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THE MEASUREMENT OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

MANUAL ON THE MEASUREMENT OF HUMAN RESOURCES DEVOTED TO S&T "CANBERRA MANUAL"

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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THE MEASUREMENT OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

MANUAL OF THE MEASUREMENT OF HUMAN RESOURCES DEVOTED TO S&T "CANBERRA MANUAL"

This Manual is intended to provide guidelines for the measurement of Human Resources devoted to Science and Technology (HRST) and the analysis of such data.

It has been prepared in close co-operation between the OECD and the DGXII and Eurostat of the European Commission, other OECD Directorates (notably DEELSA), UNESCO and the International Labour Office (ILO) and with the support of national experts.

The text was discussed at specialist workshops at the OECD in 1992 and 1993 and then submitted to the Group of National Experts on Science and Technology Indicators (NESTI) at its meeting in Canberra in April 1994. In recognition of the hospitality of the Australian authorities in organising the meeting, a suggestion was made and approved by NESTI that the guidelines should henceforth be known as the "Canberra Manual". The Group recommended that the text be submitted to the Committee for Scientific and Technological Policy for derestriction after incorporation of the proposals of the meeting and subsequent written comments and after professional editing.

After these amendments had been made, the document was approved by the Committee and is now made available to the public under the responsibility of the Secretary-General of the OECD.

PREFACE

The Measurement of Human Resources Devoted to S&T -- Canberra Manual -- is the fifth in the "Frascati family" of manuals on the measurement of scientific and technological activities. Other manuals are devoted to measuring research and experimental development (R&D) activities, technology balance of payments (TBP), innovation and patents. This is the first manual in the series to be prepared jointly by the OECD and the European Commission/Eurostat.

Highly skilled human resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being. While the number and distribution of scientists and engineers were recognised as important indicators of a nation's S&T effort when the first S&T indicators were being designed in the early 1960s, countries and international organisations usually saw a need for internationally comparable data on human resources only in the context of short-term policy issues, for example the "brain drain" debate and the "ageing" of the S&T work force.

In consequence, very few countries established and systematically maintained coherent systems for the monitoring of stocks and flows of scientific, technical and engineering personnel deemed necessary for longer term analysis or the examination of a wider range of issues. Hence, despite intermittent efforts in the 1980s, the methodology, collection and analysis of quantitative information on human resources devoted to S&T (HRST) at the OECD was confined to personnel engaged in R&D only.

With the approach of the nineties, more pressing policy needs for all measures of HRST began to emerge. In 1989, a joint report of the OECD Committee for Scientific and Technological Policy (CSTP) and its Group on Scientific and University Research (now the Group on the Science System), recommended that further efforts be made to collect data in order to fill in the gaps in our knowledge of HRST. An OECD report, Technology and the Economy: The Key Relationships (1992), stressed that an adequate supply of appropriately educated and trained human resources was a critical factor in innovation. While the report acknowledged the existing problems of international comparability, there was agreement on the need to establish databases at both national and international levels. Similar policy interest was evidenced by the Human Capital and Mobility programme, launched by the European Commission in 1992, and issues with direct relevance to HRST continue to be high-priority areas in the programmes of work of both OECD and the European Commission/Eurostat. In response, a first exercise was launched by the OECD Secretariat and the Group of National Experts on Science and Technology Indicators (NESTI) together with the European Commission (DGXII and Eurostat) to design a statistical framework and a methodology for the collection, interpretation and analysis of HRST data.

In drafting this Manual every effort has been made to incorporate the best national and international practice. It draws on the results of a comprehensive pilot inventory, undertaken specially for this exercise, of existing national experience and S&T personnel data sources in the OECD and European Union Member countries. The Manual makes the greatest possible use of the main standard international classifications. Account has also been taken of the experience and interests of international agencies, such as UNESCO, the International Labour Office (ILO), the European Commission (DGXII and Eurostat) and the OECD Directorates for Science, Technology and Industry (DSTI) and for Education, Employment, Labour and Social Affairs (DEELSA) and the Centre for Educational Research and Innovation (CERI) in charge of the OECD education statistics and indicators.

The Manual represents several years of solid international team work. We believe these guidelines represent an important step forward in the harmonisation of the data and in the use of HRST indicators. The guidelines will now be tested in practice and then revised in the light of this experience.

The initial draft versions of the Manual were prepared by Dr Richard Pearson of the Institute of Employment Studies, United Kingdom (formerly the Institute of Manpower Studies) as a consultant to the OECD. The final version was prepared by the OECD Secretariat, Eurostat (D3) and DGXII (A4) of the European Commission with the active assistance of a number of national and international experts, notably Ms Wendy Hansen of Industry Canada and Dr. Eivind Hoffmann of the International Labour Office (ILO).

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CHAPTER 1

OBJECTIVES AND SCOPE OF THE MANUAL

1. 1 Introduction

1. The combination of science and technology (S&T) and human resources (HR) is seen as a key ingredient of competitiveness and economic development and also as a means of safeguarding and enhancing our environment over the coming decades. New technologies are being developed and applied, very quickly in many cases. An increasingly skilled and effective workforce will be required if countries are to negotiate the rapid change and new challenges that are emerging in S&T.

2. The term "Human Resources in Science and Technology" (HRST) has been coined for use in this manual to describe this special skilled labour force. At its widest, it extends to everyone who has successfully completed post-secondary education (or is working in an associated S&T occupation); at its narrowest it covers only those with at least university-level qualifications in natural sciences or engineering (or working in an associated S&T occupation). "Human resources" is a synonym for "personnel" or the now obsolete "manpower", and has been chosen in order to avoid confusion with other methodologies and statistical sources.

3. A wide range of issues where HRST data are relevant will be reviewed in Chapter 2. We may note one or two of them here, beginning with those affecting the future balance between supply and demand for human resources. The demographic downturn in many developed countries is placing a constraint on future supply. Other changes, such as economic restructuring and the current decline of defence-based industries in some countries, may lead to a surplus of specialists with what were once scarce S&T skills. Imbalances between sectors or regions also occur, and the labour market for HRST is becoming increasingly international.

4. The lead times to train and develop S&T skills are long and the costs high. Forecasting future demand is at best an inexact art. Framing effective policies to train, retrain and utilise these expensive and often rare skills will call for better statistical information -- better both quantitatively and qualitatively -- about HRST demand, availability and utilisation.

