstracts is the major on-going project of a certain Documentation and Information Centre in the region. The project was started in 1976 and endeavours to publish annual volumes of abstracts (and indexes) of publications written on and about the country and by citizens in any given year in the fields of science and technology. The Scientific Abstracts is a very important project in that it brings together the nation's output in science and technology in a concise form. The abstracts may be used for studying trends in science and technology in the country, for locating local input into national research and development projects and for minimizing undesirable duplication of projects.

Every year, staff of the Centre spend at least two months visiting scientific, technical and other libraries and information centres in the country to locate and abstract publications of selected years. An abstract for each document is written on card. The cards are always kept in alphabetical order by title to avoid duplication. Upon completion of the abstracting exercise the abstracts are classified according to major subject categories e.g.: Agriculture, Engineering, Medicine etc. Under each category the abstracts are further classified into subcategories e.g.: Under Agriculture, into Agriculture Generally; Agronomy, Agricultural economics; Plant breeding; Crop protection etc. The major categories are arranged in alphabetical order, each category being followed by its subcategories also in alphabetical order. Under each subcategory, the abstracts are arranged in alphabetical order by title. At this point, the abstracts are given numbers. These are two part numbers including a two digit number for the year of publication and a three digit serial number. Hence numbers of abstracts of documents published in 1990 with serial numbers 8, 25 and 162 would appear as 90-008; 90-025 and 90-162 respectively.

This done, an author index is generated which consists of name of author and abstract numbers attributable to him/her. Then a subject index is generated. Currently a two-stage (i.e. main descriptor and qualifier) index is being used. Abstracts of a general nature have their numbers indicated at the main descriptor while those more specific are at qualifier level.

Obviously some abstracts will be indexed at more than one point. For example if an abstract from an article reviewing the world situation of AIDS is numbered 91-149, it would be indexed as: AIDS 91-149.

However if an article describing the possible treatment of AIDS with KEMRON is number 90-201, it would be indexed as AIDS: Treatment with KEMRON 90-201. In the past, the geographical, conference and workshop indexes were treated as part of the subject index. With the volume under process, the geographic index and the conference and workshop index will be treated as separate indexes. The Centre does not collect documents abstracted for back-up services and depends on the source libraries for document delivery. However, special documents and those almost running out of point are collected or photocopied. The inclusion of information on source of document and availability conditions is being considered. Indexes are free language and pre-coordinated; but extensive consultations are made of various thesauri for each major category: e.g. AGROVOC for Agriculture.

Points for Discussion

How can a countrywide abstracting service be done more economically?

How would you justify starting or sustaining an abstracting journal?

Propose a design for an abstracting journal in your country.

5.408 When assigning index terms information tools called thesauri are used. Thesauri are lists of technical concepts and terminology showing various interrelationships and context in which they must be used. These help to control indexing vocabulary. Examples of thesauri are CAB Thesaurus and AGROVOC in the field of Agriculture. Participants are encouraged to familiarize themselves with thesauri in their fields of activity.

Why is it necessary to control vocabulary?

5.5 Creating Reference Sources for R&D

5.501 Most of the information that has been dealt with so far is that produced by managers of R&D as a result of their activities. In addition to these, however, there are areas where Librarians and Information staff must render services by producing documents. There are several important documents that can enhance the progress and productivity of a manager of R&D which we shall briefly discuss here.

5.502 The reference sources that Library and Information staff must endeavour to create and which are discussed in this section include directories of organizations, directories of experts, directories of current and on-going research, abstracts and bibliographies, and union lists.

5.503 **Directories of Organizations:** This type of directory is very important in R&D activity in that it can be used to enhance cooperation and collaboration at institutional level. Such directories will provide locational and correspondence addresses, objectives and functions, subject scope, current activities and equipment and services of selected organizations.

5.504 **Directories of Experts:** This type of directory is very useful when there is need to identify individuals with special skills or working in areas of R&D of interest to other individuals or institutions. Internal directories of staff in the R&DI can also be compiled showing areas of activity and expertise. Library and information centres can also use these directories in providing managers of R&D listed with information specific to their needs through current awareness and selective dissemination of information services. These directories contain information about the

experts: contact address, subject areas of interest, qualifications and working experience, achievements and publications.

5.505 Directories of Projects: Another directory of great importance to the manager of R&D is that of past and on-going projects. This directory serves a dual purpose i.e. to alert on work being done in order to avoid duplication and/or enhance cooperation and collaboration and to help decision makers in coordinating activities in R&D. These directories provide information on title and objectives of project, executing agency, senior staff, funding, duration and collaborating organizations. Case study 5.3 is an illustration of the processes involved in the creation of this type of directory.

Case Study 5.3:
DOCUMENTATION AND
ORGANIZATION OF
INFORMATION PROGRAMMES
AND PROJECTS FOR RAPID
RETRIEVAL

The Case

In many research institutions, especially in developed countries, a major part of institutional memory on past research is to be found in journals, internal publications, and in the large cadre of scientists who tend to remain active in research for a large part of their lives. In Africa, however, this institutional memory is continually eroded due to frequent movement of staff, failure to publish annual reports and journals and the relatively short time African Scientists remain active in research. One result of deficient institutional and poor communications is unwitting repetition of research or application of research methods already proved inappropriate in past work.

A Council for Science and Technology of a country in this region receives and funds many applications

for short term research each year. The Council also assists the Government in technical assessment of applications from individuals outside research institutions who wish to conduct research. These activities generate at least 300 project proposals a year. The Council therefore decided to establish a Research Registry with the objective of providing rapid retrieval of information on past applications and to facilitate follow up of projects already approved or funded. The research registry started as a collection of files which are opened on each project proposal. These files were also listed by name of researcher, science sector e.g. agriculture, industry etc., and year of application. The files soon filled several filing cabinets and begun to pose serious storage problems. Retrieval of information from these files also became difficult. A supplemental card system was therefore introduced. The essential information in each file including status of the projects was entered on a card. This card system has greatly simplified retrieval of information but has not solved the problem of access to progress reports themselves. The Council has also gone a step further to transfer the information on the cards to a computer system. This facilitates selective listing of projects which can be used by the Research Committees during evaluation of new research proposals.

The main difficulty experienced with the computer system is retention of trained operators who can routinely update the database. It will also be necessary to upgrade the available computer capacity in order to facilitate searching through the entire database. None of the computer software system available could be

installed and used successfully on the PCs available and an in-house programme had to be developed, thus holding up the project for a long time.

Outcome

The Council's Research Registry System has worked reasonably well but is still faced with the problem of handling the files and hard copies of progress reports. Microfilming of information contained in the files and progress reports is a possible but very expensive alternative. The system is nevertheless simple and suitable for small research institutions.

Points for Discussion

Discuss the relative merits of maintaining a registry of hard copies of research information. What elements of data would you consider essential for storage in a computer-based retrieval system? List criteria which could be used to off-load unnecessary information from an overloaded research registry. How could you handle the issue of confidentiality especially where a lengthy referral and approval procedure for each project is necessary or where research results have to be protected?

5.506 Abstracts and Bibliographies: Section 5.4 of this chapter covered the concept of "abstract". A bibliography is basically the same as an abstract only that it does not have a summary of the document. Abstracts and bibliographies are very important to a manager of R&D looking for information reported on R&D activities. This information is particularly important at the planning stage of a project or when writing a state-of-art review.

5.507 Union Lists: Union lists are directories in which information on publications and their locations is published together. Union lists are

therefore very useful to managers of R&D, Librarians and other information workers in locating documents when abstracts or bibliographic information is provided.

5.508 When publications in the list are periodicals, it is called the **Union List of Periodicals**. On the other hand if the list contains books and other monographs it is called the **Union Catalogue**. The information contained in these directories is very important in the sharing of information, and identifying institutional sources of information.

5.509 In principle these directories will contain the titles and abbreviations arranged in alphabetical order, followed by the name of the holding libraries, volumes and issues held in case of periodicals. For books and other monographs, the directory will show the title and author, imprint and a classification number followed by names of holding libraries.

5.510 The process of compiling directories of publications, persons, institutions and projects involves designing of a form which is circulated for completion to libraries and information centres selected to participate. When the forms are returned, they must be studied very carefully for consistency and completeness of information provided. Where necessary follow-ups must be made.

5.511 The information given by all participating centres is then put on cards for each title, person or institution so that all titles can be arranged in alphabetical order. A manuscript is then prepared for the production of the directory. In organizations with computer facilities, the information received can be entered to create databases.

5.6 Information Storage and Retrieval Systems

5.601 In the foregoing sections, discussions have covered the processing and documentation of information using the techniques of cataloguing and classification, abstracting and indexing and

creation of reference sources of information for R&D. The purpose of this otherwise tedious processing and documentation of information is to create systems which would permit keeping information in an orderly manner, both physically and by intellectual content, and to find the information when needed. The systems that are created to do this function are known as Information Storage and Retrieval System. The chapter of this manual dealing with Information Technology reveals that computers are finding wide application in the creation of databases for information storage and retrieval.

5.602 Using the Library Catalogue: When a patron needs information from a book or other monographs, a Library Catalogue is consulted to locate the appropriate titles or name of authors or subjects corresponding to the query. The classification numbers of these documents are used to find the documents in the shelves. If the identified documents are not available in the library, the union catalogue is used to check on other libraries from where the document can be borrowed.

How often have you used a library catalogue? Have you always been able to locate the item you wanted? Why are readers discouraged to return books on shelves?

5.603 Using Abstracts and Bibliographies: When a patron approaches the library or information centre for information the indexes of abstracts and bibliographies are consulted to locate the entry numbers of abstracts corresponding to the queries. If the user is happy with the abstract and bibliographies located, the library is used to locate the information. If a periodical or book etc. is not available in the library, the Union List of Periodicals or Union Catalogue is used to identify other libraries from which the publication may be obtained. As for unpublished (grey) literature, the holding library or source can be identified using locational information given at the end of the abstract.

5.604 Using Other Directories: The directories of experts and organizations are also provided with a subject index, and name and institution indexes, respectively. When these indexes are consulted the entry of the expert or organization can be located in the directory and contact can be initiated.

5.605 Because of the large numbers of documents that have to be dealt with, the overwhelming number of data elements generated during cataloguing and indexing and the complexity of search techniques used to retrieve information, computers have found wide application in the area of information processing, storage and retrieval. This topic is discussed in more detail in Chapter 4, 'Information Technology'.

5.7 Facilities and Environmental Requirements for Storage and Preservation of R&D Information

5.701 The various materials discussed which are used for presenting information all need good care and a conducive environment in order to increase their life span. Remember that if, for example, a book gets lost or damaged it is not only expensive to replace it, but the book may even be out of print! This section discusses some important factors and facilities necessary for good storage and preservation of R&D information.

5.702 Whenever possible, books and important reports must be covered with thin plastic lamination before they are put into circulation. This will protect them from moisture, dirt and dust. Journals, smaller pamphlets and reprints must be kept in pamphlet boxes. On the shelves, all material must be supported by book-holders. These will prevent items from sliding, falling and getting damaged.

5.703 Arrangements must be made to have journals bound from time to time. This way, they become more robust and can last longer. Besides, bound journals are more difficult to steal or pilfer with. In the same vein, books must be constantly checked for wear and tear.

5.704 Arrangements must be made for the restoration of damaged or ageing books on a regular basis. Weeding, in which underutilized, obsolete and duplicate copies are removed from shelves, should be an on-going exercise. The books so removed must be stored properly in a safe place so that they can be accessed easily if need arises.

5.705 A library or information centre must be designed in a way that encourages the flow of controllable natural breeze, enhance use of natural lighting and allows no dust at all. In this way the expensive task of installing air-conditioners and a lot of artificial lighting can be avoided.

5.706 A library or information centre must be free from all types of rodents and insects. They tend to feed on library material and generally destroy them.

5.707 Computers, diskettes, CD-ROMs, microfiche and microfilm readers and other equipment must be well protected from dust, moisture, mould and abnormal fluctuations in temperature. Computers in particular should not be connected directly to the mains supply but should be protected with voltage regulators. Uninterruptible power supplies are also desirable for computers in order to protect against loss of information being processed in case of power failure. Some uninterruptible power supplies come with inbuilt voltage regulators.

5.8 Human Resources Requirements

5.801 Information is a very critical resource for R&D and its handling is a very complicated task. It is therefore important that information personnel are given good formal training, supplemented with special short courses to update them in new developments in information processing and documentation. It is also important to realize and recognize that information personnel are professionals who should be treated on equal footing with their counterparts working, for example, in the laboratories.

5.802 When recruiting personnel, it should be understood that the level and nature of information activities of today and in the future need understanding of the subject matter being dealt with, e.g. abstracting, indexing and literature searching and a good aptitude for computers. It is desirable that staff engaged for information processing have at least, or can be trained to, masters degree in Library or Information Science.

Depending on specific duties assigned, a subject first degree may be desirable otherwise a Library Studies degree would do. Of course other staff will also be needed at lower levels for whom appropriate certificate, diploma or first degree would suffice.

5.803 Lastly, information personnel must be encouraged to learn one or more languages used in R&D. Many times information in these languages is available, but cannot be processed if it cannot be read. They must also be well trained in the application of computers in information work.

How would you argue for a subject specialist to be recruited or trained as an information scientist?

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D :
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER VI

**MANAGEMENT
INFORMATION SYSTEMS**

MANAGEMENT INFORMATION SYSTEMS

Purpose

To familiarize managers of R&D with various types of management information systems, their design and their applications for effective performance of managerial functions.

Training Objectives

By the end of this Chapter, participants should be able to:

1. Appreciate the need for management information systems (MIS) in an R&D institution.
 2. Understand the various types of MIS, their design and applications in enhancing information.
 3. Understand the basic procedures in establishing MIS.
 4. Evaluate MIS in relation to specific R&D settings.
 5. Appreciate potential problems with the outputs of MIS, such as information overload.
 6. Appreciate problems of confidentiality in MIS.
 7. Understand issues relating to maintenance and cost-effectiveness of MIS.
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MANAGEMENT INFORMATION SYSTEMS

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CHAPTER VI

**MANAGEMENT
INFORMATION SYSTEMS**

6.1 Introduction

6.101 Definition of a Management Information

System: There are many definitions of Management Information Systems. The following is however recommended as it incorporates the purposes and relationships between the MIS and its sub-systems.

A Management Information System is	MIS Subsystems
- An integrated user/machine system	- Data, computers, communications models, people
- For providing information	- System output
- To support collective decision making	- MIS, DSS, OR/MS
- In an enterprise	- Framework for Information Systems

The System utilizes

- Computer hardware and software	- Computer systems
- Manual procedures	- Books, Manuals, people
- Models for analysis	- Operation research
- A database	- Computer, communications, people, models

6.102 The objective of MIS is therefore to provide information in form of messages for decision making in planning, implementation and controlling the operations within and interactions between various functions within the organization. In the case of R&D institutions, the functions are the units responsible for research, personnel, finance, supplies, documentation, transport etc., all of which must have their own information sub-systems (see Table 6.1).

