

## **Chapter 2 - THE ROLE AND DEFINITION OF RESEARCH AND DEVELOPMENT**

### **2.1 The Role of R&D**

The aim of research and development (R&D) is to promote and support the production of high-quality, up-to-date and relevant output, products, and services for citizens, business companies and other organisations. Research plays an important role in helping to describe, explain, understand and possibly predict social and economic change, generating new concepts and frames of interpretation. It also has a crucial part to play in on going efforts to further improve production processes, to raise the quality standards of products and services and to cut costs through the new introduction of new methods. New innovations inspired by research may help to create new products and services and improve existing ones. To achieve all this, research must have a sound scientific and methodological basis.

### **2.2 Defining the Scope of Research**

The definition of what research actually comprises in a government agency, a private company or even a higher institution is no simple and straightforward matter. For the purpose of this document research (and related development work) is defined as the systematic application of theories, concepts, methods and principles of scientific research in attempt to increase existing knowledge and to apply that knowledge in the development of new practical applications. A distinction can be made between three levels of research;

*Basic Research* produces new information, but it is not primarily aimed at discovering new practical applications. Basic research produces and tests new concepts, hypotheses and theories.

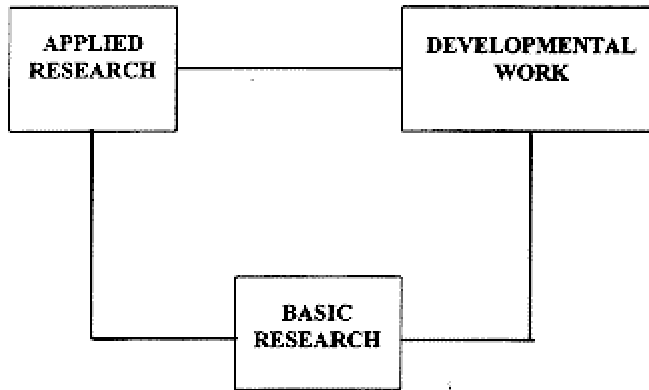
*Applied Research* produces new information and aims on this basis to discover new practical applications. Ultimately the goal is to find better methods for resolving existing problems.

*Experimental Development* is based on both research and practical experiences, which are used for the introduction of new products, production processes, systems and methods or for the improvement of existing ones.

In practice, of course, there can be and often is overlap between these levels. For instance, applied research and experimental work may also involve basic research.

Scientific research is characterised by *the principle of knowledge accumulation*. For this to be possible research is expected to follow the principle of transparency, i.e., all research results shall be published in appropriate for a

(scientific and other similar journals, international scientific conferences, etc.). The principle of transparency, for its part, makes possible another important aspect of scientific research, i.e., *the availability of research results for evaluation by the international scientific community.*



### 2.3 Areas of Research

The classification of areas of research has been rationalised in line with the Frascati Manual\*. Among the main areas of research are

- *Agricultural Sciences* - soil and water sciences, agronomy, horticulture, animal production, veterinary sciences, forestry sciences, Fisheries sciences, Food and nutrition development, Aquaculture, Physiology and other agricultural sciences.
- *Biological Sciences* - Biochemistry, Genetics and molecular biology, Microbiology, Botany, Zoology, Ecology, Genetic Engineering, Biotechnology, and other biological sciences.
- *Engineering Sciences* - Mechanical and Industrial Engineering, Chemical Engineering, Mining and Mineral Processing, Civil Engineering, Electrical and Electronic Engineering, Agriculture Engineering, Food Engineering, Environmental Engineering, Nuclear Engineering and Radiation Technology, Mechanisation and Design Engineering, and other Engineering Sciences.
- *Applied sciences and Technologies* - Aerospace technologies and Engineering, Manufacturing and Process Technologies, Nuclear Technology, Educational Technology, Resource-based Industry, Energy Industry and other applied sciences.
- *Information, Computer & Communication Technologies* - Information Systems, Hardware, Software, Current Information Technology, Communication and other related areas.
- *Earth Sciences* - Geology, Geophysics, Geochemistry, Oceanography, Hydrology, Atmospheric Sciences and other related areas.