5. Potential users of HRST data are varied and include policymakers and analysts in government, related agencies and the private sector (notably industry), and academics. Some need the data in order to assess current conditions, or else to understand how the HRST "system" and "market" work. Others are more concerned with possible future trends and developments.

6. Most countries are interested in these S&T personnel issues and frequently have some idea of what categories of human resources are of specific interest, but there is, so far, no generally accepted statistical framework in the OECD area for analysing Human Resources in Science and Technology, though some components are dealt with in existing international methodologies. Few countries in fact have any formal definition of HRST. Accordingly, there is very little in the way of internationally comparable data.

7. Quite a number of national and international data sets (such as education and labour force statistics) do contain some information about HRST, but they have seldom been collected for the purposes of S&T policy, and policymakers and analysts are not always familiar with them. Their coverage and reliability may vary both across

data sets and over time, and many series are frequently some years out of date. For international comparisons, in the first instance national data sets often have to be used, but problems may then arise because collection systems differ widely and the methodologies and classifications are frequently incompatible. It is important that policy staff and analysts are aware of these sources of data, and of their potential and drawbacks.

1.2 Objectives

8. The purpose of this manual is to provide a framework for compiling data on stocks and flows of Human Resources in Science and Technology, for analysing profiles and trends and for preparing up-to-date series for the users we have mentioned.

9. It is intended to help countries assemble data in this standard framework using both the series that are already available and the results of future surveys, and to facilitate the exchange and joint use of internationally comparable statistics by OECD, the European Commission (Eurostat) and other international agencies, notably UNESCO.

10. It sets out basic definitions of the activities to be covered, the categories of personnel to be included and the variables of interest for a proper understanding of HRST stock and flow issues. Wherever possible, the specifications proposed are based on the methodologies and classification systems in general use, on data sources set up by UNESCO, the International Labour Organisation, Eurostat and OECD, and on the latest version of the System of National Accounts, modified as appropriate by advice from experienced national data collection agencies and users.

11. Ways of making the best use of existing data sources are described in Chapter 7. Readers are referred to basic international classifications (in the annexes) for the practicalities of actual survey work or data collection.

1.3 Scope of HRST

12. The series of OECD manuals dealing with the measurement of scientific and technological activities started from the view, which underpins the whole idea of science and technology policy, that we can identify a set of activities which, though embedded in the cultural, social and economic systems of individual countries, call upon specific scientific and technological knowledge, skills and methods and contribute in a special way to social and economic progress.

13. HRST would ideally refer to the human resources actually or potentially devoted to the systematic generation, advancement, diffusion and application of scientific and technological knowledge. Developing a common conceptual framework on which to build a coherent set of statistical guidelines has not been easy, of course, and a number of compromises have proved necessary.

14. Agreed definitions, in line with international standards, of the types of human resources to be included are presented in Chapter 3, which also indicates the types of coverage that are desirable for international comparisons and offers guidance on a number of apparent problems of classification.

15. We recognised at an early stage that it was not practicable to define HRST in terms of the specific S&T activities listed above; suitable data were not available, except for the generation of knowledge (R&D) and perhaps for diffusion (teaching). The approach chosen was to review the range of occupations involved in these activities. Each one requires **skills** obtained through **education** (which usually gives rise to **formal qualifications** in the shape of degrees or diplomas, whose equivalence may be recognised internationally) or through training or on-the-job experience (countries have various ways of recognising these skills).

16. This manual does not cover every person actually or potentially engaged in scientific and technological activities or occupations, only people with higher-level skills. The chief focus is on compiling and analysing data concerning "**University-level HRST**", i.e. people actually or potentially employed in occupations requiring at least

a first university degree. We also focus on **"Technician-level HRST",** where the skill requirements are somewhat less demanding. Unlike in the UNESCO guidelines for measuring S&T activities (see Annex 1) or the Frascati Manual for the measurement of R&D (see Annex 2), people below technician level, such as clerical staff, are excluded. The emphasis on these levels of HRST is reflected in the types of coverage that we propose. The core coverage comprises data sets on people with qualifications in natural sciences, engineering and the medical and agricultural sciences only; other types of coverage (taking in social sciences and humanities, for instance) are more comprehensive, or less disaggregated.

17. Two main systems can be used to identify HRST: by **occupation** (people employed in S&T activities at the appropriate level), and by **qualification** (people with the formal education which fits them to be so employed). Whether to take occupation or qualification as the primary dimension of analysis will depend on the question being considered. Data on occupation relate to demand-side or utilisation issues such as "How many people are actually employed as HRST?". Data on qualification are most useful when looking at supply-side issues such as "What is the pool of people potentially available to work in S&T?".

18. It is important to recognise that not all those with S&T qualifications will necessarily be employed in the corresponding S&T occupations. Some will be inactive (retired, unemployed etc.), others will be employed in non-S&T occupations (clerical staff, policymakers). The interest here is to distinguish between occupations which form part of an "S&T career" and those which do not. Some may also be employed at higher (or lower) levels within the system than would be predicted by their formal qualifications, for example engineers with skills obtained via in-house training, or university graduates employed as technicians. This manual is thus concerned with data on both qualifications and occupations, perhaps with some slight bias towards qualifications because the data seem to be more readily available and comparable.

19. One of the most troublesome problems when drafting the manual was to decide on the coverage of "science and technology" (S&T) in terms of skills and qualifications, notably because opinions varied for longstanding cultural and linguistic reasons, in particular over the meaning of the terms "science" and "scientific". English speakers tend to take a narrower view based on specific fields (natural sciences and engineering); the approach allied to the German concept of "Wissenschaft" is wider in terms of fields, but perhaps more restrictive in terms of levels of skills and activity. There was agreement on the central fields of the natural sciences, engineering and technology, agricultural sciences, medical science and social sciences. Views differed on whether S&T extends to such fields as religion and theology, home economics, humanities or fine, applied or performing arts. These fields are grouped here under the generic heading "Humanities".

20. Opinions also vary on whether S&T is a clearcut system which the definition of HRST should match. It can be argued that in a knowledge-based society there is no longer anything special about science and technology, or any systematic link between the content of studies and the application of the resulting knowledge in the workplace. It is also possible to identify not one system but several, each with its own imperatives and policy issues. For example, education patterns and labour markets are clearly different, in terms of levels, for highly qualified HRST, e.g. **PhDs** destined for R&D and university teaching, and for engineering technicians. A proposal to create a third category, PhD-level HRST, was in fact abandoned only on practical grounds. Likewise, some specialists believe that the training and use of human resources in **health care** and **primary school teaching** form quite separate systems in terms of areas of knowledge, and that such data are of little relevance in a statistical framework for HRST. Similar arguments have been raised about the acquisition and application of **legal** knowledge or of skills in the **performing arts**.