Table 6.1. R&D Institution Management Functions and their MIS Sub-Systems

Management Functions	(MIS Sub-Systems)
1. R&D Programmes	Policy formulation Project Planning (proposals) Implementation and Control (progress reports) Evaluation Reports Research Directory
2. Personnel	Staff establishment Personnel Records Staff development administration
3. Finance	Budgeting Accounting Payroll
4. Supplies	Requisitions (demand) Purchasing Receiving Storage (location) Issues Inventory
5. Plant & Equipment	Purchasing Allocation Utilization Maintenance Inventory
6. R&D Information & Documentation	Sources of Information Documentation, (information Directories etc.) Storage and Retrieval Rules and Procedures Dissemination (database on user profiles)
7. Marketing	Publications Public Relations Technologies Extension linkages

6.103 MIS are also expected to ensure that all the sub-systems of MIS are organized and linked in such a way that the top management can have access to up-to-date and accurate information on each of the functions in a timely manner. This organization of sub-systems may be referred to as a process of integration and requires institute-wide planning.

6.104 **Scope of this Chapter:** In modern times, the very mention of the term MIS brings up the subject of computers. It is therefore necessary to point out at this stage that management information systems existed even before invention of computers and that it is not necessary in all situations to have computer facilities in order to have viable and efficient management information systems.

6.105 Computers have, however, been found to improve speed and accuracy in data processing, access to information and programmed decision making, but the decision to introduce computers and choice of both hardware and software fall in the realm of information technology which is discussed in Chapter 5.

6.106 In this Chapter, types of MIS sub-systems, design criteria and their application in some of the functions relevant to R&D management will be discussed. Records management, role of databases and issues relating to organization and management of MIS will also be discussed.

6.2 MIS in R&D Enterprises:

6.201 The main interest in MIS has been in the commercial sector as a means of improving profitability. MIS are, however, increasingly being developed and extended to cover the management of non-profit institutions as a means of improving efficiency in delivery of services.

6.202 Development and application of MIS in R&D enterprises has, however, been rather slow, especially in publicly funded institutions. One reason is that most managers of R&D in public institutions are basically scientists who have been assigned management responsibilities as a means

of promotion with little or no formal training in management techniques. The other reason is the resistance to introduction of new technologies and filling of forms — an activity many scientists consider unnecessary and irrelevant to their functions.

Can you think of other reasons?

6.203 The issue of MIS in R&D can therefore be addressed from three angles — training of R&D managers to appreciate the need for MIS, the various types of MIS and skills needed to operate them, and the motivation of the scientific and other cadres of staff to support and ensure the successful implementation of MIS.

6.204 The processes of planning, organization and implementation of R&D are covered in FAMESA Manuals "Strategic and Project Planning and Budgeting", "R&D Institute Facilities and Materials Management" and "Project Planning, Monitoring and Control".

In this Manual, emphasis is placed on systems which could be established in R&D institutions to facilitate acquisition, updating and use of information which is the basic ingredient of the R&D enterprise.

6.205 As was noted in previous FAMESA Manuals, the three pillars which support good quality R&D are Technical performance, Schedule performance and Cost performance. MIS in R&D institutions must therefore provide the manager with simple, accurate and timely information for planning, monitoring and control in all three areas.

6.3 Types of MIS and their Applications in R&DI Functions

6.301 The main management functions common to all R&D institutions have been listed in Table 6.1. To these, one can add functions which are peculiar to particular R&D activities such as Farm Management or Patient Management in the case of Agricultural and Medical R&D respectively.

6.302 For the purposes of this Manual it is not possible or even desirable to treat in detail the documentation necessary for each of the function's

management sub-systems. The following sections therefore describe the basic information a manager of R&D institution needs in order to guide development of key components of MIS and the integrated system.

(a) R&D Programme Management Information Systems:

6.303 There are essentially five steps in the management of R&D activities:

- (i) Definition of the problems and hence the objectives to be achieved through R&D. Priorities are assigned at this stage.
- (ii) Development of an institute-wide programme budget stating the activities to be carried out, their time schedule, the methods to be used, outputs expected and resources required.
- (iii) Implementation, which requires allocation of resources and authorization for their use.
- (iv) Monitoring of progress at given intervals and adjustment of work plans if found necessary. A project can be terminated if objectives appear to be unachievable, or suspended if resources become sub-optimal.
- (v) Evaluation of the outcome of the project including strategies for utilization of results.

Each of these steps requires not only maintenance of records, but also processing of data and access to resultant information in a timely manner. The researcher requires timely authorization and feedback from the management while the latter must be kept informed through progress reports.

6.304 **Characteristics of Programme MIS:** Without going into details of the actual information needed (see Chapter 2), we will

consider here some of the characteristics of a good programme management information system.

- **Precise and timely information:** Apart from the inter-personal communication between the researcher and the management which should be given high priority, the main source of information for the management is contained in periodic progress reports. These should be provided on time and in a form that can be absorbed easily by the management. Progress reports should therefore be brief and a standard format should be developed to ensure both uniformity and adequate coverage.

A progress report should not exceed 3 pages and if it has to be lengthy, it must incorporate an executive summary. The following features should be prominent in progress reports:

- Title of the project (including code number if allocated).
 - Name of Principal Researcher.
 - Date started and programmed date of completion.
 - Period covered by the report.
 - Achievements to date.
 - Problems encountered — methodological, resources etc. and suggested solutions.
 - Revised work plan if necessary.
 - Financial statement showing expenditure against various budgeting items, commitments and balances.
 - Endorsement by both the researcher and immediate supervisor.
- **Adequate Feedback:** Of equal importance is the reaction or feedback from the management. This may be greatly facilitated

by inclusion, in the progress report format, of a section which is to be completed by the management. If the report is submitted in two copies and one of the copies returns to the researcher, then the information circle is completed and the usual frustration arising from lack of management response is avoided.

- Progress reports are not only a means for monitoring and control, they are also invaluable in tracing back problems which may arise towards the end of a research programme and in compiling annual report of the institution's activities. A storage and retrieval system (information management) is therefore essential and once implemented major changes should be avoided.
- A simple but convenient method is to file all progress reports in a single system which allows all information relating to a particular project or programme to be located together. A directory to the system can therefore be designed to provide information at a glance on the timeliness of progress reports and the current status of implementation of each project.
- Scientific R&D is highly competitive and leakage of R&D information to unauthorized parties can be damaging to both the researcher and the institution. Coding of project titles and project data is possible but calls for a high degree of accuracy in documentation to avoid mix-ups. It is rare for such measures to be necessary in a public RDI.

(b) Human Resources Information Systems:

6.305 In his paper entitled "Management of an Agricultural Research Institution", Dr J.L. Nickel, who is a renowned scientist and research manager, considers that the most important single component of research management is "the art of managing scientists". Studies have also shown that the most important and most costly input in any R&D effort is manpower. The R&D manager

should therefore have in place MIS which facilitate not only recruitment of personnel best suited to the institute mandate, objectives and programmes, but also for monitoring their performance and professional growth.

6.306 The main components of human resource MIS are — Staff Establishment, Personnel records and Staff Lists.

- **Staff Establishment:** The first requirement in a human resources information system is a database usually referred to as the authorized Staff Establishment. This database lists all the major functions within the institute and assigns the numbers and cadres of personnel required to perform each function. The database should also include qualifications requirement, job descriptions, salary scales, unfilled vacancies (for each of the cadres) and the total remuneration of all staff in post within each function.

This database is so vital that the MIS should be designed to ensure that changes cannot be effected without the necessary reference to and automatic updating of the database. Deficiencies in this part of the information system are frequently exploited by unscrupulous staff resulting in over-expenditure due to over-establishment and distortion of resources allocation to various functions of the organization.

It is generally recommended that in R&D institutions personnel costs should be in the range of 40–60% of total operating budget, depending on the nature of the research. For example agricultural research requiring intensive field work would require a higher proportion of personnel expenses than capital intensive laboratory-based research.

- **Personnel Records:** Since the most important resource within R&D is personnel, the R&D manager needs to know the staff, their capabilities and training needs. Although in a small organization it is possible for the manager to know all the staff

at personal level, this is not possible in most R&D institutions. In any case it is highly desirable to have a system which helps new managers to get acquainted with the staff and their capabilities as soon as possible.

It is therefore important to maintain detailed information on each employee in what is commonly known as personnel records. The simplest method is to create a file for each person which contains the usual passport data i.e., Names in full, date of birth, nationality, marital status, as well as documents such as letter of application, copies of academic certificates, letters of reference, appointment, promotion, commendation or discipline and record of training undertaken. In the case of scientific staff, it is also important to include in this file a statement on principal research copies or summaries of all publications authored by the employee and descriptions of any discoveries or inventions made. Copies of the employee's performance appraisal records should also be in this file.

In view of confidentiality of some of the information, it is usually necessary to maintain two files one of which is kept in a secure place and is only accessible by the top management. In order to ensure uniqueness of personnel identity, it is necessary to assign a personal number to each employee. This number should appear on all administrative and financial documents relating to the employee and should not be changed.

- **Staff Lists:** A selection of data in the personnel files is often used to create a staff list. This is a visual display facility which enables the manager to tell at a glance who is working in which function and in what capacity. As is the case with establishment database, MIS should ensure that a new list is created every time changes occur in staff, their designations or deployment.
- **Staff Development:** This is often a neglected aspect of MIS. Managers of R&D however should establish an information system from

which the training requirements of each permanent employee can be readily assessed. The same system should carry information on training opportunities, entry requirements, details of courses offered and the cost.

Exercise: Draw a chart showing the main functions in your organization. How does inclusion of names of staff help you and other managers in the organization?

(c) **Financial Information Systems:**

6.307 One of the most controversial subjects and source of misunderstanding between management and scientific staff in R&D institutions is **delegation of responsibility for, and control of financial resources**. However, the only way managers can delegate financial responsibilities and still maintain control and accountability is through establishment of simple but **reliable financial information systems**.

6.308 The main elements of a financial information system are:

- Programme Budget — allocation of funds to individual programmes or functions
- Release of funds (authority to incur expenditure) to the functional units
- Rules governing expenditure including systems of expenditure approval
- Accounting and reporting

6.309 Let us consider what happens in some of the public R&D institutions in the African region:

- (i) The function unit is invited to submit to the Management proposals for activities in the coming year and a fairly detailed costing of the activities proposed.
- (ii) The R&D manager aggregates all the projects (existing and proposed) and their costs and prepares the institute's budget. The proposals must be reviewed by an internal committee and priorities assigned.
- (iii) The budget is submitted to the funding agencies, including the government, for approval and allocation of funds.
- (iv) The institute director apportions available funds among projects, often with emphasis on securing continuity of ongoing activities. Internal debate is usually avoided during this process.
- (v) The allocation of funds is then released to the function units and authority to incur

expenditure, is issued together with the rules of expenditure. There is usually no guidance given on the research projects to be supported, consequently the funds are distributed thinly to keep all activities going.

- (vi) R&D units submit their orders for materials and equipment to the procurement unit. Specifications have to be exact.
- (vii) The procurement unit checks on availability of funds and proceeds with procurement or tendering depending on the operational rules. Funds are committed.
- (viii) Invoices are checked and passed for payment.
- (ix) The items purchased are entered in supplies inventory.
- (x) Items are released with "issue note" to the source of requisition.

Step (i)–(v) usually occupy the last three and the first two months of the financial year. Steps (vi) to (x) are repeated each time a new item or service is required at the programme level. Time intervals of 1–3 months between requisition and procurement of materials and equipment are not uncommon, leaving the scientist with very limited time in which to accomplish the targets set for the year.

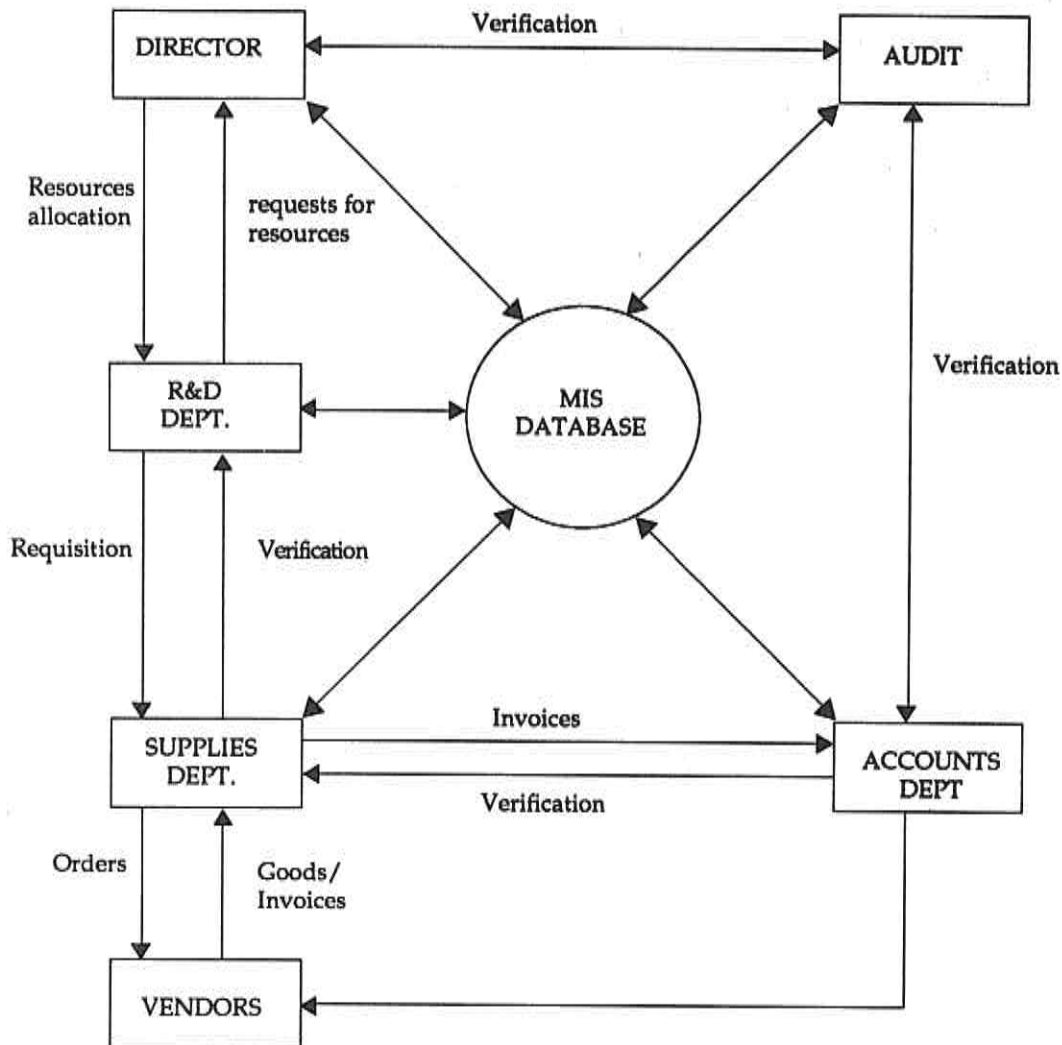
6.310 Although the programme budget cycle can be increased somewhat through a forward budget system, little progress has been made in finding expenditure control systems which combine the high degree of flexibility required in execution of R&D activities with the equally high degree of financial accountability expected of managers.