- *Chemical Sciences* - Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, Speciality Chemicals and other related areas.
- *Physical Sciences* - Astronomical Sciences, Theoretical and Condensed Matter Physics, Atomic, molecular, nuclear, particle and plasma physics, Acoustic and Optical Physics, solid state physics and other related areas.
- *Medical and Health Sciences* - Immunology, Medical Biochemistry and Clinical Chemistry, Medical Microbiology, Pharmacology, Physiology, Neuroscience, Clinical Sciences, Public Health, Environmental & Occupational Health, Nutrition, Health Services, Health Care, Pharmaceutical industry, and related areas.
- *Environmental Sciences* - Environmental Studies, Environment Technology, Environmental Assessment, Environmental management, and other related areas.
- *Material Sciences* - Electronic Material, Functional Material, Polymeric Materials, New Materials and Technologies and other related areas.
- *Marine Sciences* - Marine Biology, Algae biotechnology, Fishing Technology, Marine Chemistry and related areas.
- *Social Sciences* - Accounting, Economics, Management Studies, Political Sciences, Architecture, Sociology, Archaeology and History, Geography, Population Studies, Law Psychology, Education Media and Communication, Finance, Anthropology, Transportation, Emerging Issues, Technology, humanities, Historical and Civilisation Studies, Philosophy, Arts and Culture, Religious Studies and other related areas.

## 2.4 Industry Groups

The industry groups are classified as follows:

- *Agriculture, Livestock and Fisheries*
- *Mining*
- *Manufacturing* - Food Products, Beverages & Tobacco, Rubber & Plastic Products, wood, paper, printing and Furniture, Textiles, Wearing Apparel, Fur & Leather, Chemical & Chemical Product, Pharmaceutical, Petroleum Products & Refining, Non-metallic Mineral products, Electrical Machinery & Appliances, Electronic Equipment & Components, Transport Equipment, Basic/Fabricated Metal Products, Non-Electrical Machinery, Instrumentation and Scientific Equipment, and other Manufacturing Industries.
- *Construction*
- *Electricity, Gas & Water Supply*
- *Services* - Telecommunication Services, Computer and Related Services, and other Services (e.g. transport, wholesale and retail, financial, business services).

## 2.5 Classification of Ownership

There are four categories of company ownership/control based on their capital structure,

- *Foreign owned* - Foreigners own 100% of the equity
- *Foreign controlled* - Foreigners own more than 50% of the equity
- *Locally owned* - Locals own 100% of the equity
- *Locally controlled* - Locals more than 50% of the equity

## **2.6 The Standard Definition of R&D**

For the purpose of international comparison MASTIC has adopted the R&D definition given by the OECD countries. That is, R&D is defined as

" Creative work undertaken on beyond a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications".

The areas covered by R&D activities are

- Design, construction and operation of prototypes where the main objective is technical testing or to make further improvements;
- Construction and operation of pilot plants not operated as commercial units;
- Research on original development (or substantial modification) of computer software such as new programming languages and new operating systems;
- 'feedback R&D' directed at solving problem occurring the R&D phase, for example, technical problems during initial production runs;
- Research work in pure sciences – biological, physical, mathematical ; and
- Research work in social sciences and humanities – economics, cultural, educational and sociological research.

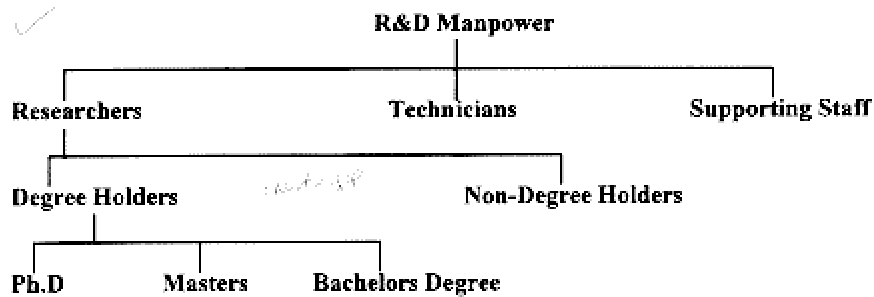
### **2.6.1 R&D Expenditure (RDE)**

RDE includes capital expenditure (acquisition of fixed tangible assets involved in R&D activities), manpower costs, and other related operating expenditures. Figures for ERD in each current year are expressed in nominal terms and are not adjusted for inflation.

### **2.6.2 R&D Manpower**

This includes all personnel, comprising of researchers, technicians and staffs supporting R&D work, irrespective of their qualifications. Researchers are personals who are principally employed in a research capacity with or without formal university qualifications.

The breakdown of R&D manpower can be illustrated in the following diagram:



### 2.6.3 Full Time Equivalent (FTE)

FTE is an approximate measure of the proportion of time a researcher, technician or other support staff spent on R&D work during the surveyed year.

### 2.7 The Malaysian R&D Classification Systems

The R&D classification system was first introduced in the "1992 National Survey of Research and Development". It was an attempt to analyse the R&D resources and activities in terms of the fields of research (FOR) and the socio-economic objective (SEO) classifications. Due to mixed responses and feedback received from various parties and to suit Malaysian environment, the original version of the classification system was revised and used in the 1994 Survey.

The 1996 survey was conducted based on the revised classification system introduced in 1994.