21. Part of the definition of HRST in this manual is based on occupation, when the person concerned is carrying out an S&T activity without the relevant formal qualification, simply with on-the-job training and experience. Despite the guidelines in the International Standard Classification of Occupations, international perceptions of the skill levels of some broad categories of S&T-relevant personnel, such as managers or engineers, differ significantly, so there is some doubt about where to place them.

22. Given all these differences in cultural backgrounds and areas of policy interest, no single and specific definition of HRST can be presented. We have opted for a very wide initial coverage which includes all people with third-level education or a job requiring similar skills, together with a ranking system which identifies a common core of occupations/fields of study of major interest but allows those with wider concerns to include further categories. As we have already noted, greater attention is paid to university-level HRST than to technician-level HRST, and natural sciences, engineering and the medical and agricultural sciences are the core fields.

23. Variations in the definition, and hence scope, of HRST are not merely of theoretical interest; they can have a significant impact on the quantity and complexity of the data included in the system. In terms of levels, for example, the number of HRST in the OECD area is almost doubled if technician-level staff are included, according to recent OECD Education Indicators Reports. Comparisons are more difficult by fields of study, but perhaps one in four university-level HRST in the OECD area has a degree in natural or mathematical sciences or engineering.

24. Some attention has been given to how long people who have an S&T qualification but are not currently "using it" should be counted in the S&T pool, especially those who have pursued a career outside the S&T system and those who are out of the labour force. The basic question is "Are their S&T skills and understanding still retrievable and relevant?" There is little problem about including someone who is out of the S&T system only temporarily, performing military service for example, or serving in a restaurant while looking for an HRST job. It is also of value to include someone who started off in S&T, in a research laboratory for instance, but has now become a senior decision-maker in industry or government. More difficulty occurs with people who have never entered the S&T system, those who have been out of it for a long period (bringing up children for example), and those who are over working age. In the end, we felt that these distinctions were too difficult to apply in practice; we simply recommend that low importance be attached to collecting data on HRST aged 70 and over.

1.4 Measuring stocks and flows of HRST

25. A schematic framework describing the stocks and flows of HRST which can be used when compiling and analysing HRST data is given in Chapter 4.

26. Stocks can be measured at many levels of detail, but the major policy interest is usually in **national stocks**. Definitions and diagrams are proposed. The boundaries between countries are breaking down in ways which complicate the collection and interpretation of HRST data. **International flows** of HRST have long been monitored, in connection with "brain drain" and "brain gain" issues for instance, but the globalisation of S&T and economic activities and hence of work and residence patterns hinders the measurement of **national stocks** of HRST defined in terms of residence. The System of National Accounts sets out guidelines for dealing with traditional cases such as international organisations, embassies and foreign military bases. No such guidelines are available for HRST employed by multinational corporations, who may be recruited and deployed worldwide, moving to meet the group's changing needs. Some may even have jobs which require them to work in several countries. Furthermore, it is by no means unusual, at least within the EU area, for an HRST to be officially resident in one country and work in another. Special arrangements are proposed to deal with people whose residence and employment vary, notably for the measurement and analysis of **regional stocks of HRST**.

27. The manual also pays particular attention to the "pipeline" of flows into the HRST stock via the education system. This is very important for policy and planning reasons, and because students, and more especially foreign students, receive separate treatment in national accounts and labour force data.

1.5 Breakdowns of HRST data

28. Chapter 5 recommends a number of breakdowns for HRST data, and cross-references them with international classifications and current data collection systems. It deals with the level and field of study of HRST, their labour force status, and the occupations, sector and industry of those in employment, and gives an optional checklist of the types of activities to be included. Chapter 6 describes some further information (age, gender, national

origins, etc.), mainly qualitative, which may usefully be compiled to supplement the basic HRST data, and some more general sets which will help analyse the HRST data in context.

29. Applying these breakdowns and combining the results in a coherent framework is made more difficult by the growing flexibility of the system or systems we are dealing with. Steady progression through school and university, acquiring a set of knowledge and skills tailored to a specific range of jobs which will lead to a lifetime career within that range, is by no means the norm that it used to be. The pattern of education has become more fluid; there are more interdisciplinary courses, more mature entrants and, in some countries, more foreign students. On the employment side full-time work is giving way to more flexible patterns, with many more part-time jobs or posts. Even highly qualified personnel must now be prepared to retrain and/or make major occupation changes over the course of their career, and the rise of consultancy is blurring the borderlines between traditional labour force categories.

1.6 National and international sources and guidelines

30. Most users of the manual are unlikely to be in a position to conduct special HRST surveys, and will have to compile their data from national and international sources. Chapter 7 lists the main sources and outlines their principal advantages and disadvantages for HRST purposes.

31. As we have mentioned, wherever possible the norms and definitions in this manual have been derived from broader international specifications. Only minimal quotations are given in the main text. As readers may not have these other international manuals to hand, the annexes contain fuller extracts and information.

1.7 Conclusion

32. The challenge in preparing this manual has been to find a framework which is both conceptually sound and realistic in practice, and combines the concepts of scientific and technological activities derived from the Frascati series and similar UNESCO guidelines with the education, national accounts, occupation and labour force categories used for more general analysis of stocks and flows of human resources.

33. This is the fifth in the Frascati family of manuals, and the first be be produced jointly by OECD and the European Commission/Eurostat. It is the consensus of the views of experts from a wide range of OECD countries, each with its own cultural, social and economic system and its own policy preoccupations. National experience has been taken into consideration during its preparation, but the manual has yet to be tried out in practice. It is hoped that it will prove sufficiently utilitarian and relevant to policy and analytical needs to receive substantial testing over the next few years, after which a new and improved version can be prepared.

CHAPTER 2

MAIN USERS AND THE NEED FOR INFORMATION ABOUT HRST

2.1 Introduction

34. A wide range of issues relating to the education, training, and utilisation of HRST are of concern to a number of interest groups. They vary, of course, according to the perspectives of these groups, be they governments or industry, the education sector, employers, academics, analysts or international agencies. They also vary from one country to another, and from region to region within a given country.