However, experience in some R&D institutions in the region shows that demands from scientists become more realistic and financial control at project level improves once the financial management system allows all concerned to participate in allocation of resources and provides timely information to all concerned on trends in expenditure and availability of funds.

One way of facilitating this interaction and access to information is to create a centralized database for the MIS subsystem (see Fig. 6.1). If the MIS is computerized, the managers in charge of various functions can access the database directly through computer terminals.

Exercise: Which of the ten steps take most time in your organization? Do you think the solution proposed in para. 6.310 would work in your RDI?

Fig. 6.1. RDI/MIS Acquisition of Materials: Advantages of a Centralized Database

**(d) Material Resources Information Systems:****6.311 Material Resources Information**

Requirements: Material resources in R&D institutions can be divided into the following categories:

- Land and buildings.
- Fixed plant and equipment: e.g. cold rooms, stand-by power generators, borehole water pumps etc.
- Movable plant and equipment: e.g. motor vehicles, laboratory equipment, computers etc.
- Consumable supplies: e.g. laboratory glassware, chemicals, stationery, spare parts etc.

Each of these categories of resources requires careful documentation and establishment of information systems which prompt managers to check and update the status (quantity, location, condition, adequacy etc).

In the case of plant and equipment and also buildings, the main concern of management is the degree of utilization, current state and cost of maintenance and schedules for additions or replacement. The latter is particularly important since the costs involved are high and have to be budgeted for on a long term basis.

6.312 Information Storage: The conventional methods of storing information on material resources is creation of registers, ledgers and cards for each category and type of material. A register or ledger entry would contain information on type of material, Serial Number or Part Number in the case of plant and equipment, date of purchase, purchase price, supplier and location. A supplementary card system facilitates recording of more detailed information on frequency and cost of repairs and maintenance.

Consumable supplies are documented centrally in a card system at the point of issue. A stock card is maintained on each type of material showing input through purchase, issues to the points of use, remaining balances and location within the store.

Ledger and card systems are supplemented by files in which legal documents such as supply and maintenance contracts are kept.

6.313 Information Retrieval: Although ledger and card systems are usually sufficient for a small organization, retrieval of information from such systems can be a lengthy process in a large enterprise. This type of system is also not easily amenable to continuous monitoring and deficiencies can go unnoticed for a long time until a major breakdown occurs. Computer-based materials management information systems are therefore increasingly gaining acceptance. The information held in such systems can be easily and selectively retrieved according to the needs of management and time factors can also be built-in

to prompt management to take the necessary corrective actions.

Another advantage of computerized systems is that they can be so designed to enable managers to obtain information directly through computer workstations in their offices. It is also much easier through computerized systems to integrate records of material resources available in various sub-centres and thus enable the manager to re-allocate resources to minimize idle capacity.

(e) R&D Information, Documentation and Marketing Information Systems:

6.314 Information Systems for these functions are discussed in Chapters 3, 5, 7 and 8 of this Manual.

6.4 Design and Implementation of MIS

6.401 Design and implementation of MIS requires at least three stages.

- Documentation and review of system goals, scope and the approach to be taken in solving management information problems. Only about a quarter of expenses of MIS are incurred at this stage and management should be able to decide whether or not to go ahead with the system before too much funds are committed.
- Physical design stage involving system design, and development of both programmes and procedures.
- Implementation. This should only proceed after both the management and all senior staff concerned are happy with the plans. The following issues should be clear to all concerned:
 - (i) the purpose of the system.
 - (ii) importance of the problems to be solved.
 - (iii) the way MIS will be used.
 - (iv) expected impact on the organization.

(v) criteria for evaluation of the system.

(a) **Criteria for Design of MIS for R&D:**

6.402 The starting point in the design of MIS is the Management System itself. An adequate management system includes a clear statement of objectives, organization structure, planning and control procedures, and other social environmental sub-systems, all of which go to make the "culture" or "personality" of the institution.

MIS cannot by themselves improve the management systems but should enable whatever management style or system in place to achieve its objectives. There is therefore no standard MIS to suit all management systems but there are basic criteria which should be considered and quantified in design of an MIS.

6.403 Every MIS and its sub-systems comprises three components:

Input	-	Basic data, materials, requisition for supplies or information.
Processing	-	Evaluation of requests. Use of stored data, knowledge, laid out procedures etc. to determine response.
Output	-	Messages in form of processed data, conclusions, status reports etc.

One can easily envisage the situation where outputs of one sub-system become inputs of another and the whole enterprise can then be reduced to a chain of inputs, processing and messages. The main business of MIS is therefore to enhance quality and relevance of outputs which must meet the information needs of management at every stage of decision making as well as the rate of information flow and hence timeliness of management decisions.

Figure 6.2 gives an example of this process in the case of R&D Programmes.

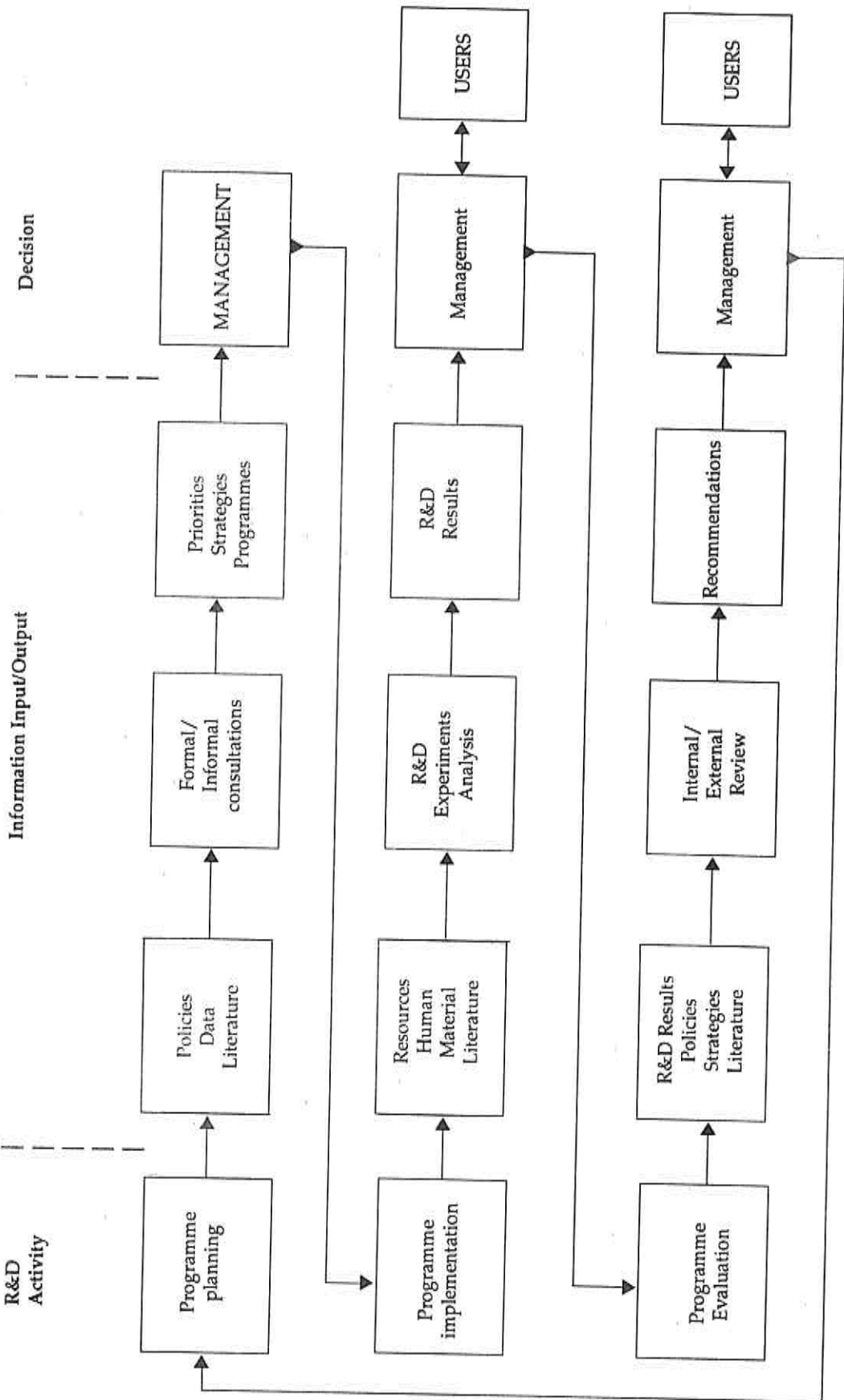


Fig. 6.2. Information Flow and Decision-Making in R&D Programmes

(b) **Utilization and Security of MIS Databases:**

6.404 It is too easy to create an MIS Database which nobody uses. One reason for such a situation is lack of skills and motivation in the managers of R&D to access the database. It is therefore recommended that in-house training seminars be organized to familiarize the R&D managers with the MIS databases established in the institution and how to access them.

6.405 Although access to information should be simplified as much as possible, databases can be misused or interfered with. It is therefore important to classify access to the information on a "need-to-know" basis and to ensure that only a few individuals can enter information in the database.

Exercise: Discuss ways in which databases can be misused. Elaborate on the "need to know" concept and its relevance to security of information.

6.406 It is therefore necessary for the design of MIS to start with careful documentation of user needs at all levels. Unfortunately most people, including managers, find it difficult to state in precise terms what their needs are as far as information is concerned. R&D managers best know the job of managing, not of systems design. Cooperation with a professional systems designer is therefore essential, especially in the difficult task of separating needs from wants.

This is done by analysing objectively the functions of a particular office or management unit and establishing a list of information needs in terms of quantity, quality and frequency. The result is a Systems Analysis which helps to establish the information sub-systems required, the nature and sources of their inputs, procedures and capacity for processing and storage, the nature of outputs and linkages with other systems.

It is important in the design process to ensure that the perceived needs reflect the collective wisdom of experienced managers within the organization, rather than those of an individual even if he/she may be the director of the institution.

During this process of consultation, the managers should understand how and why the proposed system works. With this knowledge, managers should be able to develop the necessary **faith** in the system. **Without this faith, no system, however efficient, will be able to make any impact on the organization.**

6.407 **Human Factors:** Design and implementation of MIS must also take into account the human factors in the organization. It may be easier to look at these factors in terms of the ultimate function of MIS — that is information flow.

6.408 MIS generates messages which have to be routed or directed to recipients. During this process, several things happen.

- Messages are **selectively distributed**. This is usually to be encouraged since it prevents information overload at various points within the organization.
- The messages may be **summarized** for the same reason. When this is done properly, the essential information is not lost. Examples are executive summaries of bulky reports, summaries of conclusions and recommendations, abstracts etc.
- The messages may be modified — even distorted — to suit personal or sectoral

purposes. An example of such modification is when a section head edits a technical report in order to highlight only the successes that will please the superiors or to conceal administrative inefficiency including financial losses.

- The messages may be delayed as a result of workload or intentionally to ensure that they are received in favourable circumstances.

It is the responsibility of the management to ensure that MIS addresses these issues and consider especially the interaction of MIS with various aspects of the management system and organization structure.

The system for routing of messages, for example, determines the location of information and is affected by the cost of communication, workload in the sending unit and relative power and status of the sender and receiver.

Management should also recognize that frequency of communication — verbal or written — is bound to diminish with geographical separation of the communicating units.

6.409 Use of Models: Before a manager decides to instal or change MIS, there are a number of questions which need to be answered regarding performance of existing and expectation on the proposed new systems. For example one would need to know the capacity of the system to store and retrieve information i.e. speed of response, its reliability, response to changes of input etc. One way in which characteristics can be visualized is by constructing a model of the system.

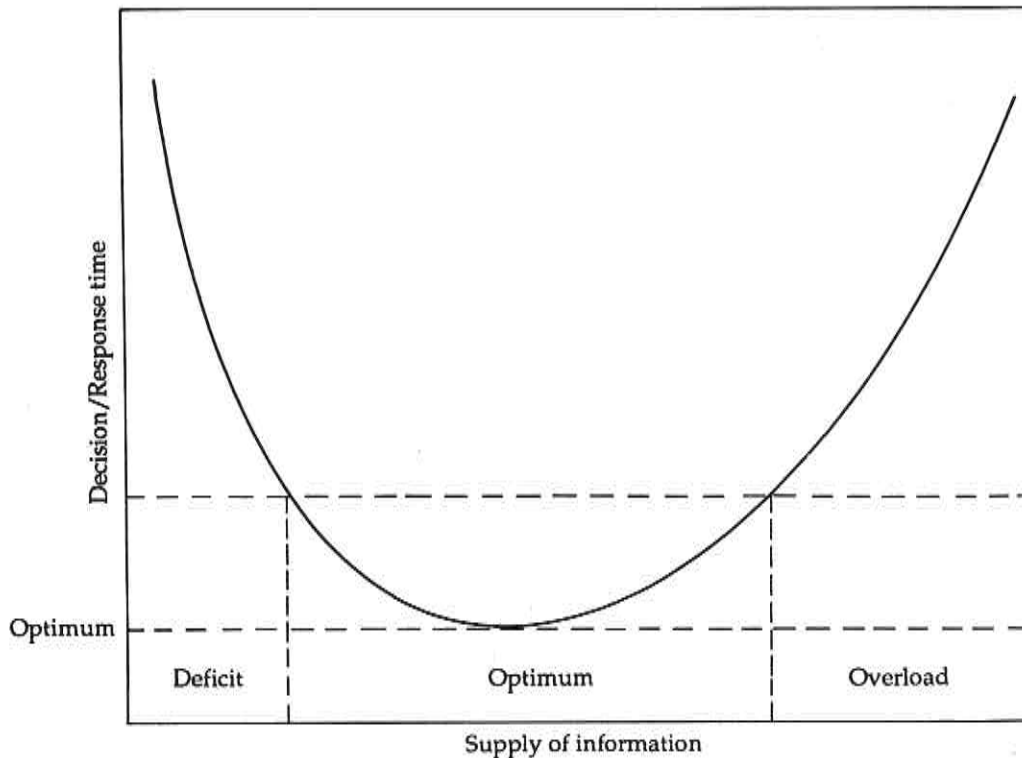
The model can take the form of a diagram comprising boxes which represent processing or storage/transfer functions and connecting lines which show the direction of information flow and feedback. The extremities of such a diagram would show the inputs and final outputs. Using such a model, a manager can see easily the number of links between input and output and hence be able to assess the advantages and potential problems in the operation of the system.

Exercise: Draw a block diagram showing all the steps a research project proposal has to go through before final approval in your organization.

6.410 Information Overload: This is a situation where information generated exceeds the capacity of the management to respond with appropriate management decisions. A common example in R&D is the requirement by managers for progress reports at short intervals. Eventually such reports become repetitive, and the management loses interest or is unable to respond to them in a proper manner. The unread reports are then filed away and forgotten to the disappointment of the scientists, who respond by ceasing to produce the reports.