35. The time period under consideration is important, as various stages in demographic, economic or technological cycles will generate different types of issues. Skill shortages, which were high on the agenda of many economies in the late 1980s, were of less concern in the recessionary early years of the 1990s when unemployment also began to affect HRST. Issues will further vary between sectors of employment and occupations and between levels of education and fields of study. There may be a shortage of software engineers, for example, but a surplus of biologists. Similarly, high-paying private sectors are likely to face fewer recruitment and employment problems than lower-paying public employers.

2.2 Some key interest groups

36. Traditionally the main users of HRST data have been **international, national and regional governmental bodies** concerned with industrial, S&T/R&D and economic policies and the planning of higher education. Those in the **education and training** system have a key interest in trends and developments as these provide important reference points when planning future provision. **Careers advisers** and **individuals** need data on S&T labour markets if they are to make informed recommendations or decisions about careers and fields of study and the level and duration of studies. As human resources come to be recognised as a strategic factor in **industry,** employer interest particularly concentrates on issues of shortage and supply, both within the labour market and in the new supply coming from the country's own higher education system or from abroad. Increasingly, employers are looking throughout the world for the "best" HRST available, and they in turn are becoming more internationally mobile.

2.3 Uses of HRST data

37. Interest usually centres on national data, the trends therein, additional relevant information and international comparisons. At a strategic level the **stock and inflow of HRST** is seen as a key resource which underpins the country's economy and technological base and -- a more recent concern -- its environmental and general well-being. Knowledge about utilisation and the size and composition of the current and future pools of HRST gives a measure of the nation's potential.

38. A number of factors are relevant on the supply side. Data on **general demographic trends** can be used to project the future supply of S&T students. The significant downturn in the number of young people in the decade to the mid-1990s is of particular concern to Japan as well as many countries in Western Europe and North America. In several of these countries the number of young people, who are the prime entry group to higher education, has fallen by as much as one third between the mid-1980s and the mid-1990s. In spite of these absolute declines, however, the numbers of students in higher education have continued to grow significantly in recent years, as a result of considerably increased participation rates.

39. Higher education and the educational infrastructure in S&T consumes a significant part of a country's GDP. **The links between education and the labour market**, and the flows of graduates into the HRST pool, are useful indicators of its value to the economy. The OECD reports in the series "From Higher Education to Employment" are relevant here. Also relevant are **student attitudes to S&T**, with some countries experiencing a significant swing of student interest away from the traditional science and technology programmes, in favour of business studies for instance. There is also a tendency for young graduates in natural sciences and engineering to opt for employment outside their specific S&T fields.

40. The **characteristics of the HRST** stock (its age profile, breakdown by skills and fields, and so on) will indicate how the pool may change in the future due to retirements and provide pointers to future recruitment levels for replacement purposes. This is currently of specific concern to many Western countries where ageing of the teaching body will become acute before the end of the century. The profiles of the teaching workforce and the participation of foreign nationals as teachers, researchers or students are of direct interest. Such information will also provide an indicator of the "maturity" of the population and the possible need for new entrants and ideas ("new blood") to boost innovation.

41. **Economic restructuring**, whether from declining to sunrise industries or from defence to civil applications of S&T, leads to adjustments in the use of HRST. Flows between sectors and pools of potentially under-utilised personnel are highly relevant for planning purposes, especially the provision of **retraining** programmes. In rapidly changing societies individuals must update (or indeed significantly alter) their skill and competence profiles. Information about training and retraining could provide indicators of adaptability and potential response to future needs.

42. **Equal opportunities** can affect the supply side as well. This is a matter of both social policy and of the economic use being made of all parts of the population. The distribution and representation of particular groups in the population, such as women or minority groups, shows where progress has been made and where problems may exist, and pinpoints pools of potential or under-utilised resources.

43. **Labour market imbalances** can be manifested as skill shortages, unemployment or underemployment. Data on shortages and vacancies are extremely important in identifying bottlenecks and mismatches in the labour market and as indicators for training requirements. Attitudes to imbalances depend on the standpoint, however. Skill shortages may be advantageous from one perspective, as they drive up wages for individuals, while for an employer or government they are likely to be seen as a constraint on development and growth.

44. These imbalances, together with differential reward patterns, give rise to **mobility** (or flows) not only between sectors, regions and countries but also between occupations. Much of the mobility will occur within the worldwide HRST stock. In some cases, of course, the motivating force is social, in that individuals seeking to change their circumstances are prepared to foresake their S&T skills and careers when migrating. Such flows can be viewed as beneficial or damaging, depending on the perspective. Migration from a country, region or activity with high unemployment may be regarded as beneficial if, for example, there is repatriation of income, skill enhancement or eventual return.

45. **HRST unemployment**, indicating the degree of unused S&T resources, is highly relevant, especially in times of recession. In more normal times, unemployment among recent graduates can be a sign of over-supply in certain fields or areas. Imperfect operation of the labour market may be a factor as well; in such cases unemployment can co-exist with skills shortages.

46. The **"brain drain"** (the emigration of highly qualified personnel), and to a lesser extent the **"brain gain"** (the corresponding immigration), have for many years been prominent topics in both general and S&T policy debate. Interest centred in the early postwar period on transfers of HRST between Europe and North America, then on mobility from developing countries (and most recently from the East) to the industrialised world. In the absence of internationally comparable statistics, these debates have often been based on largely anecdotal evidence. Analysis of

the national origins of the HRST stock can provide relevant data and show levels of dependence on foreign nationals which may be of concern for the host country as well as the countries of origin. **Globalisation of S&T/R&D** and the consequent **internationalisation of S&T labour markets** mean that national perspectives on supply and demand trends are becoming less than adequate for policymakers. The European Community has recently been investing significantly in programmes to develop its human resources base and promote mobility. Such action requires solid data to help focus priorities and initiatives.

47. Within a single country there may be large **inter- and** even **intra-regional differences** in the characteristics of HRST stocks and flows of all kinds. A region may have a large stock of qualified HRST, or a large HRST output from its higher education establishments, without necessarily having a higher level of S&T (or more specifically R&D) employment, or indeed, any such jobs at all. Conversely, a region with a small potential reservoir of qualified HRST and/or low HRST output from its higher education establishments may well have a high level of S&T (or R&D) employment. Inter- (and intra-) regional HRST flows hold very important information for regional and national governments, international organisations and industry, and so do differences in HRST immigration or emigration in different parts of the same country.

CHAPTER 3

BASIC DEFINITIONS

3.1 Human resources in science and technology (HRST)

3.1.1 Basic definition

48. In order to obtain a complete picture of both supply and demand for HRST, the definition is based on two dimensions, qualification and occupation. The qualification axis tells us about the supply of HRST, i.e. the number of people who are currently or potentially **available to work** at a certain level. The demand for HRST, i.e. the number of people who are actually **required** in S&T activities at a certain level, is related to the occupation dimension. Because demand does not always match supply and because skills can be obtained outside the formal education system, the following combined definition is proposed.

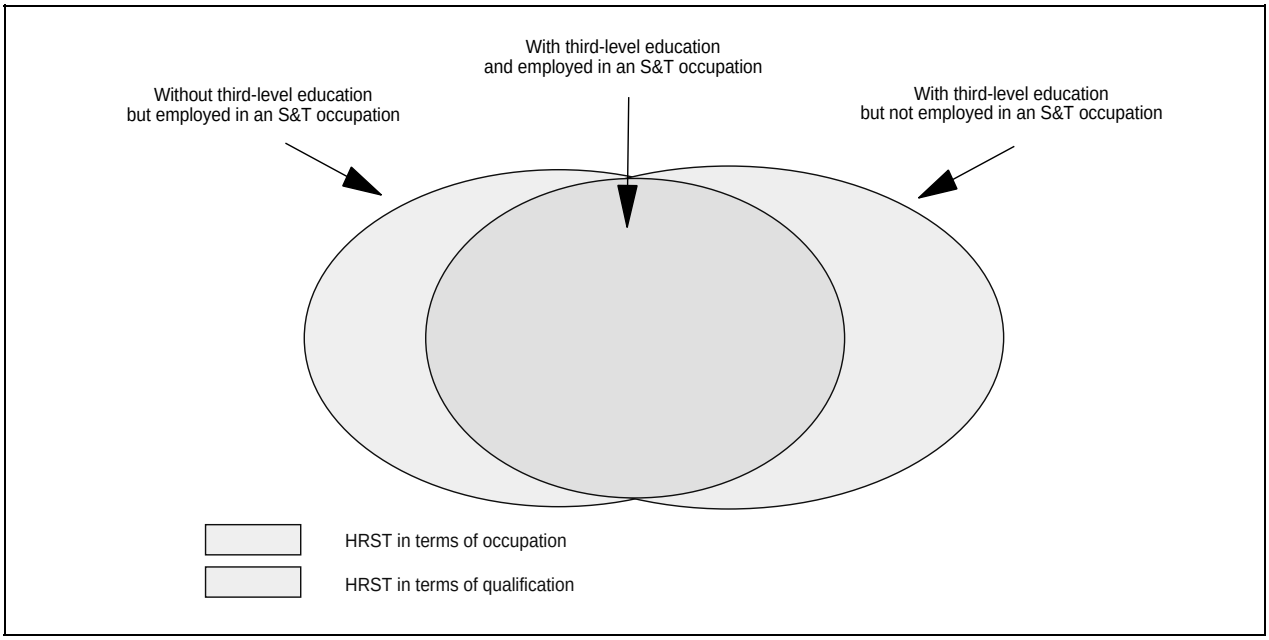
49. **HRST are people who fulfil one or other of the following conditions:**

> **a) successfully completed education at the third level in an S&T field of study;**
>
> **b) not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required.**

50. The definition of HRST needs some explanation. One crucial part refers to **Science and Technology** (S&T). At its widest, science means "knowledge" or "knowing"; in a narrower sense it is understood as being the kind of knowledge of which the various "sciences" like mathematics, physics or economics are examples (and here it is close to the Latin "scientia" and the German "Wissenschaft"). In ordinary English usage science is often synonymous with the natural sciences. To overcome differences of opinion about the exact scope of "science" we have opted for a broad definition; we then recommend a greater focus (our core coverage) on disciplines that appear particularly relevant here. Defining technology seems less controversial; it is "the application of knowledge", and more narrowly dealing with tools and techniques for carrying out the plans to achieve desired objectives.

51. **Education** is defined by UNESCO as "organized and sustained communication designed to bring about learning". (For the meaning of "communication", "organized", "sustained", and "learning", see Annex 3). Education at the third level covers studies leading to a first or higher university degree and also other studies at post-secondary level leading to awards not fully equivalent to a first university degree (formal definitions of these categories are given in section 3.2 and further developed in section 5.4.1.3). Successfully completed education at a given level leads to a formal **qualification.**

Figure 3.1 **Principal categories of HRST**



52. **Occupation** is defined in terms of jobs [or posts -- see the discussion of statistical units in sections 5.2.3 (general), 5.4.1.2.2 (ISCED) and 5.4.2.2.2 (ISCO)]. A **job** is a defined set of tasks and duties carried out (or meant to be carried out) by one person. Jobs require skills which may be acquired via education or on-the-job training (for further details see Annex 4).

53. In theory, persons may be classified to occupations in terms of a past, present or future job. Our definition relates to **current employment** only. Employment refers to any kind of work, even as little as one hour, for pay (paid employment) or profit (self-employment) during the reference period (usually one week). For further details on employment, see Annexes 5 and 8.

54. Under our definition, people can be HRST on the basis of either a renewable event (occupation) or a non-renewable one (education). Once people have successfully completed education at the third level they are HRST for life, whatever their occupation. The situation is different for people who are HRST on the basis of their current occupation, without being formally qualified. Their status as HRST ends as soon as they change to an occupation outside S&T, retire, become unemployed or inactive. They will become HRST again if they subsequently take up another S&T job. The numbers of HRST reported may accordingly increase or decrease in line with the business cycle or other changes in economic conditions, and irrespective of changes in skills, on account of people who are HRST by occupation only.

55. The definition of HRST thus relies upon one mainly objective and one mainly subjective criterion. Generally, the completion of education can be readily measured. But data on occupation are often based on self-definition, which makes them less reliable. Nevertheless, both components appear to be essential to cover all aspects of HRST.

56. Figure 3.1 illustrates the three categories of Human Resources devoted to Science and Technology as we have defined them.