Delays in decision making can also be caused by lack of information. The two effects are shown diagrammatically in Fig. 6.3.

Fig. 6.3. Information Deficiency and Overload



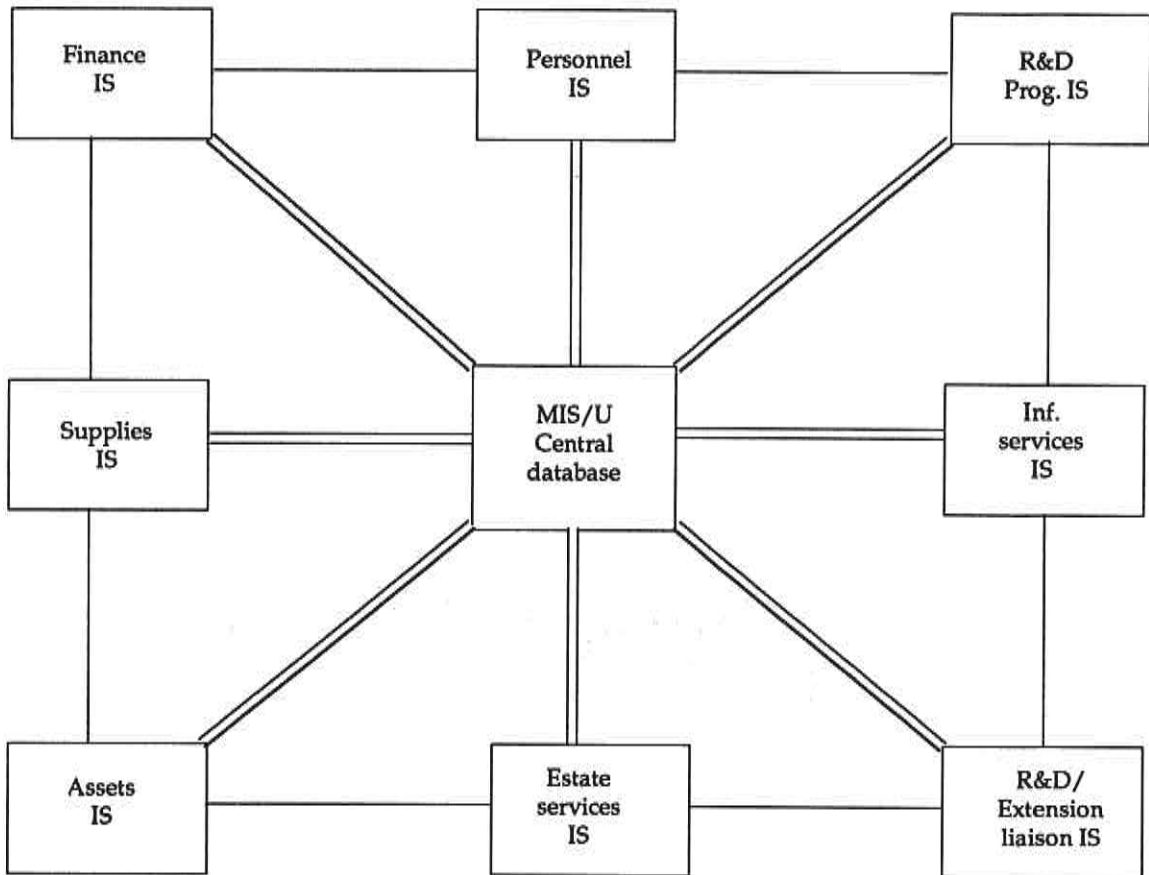
N.B.: The shape and critical points on the above curve will vary according to the nature of the problem requiring decision and the risks and delays which can be tolerated.

In many situations where a manager lacks information (situation on the left hand side of Fig. 6.3), there is strong temptation to take decisions quickly. Such decisions may prove wrong when relevant information becomes available but the damage would already have been done.

Problems of information overload can be avoided through a careful analysis of information needs and design of MIS output to match absorptive capacity.

The information system can also become overloaded due to the natural inclination of people to "hoard" duplicate information, especially that relating to their jobs. Managers also have a tendency to duplicate records or files due to insufficient appreciation of costs involved.

Fig. 6.4 Linkages in Integrated Information Systems within RDI



KEY:
 — Communication linkages
 = Communication and control linkages
 IS Management Information Subsystem

Design of MIS should therefore include specifications on number of copies of reports etc., which would normally be required for each type of output. Integration of the various information sub-systems through a centralized database could also alleviate this problem (see Fig. 6.4). The essential elements of the Function Sub-Systems (IS) are described in section 6.3.

6.411 Implementation of MIS: Like all other activities within an institution, introduction of MIS, however well designed, has to be planned. It is rare for an organization to start from scratch with fully designed MIS. Most institutions grow slowly and often change some of their original

Exercise: Human beings receive in normal life more information than they need or can use. Information overload is however unusual since psychological processes are used to filter out undesired or irrelevant information. Can you think of measures which can be incorporated in MIS to effect similar filtering of information?

objectives in the course of time. Changes have therefore to be made in various aspects of MIS in order to keep pace with management needs as well as changes in technology.

6.412 It is important that MIS changes be introduced in stages, e.g.

- Pilot trial covering say one unit in a department.
- Full-scale trial covering all departments involved in one major function e.g. Accounts. The new system is operated alongside the existing one and all concerned have a chance to evaluate advantages and to absorb the new techniques.
- Replacement of the original system.

6.413 Each of these stages has to be carefully planned and sufficient time allowed to ensure that the system can cope with all likely demands on it and that the various supporting facilities and personnel are in place. It is normal to allow a period of at least six months for the first stage and a complete financial year for the other two stages, depending on the complexity of the organization.

6.5 Records Management

6.501 Just as the quality of information depends on the quality of data used, the value of MIS depends on the organization and management of records. There are different procedures for handling various types of records, data and documents within R&D institutions. Some of these are described briefly in the following paragraphs.

(a) Legal Documents:

6.502 Legal documents within R&D organizations comprise Charters of Establishment, Contractual agreements e.g. insurances, investments, supply/disposal agreements, employment contracts, research contracts etc. These documents need to be stored in safe and secure environments but should be accessible to all levels of management when need arises.

Legal documents cannot be computerized, but can be easily and selectively copied and distributed within the organization in microfiche form. A major requirement is, however, a frequently updated directory of all such documents.

Another type of legal documents comprise records of financial transaction. There are accounting rules and procedures which determine the type of information to be recorded and national laws governing the periods such documents have to be preserved.

(b) Policy Documents:

6.503 These comprise statements of the organization's mandate, objectives and long-term strategies. Also included are organizational policies which are translated into operational rules

covering the various functions within the organization. This information is extracted and distributed in various formats e.g. publicity brochures, staff circulars depending on the intended target audience or users.

(c) **Board Minutes:**

6.504 Board Minutes provide the basic authority for many actions taken, or to be taken, by the management. These documents therefore come under the purview of classified information which, like legal documents, has to be kept in a safe and secure environment. Board minutes also provide an invaluable record of the history of the organization. MIS should ensure that once Board Minutes are confirmed, changes cannot be effected.

(d) **Registry Filing System:**

6.505 The Registry is a vital link in the organization's management information system. It is through the registry that most management documents are stored in files and retrieved when need arises. Misfiled information is usually irretrievable. It is therefore important that registry responsibilities are rated highly within the organization and that registry staff be well trained.

The main function in a registry is to segregate information into discrete subjects and to ensure that the information can be retrieved easily using the same subject heads. In R&D institutions there are numerous topics under which information can be stored.

In addition to administrative registries, there are research registries and even personal registries where individual scientists maintain temporary files holding data at various stages of analysis.

6.506 It is therefore usual to find a large number of filing systems within an organization. The systems also keep expanding to accommodate new subjects until eventually location of information becomes a lengthy and tedious process. Some of these problems can, however, be avoided by involving the technical departments in the design of the institute's registry or filing system.

6.507 The ideal situation is to create a limited number of very distinct sectors in a filing system. Sections and sub-sections of each sector can then be created with open-ended classification so that new files can be opened without disturbing or overlapping the overall system.

Table 6.2. Example of Classification and Coding of a Sector in Filing System

Classification Topic Code	
Main head	Maize Research 1
Subhead (1)	Maize Breeding 1.1
Subject (1)	Dwarf maize variety 1.1.1
Subject (2)	Coast composite variety 1.1.2
Subhead (2)	Maize Agronomy 1.2
Subject (1)	Plant population 1.2.1
Subject (2)	Intercropping 1.2.2

Individual projects and even experiments can then be given numbers such as:

1.1.1.1 Breeding of Dwarf Varieties of Maize for High Altitude Areas.

1.1.1.1.1 Trials of Dwarf Maize Varieties in Mt. Kenya Region.

Using such a system, it is possible to integrate the entire filing system up to the research unit level and to harmonize this with the programme budget, resource allocation and numbering of reports.

Exercise: Describe the registry filing system in use in your institution. What does the registry system say about opening and closing of files? Develop a scheme to expand the system to cover other files in functional departments or units.

6.508 A registry or filing system is incomplete without a comprehensive directory. Further information regarding location of the files, closed volumes etc. can be included in the directory. Computerization of the registry directory would facilitate inclusion of new files as they are created and production of directories of research projects, location of experiments etc.

6.509 The value of a filing system, however sophisticated, depends on the accuracy and speed with which documents are assigned to appropriate subjects and filed. File directories and rules for creating new files should therefore be basic tools for any person responsible for technical or administrative functions within the organization.

(e) **Archival Documents:**

6.510 All institutions generate a lot of documents which in the course of time accumulate and present serious storage and retrieval problems. Some of these documents remain useful but others should be discarded. National laws and regulations usually specify the minimum period financial and personnel records should be preserved, as well as which type of documents should be deposited in the national archives. R&DI managers should nevertheless establish procedures for assessing retention value of other documents such as raw data, reports and administrative documents. The selected documents could then be converted to microform which takes little space and filed in the institution's documentation centre or archives.

(f) **MIS Databases:**

6.511 **Characteristics of a Database:** A database is defined as a centrally controlled, integrated collection of logically organized data. It is the heart of every MIS and decisions must be made as early as possible regarding the type of databases to be established and their management systems.

In most organizations, data are organized around and within individual functions. Responsibility for design, quality control and management of the data is left to the office in charge of the function concerned. Thus the Personnel Officer or the

director may determine the personnel data required to meet management information needs, the format in which the data are to be collected and stored, procedures for updating the records, the person to be responsible for maintenance of the records and the rules of access to the data. Such collections of data may not qualify to be called databases but may be quite adequate for manually operated systems in a small organization.

6.512 The need for integration of data into databases increases as the organization grows in size and complexity, e.g. when staff numbers exceed certain levels or the institute programmes are decentralized in geographically separated research centres, a database at the headquarters becomes essential. It is also at this stage that computer-technology becomes cost-effective as a means of managing both the databases and the MIS.

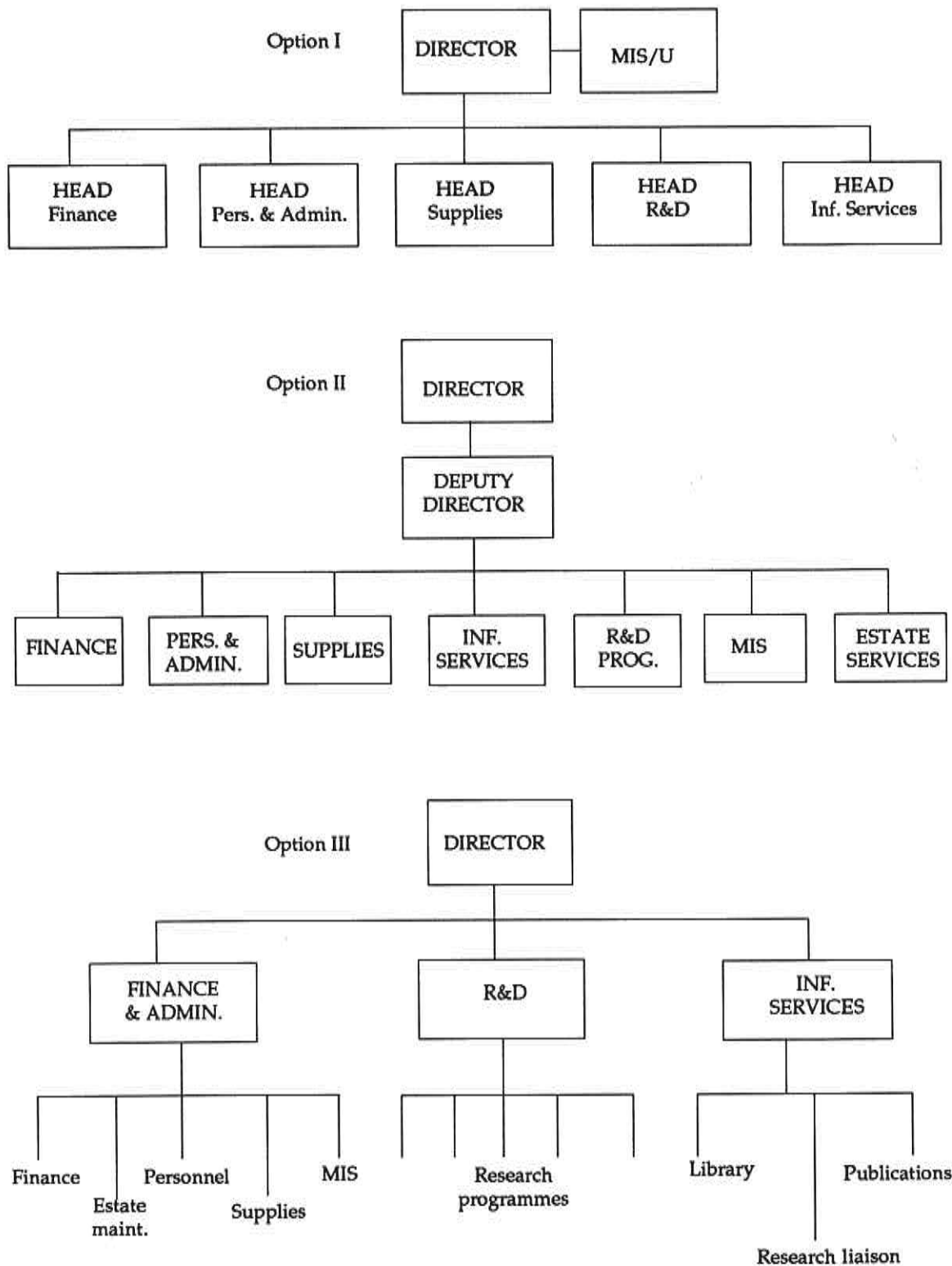
6.513 **Database Management Systems (DBMS):** Every database must have a well designed management system with the following features:

- (a) Computer technology has to be introduced.
- (b) There must be at least one person who "owns" and is responsible for the database.
- (c) There must be rules and procedures which define and govern interactions among elements of a database viz
 - database input/output
 - access to database and its contents
 - the database itself.

Responsibility for databases is usually assigned to the MIS Unit. In order to give the unit sufficient authority, the unit could be attached, at least initially, to the director's office.

As the organization grows, the MIS Unit should however, be established as an independent function at par with the other major functions such as finance, personnel, R&D Programmes, etc. Figure 6.5 shows three options for location of MIS Unit within RDI.

Fig. 6.5. Location of MIS Unit in RDI



Exercise: Which option best describes your own institution? What are the implications of location on the MIS Unit? Rank the options in order of preference, giving your reasons.

Exercise: Draw an organization chart of your institution showing the most appropriate location of a centralized DBM unit and its lines of communication with the other function units.

6.6 Issues for Consideration in the Management of MIS

(a) Policy Issues:

6.601 Management Policies: Every organization must have certain management policies which include rules and procedures covering acquisition and handling of information. There are two extremes: On the one end is the strictly hierarchical system where management authority is highly centralized at the top and only the information necessary for the execution of functions is made available to other staff. On the other extreme is the "horizontal" system where all senior staff participate in some way in most decision-making.

The first decision the top management of R&D institute must make as a matter of policy is the management system it wishes to adopt. Experience shows that R&D institutions require reasonably "open" management systems which promote sharing of information, and hence a high degree of collective responsibility.

There are also better chances in open systems that the scientific and technical staff will identify more with the overall goals of the organization. The management system chosen will influence the type of MIS required to facilitate management decisions.

6.602 Organization for Management of MIS: Another major policy issue concerns the organization for management of MIS itself. As we have seen earlier, MIS implies a high degree of integration of various systems. Since the top manager is unlikely to have the skills or the time to design, implement and monitor the MIS, these functions are assigned either to external consultants or a special MIS department is created within the organization.

There are advantages and disadvantages in either of the two methods. External consultants may be cheaper in the long run and skill requirements can be adjusted to actual needs, but they have limited opportunity and motivation to understand the

What other aspects of management influence collective responsibility?

human environment within the organization, a factor which is often critical in the success of MIS.

If MIS unit or department is preferred, it is necessary to evolve management policies and procedures at the outset which effectively integrate the MIS unit with all the other functions of the organization. If this is not done, the MIS unit will be considered an impediment rather than a facilitator in the organization and its influence will be marginalized.

Exercise: Discuss the possible use of Statistics or Biometrics Unit as a management system for MIS.

6.603 Computerization of MIS: The introduction or conversion to computer-based MIS in an organization is a major policy issue since it has both financial and social implications of a long term nature. Introduction of computer technology may be seen by the management as a means of improving efficiency, but the staff may feel threatened with redundancy and loss of authority which is normally associated with possession and control of information.

Thus within an R&D institution, scientists may welcome or even press strongly for computerization of research information systems while the personnel, finance, supplies, and other administrative functions may be strongly opposed to computerization.

Similar differences may also occur among functions within the administrative system, making the integration of various information sub-systems within MIS difficult or even impossible.

Exercise: Why would some administrative departments be opposed to computerization of their information sub-systems?

**Case 6.1: INTRODUCTION OF A
NEW MANAGEMENT
INFORMATION SYSTEM IN A
PUBLIC R&D INSTITUTION**

The Case

Management of resources within R&D can be greatly facilitated if these resources are closely tied to the R&D programmes and projects. The major challenges in establishing MIS for R&D are therefore the determination of research priorities, inventory of all resources and allocation of resources in accordance with a detailed programme budget and work plans.

A national research institution within the region embarked on a programme of reorganization in order to harmonize the resources available with the large number of research programmes and projects initiated by scientists over a long period of time. In this process, the institution management discovered that the number of programmes had to be drastically reduced and that more than half the scientists and technicians required lengthy formal training in order to improve their capacity for leadership and produc-

tivity in research.

However, in spite of large expenditure of time and effort, the Management Information System in place proved totally inadequate to provide the necessary information for objective decision making. Consequently little progress was being made in determination of research priorities, work plans and training requirements. Staff morale suffered and the enthusiasm of donors who were at the beginning prepared to provide large inputs of research funds, equipment and training fellowships started to diminish. A decision was therefore made to overhaul the MIS and to provide short-term training for managers and other staff to operate the new system. Introduction of computers was limited to only two areas — Accounts and Assets; Payroll and Personnel. The institution had also to use the services of a firm of management consultants to design and install the new MIS and to train staff.

Although the new system took about three years to design, install and bring into operation, the results were outstanding. The institution was, for the first time, able to bring all its accounting, assets and personnel information up to date and in a form that permits easy access and summarization. The management is also more able to use the resulting as well as external databases to determine the potential cost/benefit of each of the research programmes, and hence to rank all research programmes and projects in order of priority at institutional and programme levels. From this information, the reporting system could be brought up-to-date and

programme budgets more realistically attuned to available resources. The confidence of donors was also restored and assistance resumed for both research and development programmes.

Points to Note

Experience from this case study confirms the critical need for an efficient MIS which ties closely the scientific and technical staff, the research activities and the management of resources. The need to address only a few functions at a time, good professional advice and participation and re-training of all cadres of staff to appreciate and understand the system was also confirmed.

The design and installation of a new MIS, even if limited in coverage, is a lengthy and costly undertaking. However, good planning and open minded professional approach and broad consultation can make such an investment highly cost-effective.

Exercise: What functions do you consider major bottlenecks in the management of your institution? Describe the composition of the Management Team which could be used to guide development and installation of improved MIS. How could the rest of the staff be motivated to participate in the exercise?

(b) Maintenance of MIS:

6.604 All management systems — including MIS, require periodic evaluation, updating and maintenance. The responsibility for this function must be assigned to a specific person or unit within the organization. This is a good reason for establishing an MIS unit within the institution but care must be taken to ensure that MIS management does not become an end in itself to the detriment of other functions of the organization. Computer-based MIS are particularly prone to such risks due to the rapid changes in technology which can put heavy pressure on institute resources. The systems analysts and programmers may also see their professional progress in terms of more sophisticated systems, rather than the fulfilment of the needs of the management.

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER VII

**DISSEMINATION
OF R&D RESULTS**

DISSEMINATION OF R&D RESULTS

Purpose

To familiarize managers of R&D with strategies and methods for effective dissemination of R&D results.

Training Objectives

By the end of this Chapter, participants will be able to:

-
1. Appreciate the need to plan for dissemination of R&D results right from the beginning of an R&D project.
 2. Appreciate the need for timely dissemination of R&D results.
 3. Identify characteristics of various clients of RDIs.
 4. Understand potential constraints in the dissemination of R&D results.
 5. Describe various channels of information dissemination and their characteristics.
 6. Understand the organizational arrangements required for effective dissemination of R&D results.
 8. Appreciate the need for adapting and packaging of R&D information for different target audiences.
 9. Appreciate constraints of language and other communication problems in the dissemination of R&D results.
 10. Understand the need and procedures for obtaining feedback from clients.
-

DISSEMINATION OF R&D RESULTS

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-

CHAPTER VII

DISSEMINATION OF R&D RESULTS

7.1 Introduction

7.101 One of the major challenges facing managers of R&D in Africa is the task of helping the political leadership and the general public to appreciate the vital link between research and development.

7.102 Because of the short history of formal education, especially in the field of science and technology, many people including political leaders take various technologies in daily use for granted. R&D activities are therefore often given low priority during allocation of public funds until a local crisis occurs and it is apparent that there are no quick solutions which can be pulled off the shelves. Managers of R&D on their part tend to assume that their role stops at the production of new technology, and hence fail to establish linkages with the private sector which is a potential source of support for R&D.

7.103 It is, therefore, becoming increasingly evident that the R&D manager has a responsibility not only for the conduct of research but also in building effective linkages between research results and all the other stages of testing, adoption and application.

This responsibility is not confined to products of local efforts in R&D. There is often a pool of relevant information from R&D activities carried

out in other parts of the world which could be effectively adapted and applied to local development by the development agencies themselves.

This need calls for efficient systems for acquiring and distributing as widely as possible all relevant S&T information. This process is referred to as “dissemination” of R&D results.

7.104 Dissemination of information implies general distribution without necessarily any identified target group as recipients so that potential users, known and unknown, can benefit.

Products of R&D are, however, usually of interest to particular groups or sections of the population which can be identified as clients. A certain degree of targetting is therefore necessary in order to make the information meaningful to particular clientele.

7.105 The process of dissemination of R&D results is however constrained by a number of factors. These include:

- identification of client needs, (especially those of less favoured sections of the general public who may not be able to articulate their needs);
- design of messages relevant and in a form easily communicable to various target groups;
- choice of channels of dissemination;
- organizational aspects.

These factors will be addressed in this chapter.

7.2 Clients of R&D

Clients of R&D can be divided roughly into five categories:

- **Researchers** who need information especially on improved research methodologies and the latest developments

in a given area of research. This category is identified through formal and informal contacts and is usually reached through personal contact, conferences, seminars, workshops, symposia and scientific journals.

- **Policy makers** including all those who are responsible for planning and executing large scale developmental activities in both public and private sectors. This group includes heads of Government Ministries and Departments, Leaders of NGOs and Managers of manufacturing firms.

The main concern of policy makers is choice of appropriate technologies. They therefore need up-to-date information on available technologies relevant to their areas of production, especially information regarding reliability and cost-effectiveness of such technologies.

This category has certain characteristics which need to be considered in designing R&D information dissemination systems and strategies. One of the characteristics is a tendency in managerial system to concentrate decision-making at the top. Clients in this category are therefore often busy and have little time or inclination to study highly technical reports.

Information reaching policy makers is also abbreviated and re-packaged at lower levels which may result in distortions. Users in this category are also subject to intense political pressures and are reluctant to promote new ideas whose failure would certainly cost them their position.

Most of the policy makers in this category also have very limited, if any, background training or experience in scientific matters. This category is therefore the most critical of R&D and the most difficult for the R&D manager to reach.

- **External donors, national governments and other sources of funds for R&D.**

- **Small-scale operators** whose main interest is technologies that facilitate economic production at the lowest level of investment. This category includes small scale farmers, operators of "cottage" industries and small scale businessmen.
- **Educational and training institutions** which need to expose their students to the latest technologies and other breakthroughs in understanding of conceptual, natural and physical relationships.
- **The general public:** These are people who may not be particularly interested in any field of S&T but who could develop interest from a casual encounter with suitably packaged R&D information or stimulate others to follow interesting research results.

List other characteristics of users relevant to dissemination of R&D information in your country.

7.202 Identification of the various categories of users in a given society is the primary task of an R&D Manager and is crucial in selection of R&D products and channels of communication which would be of maximum interest to a particular category of users.

7.3 Types of R&D Outputs

7.301 Outputs of R&D are basically of two types:

- (a) **New knowledge** includes a better understanding of various natural systems and materials and their properties leading to new opportunities for their utilization.

These outputs are sometimes labelled "basic" or "fundamental" and are often of immediate interest only to academicians and researchers. Knowledge is however the foundation for technological development, a fact which is difficult but essential to disseminate to the general public since no immediate social or economic benefit is usually associated with such knowledge.

List some examples from physical and biological systems.

- (b) **Technological and material products:** These should be easy to disseminate since their economic benefits, actual or potential, are

usually self-evident. Major breakthroughs in this field of R&D are, however, relatively rare; and dissemination of findings is more expensive requiring production of prototypes and demonstrations. In addition there is often psychological resistance to locally produced technologies. This matter is discussed in greater detail in Chapter 8.

Exercise: List examples of this type of R&D product in your country. Can you identify the basic knowledge which went into the development of the technology?

7.4 Strategies and Channels for Dissemination

7.401 **Strategies for dissemination** of R&D results are as important as those for the conduct of the R&D itself. Dissemination strategies are however often given little thought within R&DIs until it is forced to justify its existence. A lot of information is then hurriedly put together and distributed without even a system to check on the effectiveness of the exercise. Two major areas need to be addressed in strategies for dissemination of R&D results:

- Information compilation and classification,
- Channels of communication.

7.402 **Strategies for compilation and classification** of R&D results should be well established and known to all research and documentation personnel within the R&DI. Such strategies would include the systematic collection,

evaluation and classification of all research findings. This is best done by a publications committee comprising heads of research programmes, extension liaison (public relations) officer, and the head of the R&DI documentation centre.

7.403 Classification of R&D results is especially important in that it helps to identify clearly the completeness of the results and hence the level at which dissemination should be carried out. For example, advances in research methods should be confined to journals and scientific conferences, while technological breakthroughs can be disseminated through brochures and mass media.

7.404 **Communication strategies** will vary somewhat depending on the information policy environment and the R&DI goals. The R&D manager should nevertheless try to make use of the national information systems such as radio, television, rural press, district information centres, etc. In order to ensure access and accurate representation, the R&DI may need to enter into formal agreements with the institutions concerned covering issues such as language, editing, mode of presentation (live or recorded), and charges. In the case of newspapers and magazines, location of the R&D information would be an important issue.

7.405 Another strategy is twinning arrangements with other institutions which may be better equipped to do the dissemination. Such organizations could be large R&DIs with well developed abstracting and publication services.

7.406 Targetting certain communities or social groups could also be an effective strategy for dissemination of R&D results. Messages could then be designed to inspire communication through interpersonal relationships, peer pressure or competition. An example is targeting new building technology to contractors.

7.407 In all cases, research on methods of packaging information, effectiveness of various channels for dissemination and feedback mechanisms is an important strategy for enhancing dissemination of R&D products.

7.408 Channels for Dissemination: There are various channels which can be used for dissemination of R&D results. The choice of the appropriate channel depends on the type of product and the characteristics of the target client group.

7.409 In the case of new knowledge, it is necessary to convince the client the theoretical basis for the research result and any implications regarding prevailing theories and hypotheses. Dissemination of such results is therefore done through, among others, refereed journals, scientific meetings and personal contact between scientists.

7.410 It is, however, a common experience that researchers find difficulties in, or tend to restrict sharing of technical information. The R&D manager must therefore recognize this natural tendency and devise ways in the R&D information systems to promote confidence and team spirit among scientists.

7.411 In many R&D institutions, informal social contact between scientists is promoted on a daily basis by providing suitable facilities for the staff to meet for tea-break or lunch.

7.412 At a slightly more formal level, scientific colloquia can be programmed giving scientists an opportunity to describe their work and to benefit from criticism from colleagues in a friendly atmosphere.

7.413 In the case of technological or material R&D products, various channels of dissemination are available and can all be used in different sequences depending on the target group to be reached.

7.414 The most powerful method is that of demonstration. R&D managers should therefore seek opportunities during public shows and exhibitions as well as during open-days at the R&D institutions to demonstrate the characteristics and benefits of new R&D products.

7.415 These efforts can be further strengthened by publication of brochures and leaflets explaining

the nature and benefits of new R&D products and where possible, distribution of samples of such products e.g. seeds of new crop varieties.

7.416 The mass media which plays a major role in commercial advertising can also be used with good results in dissemination of R&D results. There is, however, a serious danger of exaggeration and misrepresentation unless the R&D management remains in control of the messages passed through the mass media.