57. The oval on the right contains individuals who meet the formal S&T qualification criteria. The oval on the left contains those who are working in S&T occupations, whatever their qualifications. The central group formed by

the intersection of these two is the key group of HRST: people formally qualified at the third level in an S&T field of study and working in an S&T occupation. The outer part of the qualification oval can be seen as the **HRST reserve:** people duly qualified but not employed in S&T. The outer part of the occupation oval contains people who are HRST solely by their current occupation.

58. Examples of HRST:

Qualified and employed as HRST:

-- university professor with a PhD in economics;
-- computer system designer with a degree in computer science;
-- dentist practising in his/her own dental surgery.

Qualified as HRST but not so employed:

-- unemployed marine biologist;
-- engineer staying at home to raise his/her children;
-- professional sportswoman with a university degree in medicine.

Employed as HRST but not so qualified:

-- computer programmer who did not complete second-level education;
-- language teacher with second-level education;
-- sales department manager without completed third-level education but with sufficient experience from training on the job.

Examples of people working in an S&T activity but at **too low a skills level** to be included in HRST (unless they have a third-level qualification):

-- secretary in a research and development department;
-- library clerk in a university library;
-- data entry operator at a national statistical office.

59. Accordingly, HRST will include all individuals who have completed education at the third level, regardless of whether they have ever used their education in a job, and regardless of whether or not their knowledge is still up to date after a break. Taxi drivers with PhDs are included, and so are retired people, whatever their age. This very broad definition, which would seem to refer to virtual or potential personnel rather than actual stocks, has been adopted partly on practical grounds. The basic idea behind it is that, even if people educated at the third level have never used their education or have left an S&T job for some time, they still have basic knowledge which can be "polished up", and they could thus be employed (or re-employed) in an S&T occupation. The availability of retired people for the labour market of course diminishes with age. HRST aged 90 or 100 are of little relevance for the labour market, but recent retirees may well become consultants, for example. Some cut-off point is obviously desirable, but setting an age at which retired people are no longer deemed able to practise an S&T occupation is bound to be somewhat arbitrary.

60. It is recommended that higher priority should be given to obtaining information about HRST aged 70 or less than to older ones.

61. A problem likewise occurs with people who are HRST by occupation only, without being formally qualified. Some people hired for an S&T job may not have the required skills when they start. Even so, they are HRST from their first day of employment. Ideally, these persons should not be included in HRST until they have gained experience. For practical reasons, however, we recommend that lack of experience should be disregarded: it is difficult to define how long it takes to acquire "sufficient" experience, and in any case information on experience would be exceedingly hard to collect.

3.1.2 University-level HRST and technician-level HRST

62. HRST can be split into two major categories: **university-level HRST** and **technician-level HRST**. The split between the two is related to skill levels and thus mainly to education. In general, education at the third level begins at the age of 17 or 18 and lasts three or more years. Successful completion of either a first or a postgraduate university degree (or equivalent) is the main criterion for university-level HRST, whereas an award lower than a first university degree is the criterion for technician-level HRST. People without qualifications may enter these categories by virtue of occupation; they will usually have skills acquired outside the formal education system. This distinction leads to the following definitions of university-level HRST and technical-level HRST.

University-level HRST are people who fulfil one or other of the following conditions:

a) successfully completed education at the third level of the type that leads to a first or postgraduate university degree or equivalent, in an S&T field of study; or

b) not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required.

Technician-level HRST are people who fulfil one or other of the following conditions:

a) successfully completed education at the third level of the type that leads to an award not equivalent to a first or higher university degree, in an S&T field of study (other than those employed in occupations normally requiring a higher qualification); or

b) not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required.

63. The relation between these two categories of HRST and education levels is further developed in section 3.2.1 below.

64. Because we combine education and occupation criteria, there are two categories of people who appear to fall into both the university-level and technician-level definitions of HRST:

-- people qualified at technician level and working in university-level occupations;

-- people qualified at university level and working in technician-level occupations.

65. Following the definitions we have proposed, both would be counted as university-level HRST. Some examples of overlapping cases:

-- an electronic engineering technician who becomes computing services department manager after 20 years of working experience (university-level HRST by occupation);

-- a forestry technician working as a landscape architect (university-level HRST by occupation);

-- a statistical assistant with a PhD in sociology (university-level HRST by qualification);

-- a flying instructor with a university degree in astronomy (university-level HRST by qualification).

3.2 Coverage of HRST in terms of education

3.2.1 Levels

66. To obtain internationally compatible data, standard classifications must be applied to define "education at the third level in a S&T field of study" and "S&T occupation". The International Standard Classification of Education (ISCED) is the most relevant source here. It is a classification both of levels of education and of fields of study. Further details of ISCED are given in Annex 3. Proposals for its use for breakdowns of HRST are found in section 5.4.1.

67. ISCED distinguishes seven categories of education (together with a residual category for education not definable by level), grouped into three broad levels. For the purpose of defining HRST, only the third level of education is relevant. This comprises ISCED categories 5, 6 and 7, which are defined as follows:

ISCED category 5: "education at the third level, first stage, of the type that leads to an award not equivalent to a first university degree";

ISCED category 6: "education at the third level, first stage, of the type that leads to a first university degree or equivalent";

ISCED category 7: "education at the third level, second stage, of the type that leads to a postgraduate university degree or equivalent".

68. The breakdown corresponds to the categories identified above, hence:

-- university-level qualifications are defined as covering ISCED levels 6 and 7;

-- technician-level qualifications are defined as covering ISCED level 5.

69. Attributions should be made on the basis of the highest qualification that a person holds (see also section 5.4.1.5).

70. The education and utilisation of PhD holders can be seen as a subsystem of HRST, with its own labour force characteristics and policy priorities, as noted in Chapter 1, and the possibility of identifying them as a third category of HRST was reviewed. As education systems vary substantially from country to country, such data might be very difficult to compare and this, combined with the difficulty of identifying the corresponding occupation categories, ruled out a separate category for PhDs. For a more detailed discussion on further breakdowns of HRST by qualification, see Chapter 5.

3.2.2 Fields of study

71. ISCED distinguishes twenty-one main fields of study. For macro-measurement of HRST, it is recommended that they are regrouped into the following seven broad fields of study in S&T:

- -- natural sciences;
- -- engineering and technology;
- -- medical sciences;
- -- agricultural sciences;
- -- social sciences;
- -- humanities;
- -- other fields.

3.2.3 Core coverage, extended coverage and complete coverage

72. The definition of HRST is as wide as possible, both for levels of education (ISCED categories 5 to 7) and for fields of study. Although this is appropriate from a general point of view, the coverage will have to be modulated when data are collected.

73. Some levels or fields should always be included (core coverage), for a number of reasons. University-level HRST are more central to S&T activities and policies than technician-level HRST. Furthermore, international comparisons of data based on ISCED level 5 may be misleading because they are particularly affected by differences in national education systems. Third, lead times to train and develop university-level HRST are in general longer, and the costs involved higher, than for technician-level HRST. In terms of fields of study, as discussed in Chapter 1 and in section 3.1.1 above, some fields, like the natural sciences or engineering and technology, are often considered, at least in English-speaking areas, to be more directly relevant to S&T activities than the social sciences, humanities or other fields.

74. It thus seems appropriate to modulate the coverage for both dimensions of education: level of education and field of study. These dimensions are not independent. The type of coverage should not be selected for level of education regardless of field of study, or vice versa; it must be chosen for a given combination of level and field of study.

75. These considerations lead to the following general proposals for the types of coverage to be used, by level of education and field of study in S&T, for the collection of internationally comparable data (Figure 3.2).

76. These recommendations for items to be included in core, extended and complete coverage are based on the cultural differences we have outlined. When data are being collected internationally for specific purposes, it may be appropriate to upgrade some items to core coverage, or relegate others. To the extent possible, the levels/fields should be presented in a disaggregated way so that countries can employ the permutation of coverage that is best suited to their particular needs.

Figure 3.2: **Coverage for data collection, by field of study and level of education**

Field of Study	Level	
	6/7	**5**
Natural sciences	core	extended
Engineering and technology	core	extended
Medical sciences	core	extended
Agricultural sciences	core	extended
Social sciences	core	extended
Humanities	extended	complete
Other fields	extended	complete

77. **Examples:**

Core coverage includes people with

-- a PhD in meteorology;
-- a PhD in medicine;
-- a university degree in economics;
-- a university degree in engineering.

Extended coverage will further include people with

-- a PhD in English literature;
-- a university degree in dramatic arts;
-- a technician award in electrical engineering;
-- a medical technician award.

Complete coverage will additionally include people with

-- a third-level non-university award in languages;
-- a third-level non-university award in graphic arts;
-- a third-level non-university award in singing;
-- a third-level non-university award in religion.

3.3 Coverage of HRST in terms of occupation

78. The equivalent to ISCED for occupations is ISCO, the International Standard Classification of Occupations -- the only one currently available at international level. For details about ISCO, see Annex 4.

79. The latest version of ISCO dates from 1988. However, most of the available data that are relevant to HRST are still based on the earlier version, ISCO-68, or else make use of national classifications.

80. The main interest in using ISCO in this chapter is to define which occupations justify including people in university-level HRST or technician-level HRST when they lack the appropriate formal qualifications, and to suggest types of coverage for collection of occupation data. The use of ISCO for general breakdowns of HRST data is discussed in section 5.4.2.

81. ISCO-88 distinguishes ten major professional groups. Two are of specific interest to HRST: the major groups "Professionals" (major group 2) and "Technicians and Associate Professionals" (major group 3). Major groups 0 ("Armed Forces") and 1 ("Legislators, Senior Officials and Managers") are also considered to be of some relevance.

82. The Professionals group (major group 2) is defined as follows:

> *"This major group includes occupations whose main tasks require a high level of professional knowledge and experience in the fields of physical and life sciences, or social sciences and humanities. The main tasks consist of increasing the existing stock of knowledge, applying scientific and artistic concepts and theories to the solution of problems, and teaching about the foregoing in a systematic manner. Most occupations in this major group require skills at the ISCED categories 6 or 7."*

83. Given this definition, all people working in ISCO major group 2 can be considered HRST, and more specifically university-level HRST. Those employed in such occupations without qualifications at ISCED categories 6 or 7 fall under part b) of the definition of university-level HRST (see section 3.1.2 above). The reverse is not true; not all university-level HRST are employed in ISCO major group 2. They may work in other occupations, including groups 0 and 1, be unemployed or out of the labour force.

84. The Technicians and Associate Professionals group (major group 3) is defined as follows:

> *"This major group includes occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities. The main tasks consist of carrying out technical work connected with the application of concepts and operational methods in the above-mentioned fields, and in teaching at certain education levels. Most occupations in this major group require skills at the ISCED category 5."*

85. Given this definition, all people working in ISCO major group 3 can be considered HRST. They can be divided into three categories: (i) those with qualifications at ISCED categories 6 or 7 who are part of university-level HRST, (ii) those with qualifications at ISCED category 5 who form part a) of the definition of technician-level HRST, and (iii) those with lower qualifications who form part b) of the same definition (see section 3.1.2 above). Not all people with qualifications at ISCED category 5 will be in ISCO main group 3 occupations. They may be employed in any of the ISCO main groups, be unemployed or out of the labour force.

86. In addition to ISCO groups 2 and 3, some HRST-relevant occupations may be identified in major group 1 ("Legislators, Senior Officials and Managers"), especially among the managers. There are three subgroups here which seem of specific interest when deciding whether people with less than third-level education are HRST: "Production and Operations Department Managers" (subgroup 122), "Other Department Managers" (subgroup 123), which includes R&D managers among others, and "General Managers" (subgroup 131).

87. Not all managers in these subgroups are employed in S&T activities, but some categories, like R&D managers, are clearly HRST. Ideally, consideration should be restricted to those managers in ISCO subgroups 122, 123 and 131 who are in fact employed in S&T. In practice, however, it would be very difficult to split the subgroups any further and extract only managers who are employed in S&T activities. The obvious options are to include the subgroups in full, or to leave them out completely. To exclude all types of managers will mean excluding important groups employed in S&T. On the other hand, if all managers in ISCO subgroups 122, 123 and 131 are included, HRST will cover many people who are involved in S&T only marginally, if at all. Research shows that in some countries a substantial share of managers have neither qualifications nor activities to justify inclusion in HRST. Bearing in mind that HRST has been defined as broadly as possible, however, it seems reasonable to include these subgroups in full and to treat them as university-level HRST. Some caution will be necessary when interpreting data on HRST which include all managers as defined in ISCO subgroups 122, 123 and 131.