7.417 The R&D manager is therefore faced with the dilemma of how much information to give and when. Clearly use of the mass media should be reserved until a simple and accurate message can be safely entrusted to the news media.

Case Study 7.1

The Case

An example of this difficulty was encountered by a local R&D institution in dissemination of information regarding a new drug.

The RDI announced through media the discovery of the new drug which seemed effective in alleviating painful symptoms in patients suffering from a disease difficult to cure.

Outcome

The news was so enthusiastically received by the general public that it became very difficult for researchers to explain the difference between cure of a disease and relief of suffering through control of unpleasant symptoms. A large section of the Scientific Community, on the other hand remained skeptical and contributed much to the slow acceptance of the new drug at technical level.

Points to Note

The RDI was perhaps too keen, or succumbed to pressure, to release information on the new product before adequate peer review had been conducted. The RDI also underestimated the possible exaggeration of the message in newspaper headlines.

7.418 Another powerful channel for dissemination of research results is audio-visual films. Such films if skillfully produced can increase the "users" confidence in the product by key stages in the research, development and testing of the product. The films can also be used in group presentation thus facilitating discussions on the spot.

7.419 A common and potentially powerful channel of R&D information dissemination is the use of brochures, pamphlets and posters. This channel has been used with good effects in the agricultural sector within the region and its potential will increase with improvement in levels of literacy in the population.

7.420 Care should however be taken to ensure that these materials reach the end-users. It is not uncommon to find extension materials gathering dust in district offices.

7.421 Extension brochures should, however, be written in simple, clear language which leaves no opportunity for misinterpretation. An example of this problem is a brochure which advises a farmer to "Plant early" without defining earliness in clear terms such as depth of wetness in the soil or dates with highest probability of expected rainfall.

7.422 **Visitor Services:** The business sector has long recognized that good public relations is

Discussion: In one country in the region, this problem was solved through a system of follow up and verification at the end-user level. Have you encountered this problem in your country? What kind of follow-up would you suggest?

Examples of brochures, pamphlets, posters should be displayed during the session.

Can you find other examples of vague extension messages in your country?

essential for the welfare and profitability of the enterprise. RDIs are not exempted from this rule and their need for public support is even greater since investment in RDI is made with only a hope that positive results will be realized at an unknown future date. RDIs should therefore ensure that visitors to the institute are received by well trained, well-informed and highly motivated staff. The visitors should be given a good insight into the problems scientists have to solve in order to realize useful research results, progress realized in this process, and prospects for the future.

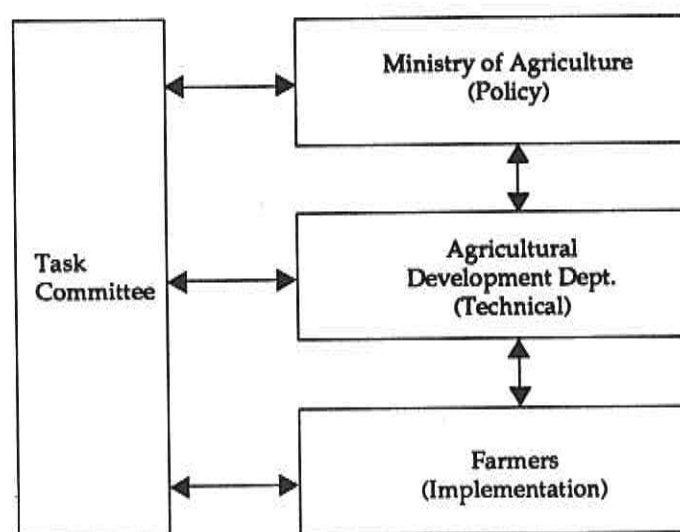
7.5 Organizational Issues

7.501 Although researchers are the most knowledgeable on characteristics of their R&D products, it is uncommon to find scientists who combine scientific skills with the high level of communication skills required in dissemination of the results. The R&D management is therefore often obliged to establish a separate cadre of personnel with the necessary skills to prepare and edit messages to suit the level of understanding, interest and other characteristics of various target groups. Such a cadre could be formed through intensive training of some of the research scientists in communication skills.

7.502 Whether the dissemination function is in-house as in the case of a manufacturing concern or external to the R&D institution, as often happens in the common separation between research and extension in the public sector, the need for a suitable organizational structure is paramount.

7.503 Such a structure should however allow the researchers to interact closely with the information dissemination personnel so that essential elements are not lost or glossed over in the final package leading to misleading messages. The worst scenario is where the R&D manager has to issue clarification on messages already disseminated.

Fig. 7.1. Role of Task Committee in Communication Project



Case Study 7.2: ESTABLISHMENT OF TWO-WAY COMMUNICATION BETWEEN RESEARCH AND USERS OF RESEARCH RESULTS

The Case

One of the frustrating problems to research and extension is that of creating effective two-way communication between technology generators and promoters on the one hand and users on the other. Adoption of otherwise appropriate technology may not take place but the real reasons often prove evasive to the technology generators and promoters. The presence and effectiveness of two-way communication is a major factor in these situations and a project based on this principle has been initiated in one of the countries in the region.

The objective of the Project is to enable the researchers and extensionists to design messages which convey effectively farming technology to farmers and which also allows effective communication of feed back from the farmers.

A Task Committee was established comprising research, extension, animal husbandry and other relevant personnel. The key skills needed in the committee were ability to infuse with and listen to farmers. The role of the committee is indicated in Fig. 7.1.

In this project, the members of the Task Committee use the three major senses of hearing, sight, touch, to convey their messages. The researchers are involved in design of visual aids. Extension messages are thoroughly evaluated before they are put to the farmers. The Committee also compiles farmer's reactions and

makes sure they reach policy level for necessary action.

Outcome

The project has been operative for the past three years and has demonstrated on several occasions the value of simplified messages as well as feed back from users as a basis for adjustment of technological packages.

Questions for Discussion

- (a) *Would the idea of such a Task Committee be workable in your country or field of research? If not, how could it be modified to suit your environment?*
- (b) *Communication skills and seniority may not necessarily be found in the same individuals. How could this conflict be alleviated in membership of a committee similar to the one described here?*

Case Study 7.3: RESEARCH/ EXTENSION LINKAGE FOR TECHNOLOGY TRANSFER: THE CASE OF A COMMITTEE FOR ON-FARM RESEARCH AND EXTENSION

The Case

The need for multi-disciplinary approach to on-farm agronomic experimentation led to the formation of a broad-based committee to oversee such trials in one country in the region. The functions of the Committee are to Plan, Coordinate and set priorities for on-farm research trials based on results of previous trials, critical factors to be

investigated, relevance to particular regions and farming systems and the facilities likely to be available to carry out the work.

Membership of the committee comprises Research, Extension and other agencies concerned with application. In order to speed up decision making, the committee operates through a series of sub-committees with primary interest on a particular crop e.g. cotton, oilseed etc. There are 8-10 members in a sub-committee and this has helped to reach consensus on issues.

The sub-committees meet once a year about four months before the start of a crop season. The sub-committees also conduct mid-season tours of various on-farm trials. During these meetings, a technical assessment is made of progress in various series of trials and decisions reached on which trials will be incorporated in the following season.

The decisions of the sub-committees are then reviewed by the main committee which comprises the heads of research and provincial extension officers. This committee is executive and can assign responsibilities for various activities. There is a special budget allocated for the committee's COMFRE activities, a facility which is essential in successful operation of such a system.

Outcome

On the whole, the idea has worked well. It has, however, not managed to solve fully the problems and delays caused by lengthy processing of research proposals. The main achievement is integration of research and extension in decision making which ensures that on-farm research

is carried out successfully on the ground. The involvement of both research and extension at all stages and incorporation of socio-economic inputs should eventually promote applicability of research results.

Questions for Discussion

- (a) *Is there a research/extension committee or committees established in your country along the lines described in the case study? How do they work and have they been successful?*
- (b) *Why is it necessary to have a formal committee where informal collaboration could be equally effective?*

Draw an R&D Institution Organogram showing the appropriate position of the Liaison Unit to give it both authority and accountability.

- (c) *Are executive powers of a committee such as the one described compatible with overall management of a Research Institution? Do you see any potential areas of conflict and how they can be avoided?*

7.504 Dissemination of R&D products is beneficial but has its hazards to the individual scientist or the R&D institution. It is therefore necessary to institute a standing mechanism for in-depth examination of the products to be disseminated in order to verify technical claims as well as potential negative impact (economic, social or political) which could be precipitated by the information disseminated.

7.505 One of the possible measures is to establish an institution-wide publications committee which gives scientists from various disciplines the opportunity to evaluate the scientific basis of proposed R&D products. The top management have also to discuss the results separately in terms of potential impact and possible liabilities.

7.506 A major challenge in dissemination of research results is the publication of scientific journals and magazines. At the outset, it is important for research managers to realize that while it may seem easy to start a scientific journal, it is an extremely difficult task to maintain the publication.

7.507 As a result of high cost of journals, readership of journals is very low in Africa.

7.508 Very few journals started in Africa have survived and those which have done so can hardly maintain regular publication schedules due to shortage of resources — editorial and financial.

7.509 Those who wish to start a journal should also recognize that there are very few trained science editors and African scientists have often too many extra responsibilities to serve effectively in editorial boards.

**Case Study 7.4: PUBLICATION
OF A REGIONAL JOURNAL —
THE CASE OF E.A.
AGRICULTURAL AND
FORESTRY JOURNAL**

The Case

The need to create a regional journal covering the fields of agriculture and forestry was realized very early during the colonial era in East Africa and the E.A. Agric. and Forestry Journal was therefore established during the thirties. This journal achieved international recognition and was published regularly at the rate of four issues per year. A number of special issues containing articles on a particular research programme were also published.

Outcome

The journal was in great demand locally and overseas and a lot of foreign journals were supplied on exchange basis. Editorial services, the time-consuming liaison with the printers and proof-reading were provided on a voluntary basis by scientists at the East African Agriculture and Forestry Research Organization. The financial/currency systems were also much freer and marketing of the journal within and outside the East African region was not a problem.

After the East African countries achieved independence, separate currencies with rigid exchange regulations were introduced. Many of the scientists who had volunteered to publish the journal also left and the few local scientists trained were overloaded with research and administrative responsibilities. The result was delays in publication

leading eventually to publication of combined volumes one or two years late. Sales and exchange contracts were lost and the whole idea of a regional journal has had to be re-evaluated.

Points to Note

- (a) While the idea of local or regional journal is attractive, viability of such an enterprise needs a solid resource base which does not depend entirely on revenue from sales.*
- (b) It is risky to assume that local scientists, who are usually lowly paid, will provide their time free of charge to meet the heavy duties of editing, refereeing and other administrative responsibilities.*
- (c) Frequent movement of scientists and slow postal communication within the African region makes refereeing of journal articles a difficult and time consuming process.*

Question for Discussion

In spite of the above problems, a journal published on a regional basis probably stands the highest chance of success. How would you handle the issues mentioned in this case study?

Exercise: It is felt in many quarters that publication of R&D results could improve if scientific journals are initiated at national level. Advocates of this theory claim that cost can be reduced by using part-time editors, use of cheap quality paper etc. Discuss the merits and disadvantages of journals published for local reading only. What incentives would R&D managers use to obtain the services of local scientists as part-time editors and referees? Desk-top computer based publication system is claimed to reduce costs and improve quality of publications. Study a desk-top publishing system in your country and determine the level of cost saving which can be achieved through such a system.

7.6 Adaption and Packaging

7.601 R&D products must be adapted and packaged in such a way that their dissemination will have the intended impact. This may involve re-writing and presentation of results in such a way and in a language which will make the information attractive visually and easily understandable by the target client group.

7.602 Language, cultural diversities and levels of literacy are important factors in the dissemination of R&D results in developing countries. New terms may need to be coined and introduced to explain the new ideas. There are, however, alternative methods of communication which need to be developed further to meet special requirements of scientific and technological information. These methods include:

- songs composed to carry particular messages,
- plays in which the message is acted,
- pictures and pictographs,
- oral stories and poetry.

Most of these methods are used intensively and with good effects in commercial advertising, but their application in dissemination of R&D results is yet to develop.

Case Study 7.5:
**AN EXAMPLE OF SELECTIVE
DISTRIBUTION OF
INFORMATION (SDI)**

The Case

The Documentation and Scientific Information Centre (DSIC) of the National Science Councils in the region has a sizeable population of users both on campus and in other institutions. In order to help some of its clientele keep abreast with advances in their fields of specialization, the DSIC has been running a selective dissemination of information service (SDI) using both its own and local resources and those of relevant computerized information centres overseas.

In this service, users were requested to complete a form, essentially indicating their field(s) of activity and interest. This information was indexed and is used for selecting only that literature which is of interest to the user and sent to him/her periodically. The same information has been sent to cooperating computerized databases overseas who run computer searches on these profiles and make available to our users only that information which would be of interest to them.

Points to Note

With this service, users are not overloaded with stacks of information they do not need.

Exercise: Draw up a format for soliciting from users the type of information they would appreciate from the documentation service. What procedures would you use to keep the SDI database up to date?

7.603 Another aspect of adaptation and packaging is the compatibility of new technologies with existing production, consumption, utilization or socio-economic systems.

A good example of this problem is the common general recommendation issued to farmers regarding fertilizer application. In most cases such recommendations are based on average results from agronomic trials in broadly defined environments. The farmer is primarily interested in economic return from investment in fertilizer. The farmer is, however, not given any advice on how to adapt the recommendation to his farm circumstances by checking economic returns at various levels of fertilizer inputs.

Another example is the recommendation on pesticide application which does not include proposals on how a farmer can estimate the level of infestation and hence the expected return from the investment.

Exercise: Can you think of other examples in your area of interest and how R&D results can be adapted and packaged to avoid these problems?

7.7 Feedback Mechanisms

7.701 It is easy for the research manager to assume that R&D products are reaching the clients just because the information has been widely distributed.

7.702 It is, however, necessary to follow up information dissemination with a carefully planned survey to find out:

- (a) Whether the information is reaching the clients.
- (b) Whether the message is clearly understood.
- (c) The usefulness of the new technology.
- (d) Suggestions for further improvement in either the technology or the packaging and dissemination procedure and strategy.

7.703 Such surveys can be conducted through questionnaires, personal interviews or group meetings depending on the nature of the client target group. If questionnaires are to be used, they have to be kept very simple and the respondent encouraged to return it by being provided with an addressed envelope and pre-paid postage.

Exercise: Design a questionnaire to establish whether farmers are aware of a new and better yielding crop variety. Through the response to the questionnaire you should be able to judge whether the new variety has gained acceptance and if not why. The questionnaire should not take more than about five minutes to fill in.

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

CHAPTER VIII

**PROMOTION AND MARKETING OF
R&D RESULTS**

PROMOTION AND MARKETING OF R&D RESULTS

Purpose

The purpose of this Chapter is to help the managers of R&DIs to appreciate the role of R&DI information systems in promoting, through appropriate marketing systems and strategies, the application of R&D results for economic or social development.

Learning Objectives

By the end of this Chapter, participants will be able to:

-
1. Appreciate various strategies and mechanisms for promoting the application of products of R&D.
 2. Understand organizational and other resources required within R&DIs information systems for effective promotion marketing of R&D results.
 3. Appreciate the complementarity (interdependence) between marketing systems for R&D results within R&DIs and in other public and commercial systems, and how this complementarity can be used to enhance the application of R&D results.
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PROMOTION AND MARKETING OF R&D RESULTS

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CHAPTER VIII

PROMOTION AND MARKETING OF R&D RESULTS

8.1 Introduction

8.101 Discussions in Chapter 7 concentrated on strategies for dissemination of research results in order to reach actual and potential users. In this chapter we go a little further in this process by introducing the idea of active promotion and marketing of research results. This is done from the perspective of the information systems which must be put in place for effective promotion and marketing of R&D results.

8.102 Once in a while R&D is rewarded with valuable results which could be of economic or social benefits to society and which could also generate the much needed funds for research within the RDI.

8.103 The research manager is, however, faced with a difficult decision regarding the timing and content of information release, especially where there is no information system developed for these purposes.

8.104 In the private sector, developers of new technology are so motivated by the need to recover the cost of R&D that release of new products is done through highly professional

and coordinated promotional and marketing information systems. The product is also prepared in sufficient quantities to ensure that initial demand will be fully satisfied.

8.105 In the public sector, however, the motivation is usually not so strong and marketing information systems are not as well developed. Scientists tend to be much more concerned about professional reputation than recovery of research expenses. They may also be under pressure from politicians who are keen to show that the government is meeting the needs of the public. There is also the fear that the R&DI is likely to lose control once the information reaches the non-technical information dissemination (extension) system.

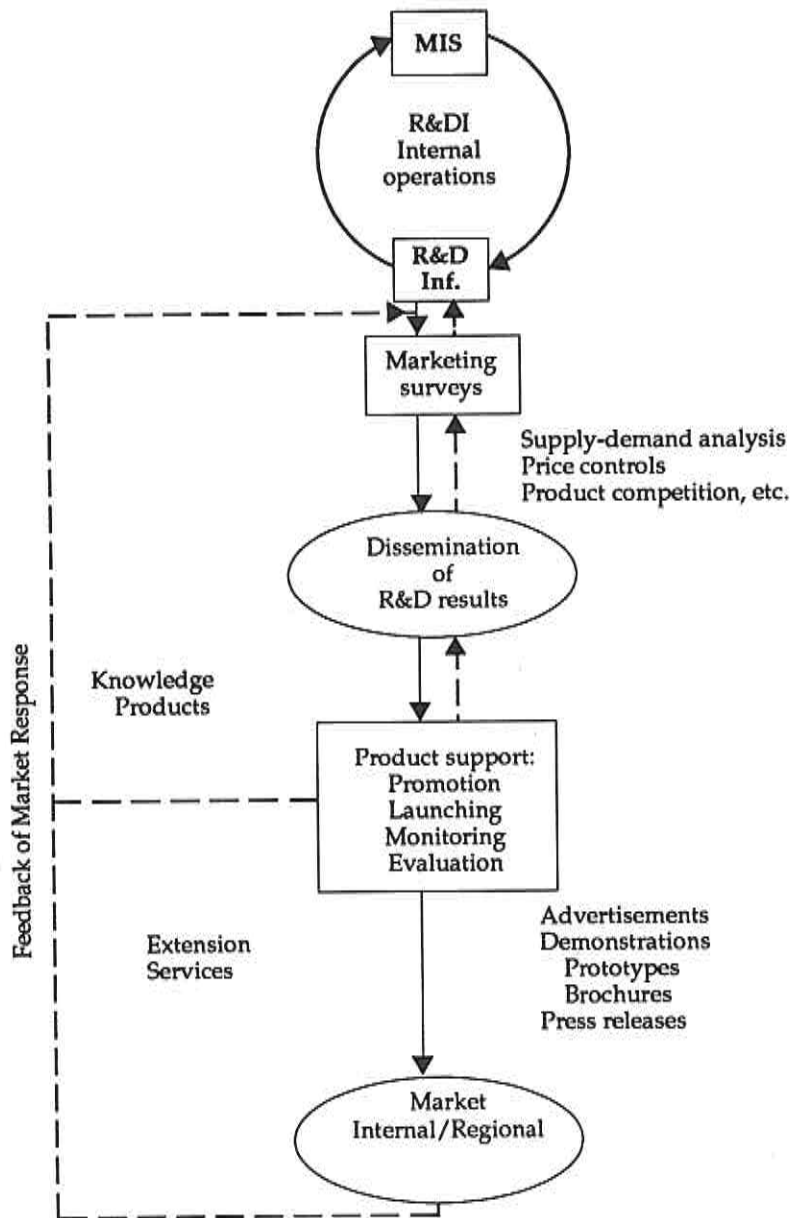
8.106 In both cases, the research manager is often faced with various critical decisions in choice of strategies and requires an effective information system to carry out these tasks. (see Fig. 8.1)

8.2. Markets for R&D Results

8.201 The starting point in R&D process is identification of intellectual and socio-economic needs and hence the potential markets for the R&D results. Markets may be defined as physical locations or points of acquisition and consumption of a given product. When applied to the case of R&D results, it means points of utilization of those results, be they intellectual processes or physical products. Markets for intellectual property are primarily other researchers, entrepreneurs, policy makers and data-bases, while markets for technology are public and private sector production systems.

8.202 The R&D manager must therefore have access to information systems which enable him to be fully conversant with the characteristics and requirements of the various markets for R&D products. This information would influence the objectives of the research to be conducted as well as the packaging and choice of channels of communication of the research results.

Fig. 8.1. Information System for Promotion and Marketing R&D results



8.203 The R&D information system should therefore be able to provide the R&D manager with relevant information in form of economic policies and data, potential size of markets and other socio-political information.

8.204 An important characteristic of markets for R&D results is that their requirements change frequently. R&D information systems should therefore have efficient mechanisms for

accessing the latest information and for disseminating this information to research managers in a timely manner. In addition, R&D managers should maintain close links with the markets. This need is illustrated by Case studies 8.1 and 8.2.

Case Study 8.1: RESEARCH RESULTS "ON SHELVES"

The Case

Adoption of technologies resulting from research depends on the priority needs of the users. Research results or technologies which remain on "shelves" in research centres are therefore either inappropriate to current user needs or are not implementable due to socio-economic constraints. Survey of user needs and collection of socio-economic data is a vital step in the identification of markets for R&D results and hence the planning and conduct of research. The case of a coffee drying technology developed to meet perceived needs of cooperatives in the region provides a good example of what can happen if this step in research information is omitted or inadequately carried out.

In the early eighties, it appeared that coffee factories in one of the countries in the region were experiencing difficulties in drying large quantities of coffee parchment during wet weather. A number of mechanical driers available in the market were tested but did not prove satisfactory due to high cost and technical sophistication.

The National Coffee Research Institute then embarked on a

research project to develop a simple and relatively inexpensive coffee drying system suitable for cooperative coffee factories. After four years of research, a new drying system was ready and tested. This system cost only a fraction of the commercially available dryers and was simple to fabricate locally and to install.

Outcome

Efforts to market the technology to the intended users, however, did not succeed and the technology remains largely unused. The researchers were only to learn at this stage that no more than about 10 percent of all coffee factories needed such a system and then only during years of exceptionally wet weather. The problem was therefore not as important as had been assumed at the initiation of the research, and hence lack of market for technology.

Points to Note

There are several points to be noted from this experience regarding need for and use of research information systems:

- (a) In the absence of systematic documentation of technical, organizational and environmental factors in the drying of coffee it was not possible to evaluate the real problem in the drying of coffee parchment. The wrong conclusion was therefore reached and an unnecessary research started. A better research information system would*

have revealed the real problem leading to a management rather than technological approach to the problem.

- (b) *Although this research programme was regularly reviewed by the Board of Management which includes representatives of the clients, this mechanism was not adequate to prevent an inappropriate research project being carried out. It is possible that the enthusiasm of the researchers overshadowed other considerations.*

Questions for Discussion

- (a) *Have you experienced a similar problem in your research institute? How was the problem solved in the end?*
- (b) *Would you regard the above research a complete waste of effort considering that new technology was in fact developed in the process?*
- (c) *What else could the RDI have done with the results e.g. market to other countries?*

Case Study 8.2: INAPPROPRIATE OUTPUT TECHNOLOGIES DUE TO INSUFFICIENT INFORMATION

The Case

It was observed that tobacco growers in one of the countries of the region were always short of curing capacity for tobacco leaf, seasonal effects making barn space

completely inadequate. In order to improve this situation, the Tobacco Research Organization mounted an R&D programme in the late sixties and early seventies to produce a system which could increase the through-put by shortening the curing time for tobacco.

Outcome

An inexpensive convectional heat exchanger which fitted between the furnace and the flues was produced and tested in the latter half of the curing season. Curing time was found to be shorter and quality appeared to compare favourably with a conventional flue-curing barn. The design was released to growers, who, because of the low cost, installed a large number of the heat exchangers. The capacity of the equipment however, turned out to be inadequate for the purpose it was intended and could not solve the problem even at the research station.

Points to Note

This is a classic example of insufficient market research information before a new technology is released — in this case involving lost investment on the part of growers who adopted the technology. While the researchers were obviously convinced and managed to convince growers that the new technology was useful, the research information system did not allow or encourage research management and/or users to verify the basis of the results and their reproducibility in actual production systems.

Exercise: Describe a research information system that could have helped management to assess more realistically the real application of the new technology. How could users or clients be incorporated in such a system?

Questions for Discussion

- (a) *How long should a new technology be tested before being released to users?*
- (b) *Would it have been better to release the technology on limited trial basis first? Who should meet the cost of the prototypes and any losses incurred in trying them out?*

Should a manager of public R&DI be concerned with marketing of research results?

8.205 The R&D manager should also recognize that in addition to solving current problems, R&D effort should be futuristic in approach. The R&D information system should therefore be able to guide researchers in identifying future trends in technology and hence potential markets for R&D results.

8.3 Promotion and Marketing Strategies for R&D Results

8.301 Marketing of a commodity has four major requirements:

- Preparing potential customers or clients to receive the product. An atmosphere of expectation needs to be created but the promises should be realistic. The reaction of the client at this stage will confirm the level of need for the product and help to establish the presence and level of resistance.
- **Batch production:** This refers to production of the first items of the new product. This is usually a difficult and expensive phase since investment is needed without assurance of revenue. The research institute should be prepared to produce the initial batch of the products if necessary but this responsibility should be handed over to commercial production as soon as possible.
- **Launching of the Product:** It is essential to ensure as far as possible participation of representatives of major sections of potential clients in this exercise. Symposia are good occasions to announce new research findings while new technologies are best launched in a social or informal gathering where the products can be demonstrated.

Sufficient samples or handouts as the case may be should be available to ensure that as many people as possible get first hand information.

Press releases and Press conferences have also proved useful in launching new research findings. These should, however, be well rehearsed and supported with written materials and visual aids.

- **Availability of the Product:** It is essential to ensure that interested users have access to the product. The R&D institution cannot usually handle this effectively and requires an organized distribution system involving reputable agents. These agents require an **information system** which enables them to respond directly to queries from users.

8.302 Information is therefore a major component of strategies for promotion and marketing of R&D results. This information should be released at the right time and should be able to convince the users the important characteristic such as novelty and price and how the products can be obtained. Case study 8.3 shows what could happen if there is deficiency in this area of R&D.

8.303 **Monitoring and Evaluation:** A system for promotion of application of research results is incomplete without an equally efficient feedback or monitoring information system. The research institution needs to know how well the results have been received and any impact which they are making at the user end.

8.304 Promotion and marketing strategies should therefore ensure that monitoring information can be collected on a continuing basis through questionnaires from the Liaison Office and monitoring visits by the research staff, or through periodic in-depth evaluation exercises. The resulting information is normally entered in the research information system of the institution and enables the researcher to improve their R&D products.

Exercise: Design a questionnaire to assess the degree of adoption of a new technology in the production system, including information on performance of the technology. What strategies would you adopt to ensure that the information is reliable?

**Case Study 8.3: ROLE OF
INFORMATION IN
MARKETING STRATEGY
FOR RESEARCH RESULTS**

The Case

For some years the coffee industry in humid highlands of a country in the region was threatened by coffee berry disease (CBD) control of which necessitated frequent spraying with expensive fungicides.

The National Coffee Research Institute therefore embarked on a long-term research programme to breed a variety resistant to CBD and leaf rust while retaining or even improving quality and yield. After many years of research, a new variety of coffee was developed and extensive trials confirmed that it had the needed superior characteristics.

The researchers however assumed that coffee farmers will automatically adopt the new variety and largely ignored the strong commercial interests of those with large quantities of seedlings of the earlier varieties for sale, as well as the thriving pesticide/fungicide industry supported mainly by the coffee farmers. Establishment of a coffee plantation is also an expensive undertaking and farmers would be highly sensitive to any negative comments regarding new varieties before they adopt them. In the absence of a well coordinated research information system, the announcement of the new variety was done almost casually with little client preparation.

Outcome

The immediate result was disbelief on the part of many farmers who were exploited by some commercial interests, thus reducing the rate of adoption of the new variety. The limited stocks of seedlings of the new variety became an excuse for slow adoption.

Points to Note

The main point to note from this experience is the need for a system capable of preparing clients through systematic information and demonstration before a new product or technology is launched. Research managers should also recognize that good ideas can be killed by interest groups who may stand to lose, even if temporarily, from introduction of new products. A research information system should therefore be able to counteract a well orchestrated negative publicity by selecting, packaging and timing release of the necessary information.

Exercise: Draw up a plan of information dissemination system which could have been used to prepare the entire coffee industry to commercialize the new coffee variety. What could be the optimum skill mix, facilities and position of such a system in the research organization?

8.4 Information Structure for Promotion and Marketing R&D Results

8.401 Sometimes marketing of R&D results has policy, prestige, political and legal implications. It is therefore highly desirable that it is done professionally by a team reporting to the top management. This team should be guided by an advisory committee comprising scientists and other experts in public relations, finance and law. The research institution may also decide to appoint a commercial concern to market some of its research products. In such cases, a carefully written legal agreement is required to protect the research institution from misrepresentation and legal liability.

8.402 One possible information structure for marketing R&D results is a public relations or Liaison department. Where such a unit is present, manned by competent staff and given the necessary support by both research and management, the institute has a powerful tool for promotion of its research activities and the resulting products.

Exercise: (a) Describe the public relations functions in your research institute. How are these functions coordinated?

(b) Draw up an organogram showing the optimum position of a Liaison Unit within a research institution. What skills would be crucial to the success of such a unit?

8.403 Channels for communication are an important component of any information system: Conferences, seminars and journals are important markets for research results. It is therefore important for the RDI information system to access and communicate to the researchers in good time notices of forthcoming scientific conferences. Scientists are often unable to obtain places in conferences or publication space in journals due to inappropriate preparation of their scientific papers. The system should also provide guidelines on the "instructions to authors" for the journals relevant to the work of the institute. There is also a major need to have editors within the RDI.

8.5 Development and Application of Information Resources for the Promotion and Marketing of R&D Results

8.501 A major consideration in the establishment and maintenance of an information system for promotion of research results is the continuous development of various resources needed. The most important resource is personnel. Staff charged with such responsibility should be well trained in communication skills and should be thoroughly familiar with both technical and utility aspects of the various products of research.

8.502 It is not possible to sell a product one does not know well. This exposure can be promoted through periodic visits to the laboratories and field experiments in the company of researchers and attendance at scientific meetings within the institute.

8.503 The second resource is the information itself. Trained personnel should then be in a position to develop information material and to package and distribute it in a way that promotes the products of research to potential users.

8.504 An important resource which needs to be developed for this purpose is a collection of photographs and other audio-visual materials.

A professional photographer within the institution can, in collaboration with researchers, create a valuable record of various stages in the development and application of a new technology as well as a permanent record of important events within the institute.

8.505 Researchers should also be encouraged to contribute to this effort by taking photographs of field experiments and other relevant field situations. These materials can then be used with good effect in promotional activities such as public lectures, posters, magazines and mass media presentations.

8.506 Once the information is ready, it has to be communicated. This requires use of public media and/or RDI facilities such as mobile cinema vans, public address system and printed brochures.

Exercise: Describe the steps taken in your RDI to collect information for marketing R&D results.

8.6 Constraints in Promotion and Marketing of R&D Results

8.601 **Ownership of Results (Intellectual Property):** The question of ownership of R&D products is discussed at length in various publications (see bibliography) and is covered to some extent in the FAMESA Manual on

What is your RDI policy regarding ownership of R&D results? Are all the scientific staff familiar with this policy?

Institute - Constituency Relationships. There are basically two issues — ownership of the intellectual property and the rights of the R&D institution concerned.

8.602 All R&D activities represent substantial investment from which the investor expects returns. The scientist invests his intellect for which he is partially compensated by his employer through a regular salary and other benefits. A special award tied to discovery of new technology would, however, provide an added incentive for the researcher to be innovative, motivated to publish research findings and to maintain interest in the application of the results.

8.603 The owners of the R&D enterprise may have a policy to protect inventions or discoveries made in their R&DI with a view to recovery of costs and profits through sale of the information or resulting products. Patenting is however, a lengthy process and delays in release of research results are inevitable.

8.604 Scientists depend largely on goodwill and exchange of information with their colleagues in order to make progress in their research. Reciprocation is therefore the rule of the game. Sufficient information has also to be released in order to convince would-be users that the new product does work, is safe and is truly new. The manager is in a dilemma regarding how far to go in restricting information flow.

8.605 Many R&D institutions, especially those connected with highly competitive industries therefore opt to keep the technology secret as long as possible. R&D managers should however take note of a common saying that “the security of a secret depends on the value and hence the cost of acquiring the information”. Commitment to professional ethics on the part of the scientists and other key personnel in management is therefore a key issue which will determine security of the R&D results.

8.606 **Legal Constraints:** The most common legal problems in marketing R&D results arise from intentional or unintended plagiarism in the case of publications and public liability in the case of material products or technology. Plagiarism can be prevented through **extensive peer review** of research findings before publication.

8.607 **Public Liability:** It is never possible to ensure that all possible effects of new products and hence public liability (e.g. environmental pollution) are evaluated before the product is released to the market. The research institute must therefore seek adequate technical and legal advice before releasing new products into the market. An adequate insurance coverage should also be maintained if the institution is not covered by state indemnity. The R&D should therefore facilitate access to the relevant laws so that the necessary safeguards can be incorporated in information on R&D results.

Exercise: Describe the role of the information system in your institute in safeguarding the institute from legal liabilities arising from publication of research results. How are the individual scientists made aware of legal requirements and their individual responsibilities? What sanctions can be applied to a researcher in the event of a breach of these responsibilities?

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*MANAGEMENT MANUAL FOR PRODUCTIVE R&D:
R&D SCIENTIFIC, TECHNICAL AND MANAGEMENT
INFORMATION SYSTEMS*

**SUMMARY OF CONCLUSIONS AND
RECOMMENDATIONS**

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1. General Observation

The participants noted that the purpose of the Workshop was to familiarize them with the contents of the manual and to give them an opportunity to exchange ideas on how the manual can be used effectively to promote development of R&D information systems at national level. The participants therefore agreed that except for recommendations made to FAMESA relating to structure and format of the manual, all other observations should be regarded as issues which should be emphasized in training activities at the national level.

2. *CHAPTER I* — Introduction and Format of the Manual:

2.1 The participants recommended the following improvements which should be considered in the process of final editing and publication of the Manual:

- (a) Subject to availability of funds, the manual should be published in loose-leaf binding with colour markers separating the different modules.
- (b) Efforts should be made to reduce the bulk of the manual by printing on both sides of paper and using small print where desirable.
- (c) Case studies should be clearly marked to separate them from main text and preferably put together at the end of each chapter with cross-references in the text.
- (d) The Manual should be made available in other formats such as diskette, and in other languages commonly used in the African region.
- (e) A glossary of terms should be presented at the end of each chapter.
- (f) Efforts should be made to find a title which is more catchy and enriched.
- (g) The FAMESA Manuals should be institutionalized through the national research councils and S&T Commissions or ministries. These agencies should take the lead in promoting the use of the manuals at national level.

2.2 Regarding the mode of presentation of the manual in training workshops, the participants recommended that:

- (a) Only a few topics/modules at a time should be presented at training workshops and their selection should be based on the perceived priority needs of the participants.

- (b) The learning objectives should be adjusted to conform to the needs of each training activity.
- (c) The subject matter should be presented in such a way that issues are handled progressively from the simple to the more complex.
- (d) Training courses should be organized for librarians, information scientists, research scientists, finance staff, extension staff, R&D managers and technicians. Graduate students as future R&D managers should also be exposed to the various issues discussed in the manual.
- (e) Models of presentation of the manual would include staff seminars at R&DI and universities, formal courses, awareness seminars lasting 1¹/₂-2 days. Hands-on courses could also be arranged but these would require about one week.
- (f) Guest speakers can be used to present various topics and training can also be conducted as part of various courses organized by Management Development Institutes.

3. *CHAPTER II — Information in R&D Process:*

The participants noted that this is an overview of the whole subject of R&D Management Information System and is designed to sensitize users on the vital role of information as a resource in all aspects of R&D.

3.1 Support for information activities in R&D

The participants observed that information activities are rarely accorded priority in resource allocation within R&DIs. It was recommended that:

- (a) R&D information activities should be accorded both line and staff functions within R&D Management Systems.
- (b) R&D information activities should be allocated at least 5-10% of the R&D Programme budget for recurrent costs. A higher allocation will be required where capital costs e.g. buildings, computers etc. are required.

4. *CHAPTER III — Sources of Information for R&D:*

4.1 Keeping R&D managers up to date with trends. Participants agreed that a major role of R&D Information System is to keep R&D managers up-to-date with changes in policy, priorities and scientific trends. The following issues should therefore be highlighted regarding relevant types of information and their sources and access:

- (a) R&D managers should know the mandate of their institutions and should keep up-to-date through subscription to journals, membership of professional associations, participation in seminars, workshops etc. programme review reports and by devoting adequate time to professional activities.

- (b) Arrangements should be made to access patent information from local patent office, WIPO and ARIPO.

4.2 Access to R&D information can be improved and facilitated through:

- (a) Establishment and strengthening of National Documentation and Information Centres in Africa.
- (b) Establishment and promotion of information networks in Africa.
- (c) Encouragement of publishing and utilization of grey literature, raw data. There is need to increase publishing houses, desktop publishing and scientific journals and to give incentives to R&D managers to participate in these activities.

5. **CHAPTER IV — Information Technology:**

Participants noted the vital role of various types of Information Technology in the R&D Management Information Systems. It was recommended that R&DIs should take advantage of these technologies in improving documentation, access and utility of information in R&D activities. The following points were noted for special attention:

- (a) Care should be exercised in selection of information technologies, especially where computers are to be installed. Costly mistakes can be avoided by setting up committees of experts to advise on hardware and software. Donors should be encouraged to donate equipment which is compatible with existing systems.
- (b) Instrumentation Centres should be established to provide back-up and maintenance services.
- (c) Proper training of both information staff and information users is vital for successful introduction of information technologies. Special attention should be given to the needs of existing staff who may need retraining. User guides should be developed where appropriate.
- (d) R&DI management should be carefully sensitized to the need for introduction of new technologies.
- (e) Networks should be encouraged as a means of enhancing sharing of information.
- (f) Buildings should be designed to accommodate various IT facilities and Power regulators and back-up equipment should be included in purchase of computers.
- (g) Training institutions offering courses in information science should include Information Technology in the curriculum.

6. CHAPTER V — Processing and Documenting Information for R&D:

- 6.1 Participants highlighted the following points and issues regarding the processing and documentation of R&D information:
- (a) Union List should be given priority as a means of improving access to information.
 - (b) Subject matter specialists should be encouraged to become information scientists.
 - (c) Training facilities available in Information Sciences in the region should be highlighted in the manual and in training courses.
 - (d) R&DIs should be encouraged to share information resources through formal and informal means.
 - (e) Human resources development through training is a vital requirement in the processing and documentation of R&D information. Every effort should be made to increase the cadre of information scientists and the various cadres of supporting staff.

7. CHAPTER VI — Management Information Systems (MIS):

- 7.1 The participants noted the increasing need to adopt more coordinated and integrated Management Information Systems and the use of computer technologies in R&DIs. The following points were highlighted:
- (a) MIS are important for decision-making within R&DIs. However, MIS are closely related to styles of management. MIS should be used to encourage R&DI managers to be more open in their management styles.
 - (b) MIS should pay particular attention to production of executive summaries of various documents to facilitate decision-making.
 - (c) Managers of R&DIs should be encouraged to be conversant with various aspects of MIS that could improve the R&DI operations. Chapter 6 of this manual could help in organizing training sessions on this subject.

8. CHAPTER VII — Dissemination of R&D Information:

- 8.1 Delegates discussed possible technologies which R&D managers can use to ensure that policy makers are well informed of research matters. It was noted that the techniques would depend on whether they were designed for external or internal policy makers. Delegates emphasized the role of good communication between research and policy makers. The following were suggested as possible techniques:
- (a) Well written quarterly and annual reports should be circulated.
 - (b) Personal contact wherever possible was recommended.

- (c) Research institutions should organize open/field days where policy makers and/or donors should be invited and given an opportunity to witness the research being carried out.
- (d) The policy makers should be involved in the formulation and prioritization of research plans of research institutions.
- (e) Researchers should organize Annual Research Conferences at their stations. Policy makers should be invited to these functions.
- (f) The R&D institutions should establish and maintain good working relationships with the mass media. Careful use can be made of media such as newspaper, radio, and television to spread information on research.
- (g) R&D institutions should use the opportunities afforded by trade fairs and exhibitions to display research results.
- (h) Individual researchers should invite managers and directors of their institutes to see their research.
- (i) Formal reports on research should be written by researchers for the consumption of the managers and directors of research.
- (j) Regular, such as monthly, in-house technical meetings and seminars should be encouraged.
- (k) In-house newsletters should be produced to keep R&D managers informed.
- (l) On-farm and adaptive research should be encouraged as a good method for disseminating results and methods.
- (m) It is recommended that RDIs have a department for repackaging information. This department should work with the researcher to prevent distortion of the information/results.
- (n) Researchers should help to communicate results and project needs effectively. Staff with different expertise should be responsible for dissemination, e.g. technical writers, illustrators, proposal writers and scientific editors. These should be in the research department.

8.2 Delegates then discussed the question of how R&D institutions could encourage mass media to give time and space for local R&D information. Keeping good working relations with senior and influential members of the mass media was emphasized. As recommendations, the following techniques were proposed:

- (a) Members of mass media organizations should be involved in the R&D institutes' social and technical activities. Wherever feasible, personal contact should be used. Researchers are, however, advised to work closely with journalists and particularly science editors in order to avoid misrepresentation of ideas.

- (b) The choice of medium should be dictated by the intended target audience for the information.
- (c) Governments should devise science and technology policies which promote research and development. These policies would empower the relevant ministries of Information and Broadcasting to play their roles in disseminating research information.

8.3 African Science Journals

Delegates observed that often African science journals fail. Reasons for the failure were explored and recommendations made to reverse the trend. The following is a summary of the suggestions:

- (a) Publishers should make contacts with relevant institutions and individuals who can subscribe to the journal.
- (b) Publication of the journals should be done on a regular basis.
- (c) Reputable professional journals outside Africa should be used as advertising media.
- (d) Competent editors and editorial boards should be used to produce high quality refereed journals.
- (e) Institutional libraries should be given copies of the journals to promote wider circulation of the journals through exchange programmes.

9. *CHAPTER VIII — Promotion and Marketing of R&D Results*

9.1 Delegates observed that in the private sector where competition was high and the need to get returns on research investment was high, active promotion and marketing are pursued. However the trend did not seem to extend to the public research institutions.

It was accepted that active promotion and marketing were necessary and that to achieve these, effective information systems were needed. The delegates made specific recommendations as follows:

- (a) The marketing function should be located high in the organization to facilitate constant review by top management who are ultimately responsible for any liability and legal problems.
- (b) R&D institutions should establish effective information systems to help in the identification of markets and their needs. The information systems should provide feedback.
- (c) As the resource needed for marketing include personnel, the R&DIs need specially trained personnel with the right tools.
- (d) African researchers should endeavour to build on research done elsewhere rather than "re-invent the wheel". Networking with colleagues and encouraging scientists to disseminate their results can help reduce unnecessary duplication.

LIST OF ACRONYMS USED IN THIS MANUAL

AACR	Anglo-American Cataloguing rules
AGRIS	Agricultural Information System
CAB	Commonwealth Agricultural Bureaux
CAD	Computer Aided Design
CARIS	Current Agricultural Information System
CDS/ISIS	Computerized Information System/Integrated Set of Information Systems
CGIAR	Consultative Group for International Agricultural Research
ECA	Economic Commission for Africa
FAO	Food and Agriculture Organization
GIS	Geographical Information Systems
IAEA	International Atomic Energy Agency
ICRAF	International Centre for Research in Agroforestry
IITA	International Institute for Tropical Agriculture
INFODOC	Information and Documentation
INFORM	Information for Agricultural Research Managers
INFOTERRA	International Reference System of Environmental Information
INIS	International Nuclear Information System
ISNAR	International Service for National Agricultural Research
OCR	Optical Character Recognition
PAC	Programme Activity Centre
PGI	General Information Programme (of UNESCO)
PTA	Preferential Trade Area
R&D	Research and Development (of technology)
R&DI	Research and Development Institute(ion)
SADCC	Southern Africa Development Coordination Conference
SSS	Special Sectoral Source
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIPO	World Intellectual Property Organization



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