88. There is another major ISCO group which is of some relevance for identifying individuals with less than third-level education as HRST by occupation, since it contains a number of people employed in S&T activities. This is major group 0, which includes all members of a country's armed forces. It hence covers a wide range of occupations, only some of which are significant for HRST. Few members of the armed forces with less than third-level education are probably employed in S&T activities at all. It is hardly feasible to subdivide the armed forces according to their significance for S&T, so they should either be left out entirely or included in full. As any members of the armed forces employed in S&T activities are very probably also qualified at the appropriate level, and hence are HRST by qualification, it is recommended to exclude ISCO major group 0 from HRST. This means that members of the armed forces will be HRST only by qualification, not on the basis of their occupation.

89. In conclusion, it is recommended that:

All people employed in occupations which are classified in ISCO-88 major groups 2 or 3 or in the management subgroups 122, 123 or 131 are considered to be employed in an S&T occupation and as such are HRST even if they do not have a third-level qualification.

People in occupations in ISCO-88 major group 2 or subgroups 122, 123 or 131 are to be considered university-level HRST regardless of the level of their highest qualifications.

People in occupations in ISCO-88 major group 3 are to be considered technician-level HRST unless they have ISCED level 6 qualification or above (justifying their inclusion in university-level HRST).

90. It is often felt that some of the occupations classified in these major groups and subgroups are more relevant to S&T than others -- a point already discussed in connection with field of study in section 3.2.3. It is accordingly recommended to modulate the coverage of data sets by occupation as well.

91. The coverage shown in Figure 3.3 is a compromise between what would be desirable in an ideal world and what is realistic. Many groups selected in fact are of varying significance for HRST, as we saw with the coverage by qualification. For example, ISCO subgroup 123 contains R&D managers, who ought to be included in the core data set; they cannot be separated from the other managers in this subgroup, so it is proposed for extended coverage. "University Teaching Professionals" (ISCO subgroup 231) ought to be in the core set, as opposed to the extended coverage proposed for "Teaching Professionals" (ISCO group 23); similarly "Statistical, Mathematical and Related Associated Professionals" (ISCO subgroup 3434) ought, ideally, to be in the extended set, rather than in the complete one along with all the other occupations in ISCO group 34 ("Other Associate Professionals").

Figure 3.3: **Coverage for data collection, by occupation**

	ISCO-88 groups of occupations	Coverage
122	Production and Operations Department Managers	extended
123	Other Department Managers	extended
131	General Managers	extended
21	Physical, Mathematical and Engineering Science Professionals	core
22	Life Science and Health Professionals	core
23	Teaching Professionals	extended
24	Other Professionals	extended
31	Physical and Engineering Science Associate Professionals	extended
32	Life Science and Health Associate Professionals	extended
33	Teaching Associate Professionals	complete
34	Other Associate Professionals	complete

92. To the extent possible, the occupation categories should be presented in a disaggregated way so that countries can employ the permutation of coverage that is best suited to their particular needs.

93. Examples of **core coverage occupations**: physicist, meteorologist, chemist, geologist, operation research analyst, statistician, computer system engineer, computer programmer, architect, bridge construction engineer, electrical engineer, mechanical engineer, cartographer, microbiologist, zoologist, pathologist, agronomist, dentist, professional level nurse.

94. Examples of **extended coverage occupations: the above list, plus** department manager (for example in manufacturing, in business services, of a personnel or R&D department), general manager (for example in agriculture, in retail trade or hotels), university professor, school teacher, curriculum developer, school inspector, accountant, career adviser, lawyer, notary, museum curator, librarian, economist, sociologist, historian, professional social worker, author, journalist, cartoonist, orchestral conductor, actor, engineering technician, draughtsperson.

95. Examples of **complete coverage occupations: the above lists, plus** assistant to school teacher, driving instructor, foreign exchange broker, estate agent, technical salesperson, auctioneer, clearing agent, job placement officer, sports agent, verbatim reporter, bookkeeper, mathematical assistant, executive secretary, tax officer, customs inspector, detective, fashion designer, newscaster, clown, athlete.

3.4 Combined approach

96. Figures 3.4 to 3.6 show the coverage of HRST, university-level HRST and technician-level HRST in terms of both qualifications (ISCED) and occupation (ISCO-88), including people who are unemployed or out of the labour force.

97. Each letter in Figures 3.4 to 3.6 symbolises one cell in the two-dimensional distribution of the two variables defining HRST, qualification and occupation. For example, cell F comprises people who are employed in an occupation classified in ISCO main group 2 and are, at the same time, qualified at an ISCED level less than 5.

98. The breakdown shown in Figures 3.4 to 3.6 can be used to describe additional groups of interest besides HRST, university-level HRST, and technician-level HRST. The HRST **reserve,** defined as people qualified at the

third level in an S&T field of study but not employed in S&T (see section 3.1.1), consists of cells J, K, L, M, N and O. Other combinations that can be identified are people formally qualified at the third level in an S&T field of study and working in an S&T occupation (cells A, B, D, E, G and H) -- the HRST core, people with a formal qualification at the third level in an S&T field of study whatever their occupation is (cells A, B, D, E, G, H, J, K, L, M, N and O), or people working in S&T occupations whatever their qualification is (cells A to I).

99. A number of cases may cause problems or raise doubts. But the individuals do belong in HRST, given the broad definition we have adopted by qualification and occupation:

> a journalist with a PhD in medicine (ISCO-88: 2451) is **qualified and employed as HRST**, and belongs in field D of Figure 3.4;

whereas

> a journalist with second-level education (ISCO-88: 2451) is **employed as HRST but not so qualified**, and belongs in field F of Figure 3.4;
>
> a production department manager with a PhD in physics (ISCO-88: 122) is **qualified and employed as HRST** and belongs in field A of Figure 3.4;

whereas

> a director-general of an enterprise operating worldwide with a PhD in physics (ISCO-88: 1210) is **qualified as HRST but not so employed** and belongs in field J of Figure 3.4;
>
> an actor without third-level education (ISCO-88: 2455) is **employed as HRST but not so qualified** and belongs in field F of Figure 3.4;

whereas

> a head of government without third-level education (ISCO-88: 1110) is **not HRST**.

Figure 3.4

Coverage of HRST in terms of Qualification (ISCED) and Occupation (ISCO-88)

	Qualification		
Occupation	ISCED Level 6+7	ISCED Level 5	Less than ISCED 5
ISCO 122+123+131	**A**	**B**	**C**
ISCO 2	**D**	**E**	**F**
ISCO 3	**G**	**H**	**I**
All other occupations (incl. armed forces)	**J**	**K**	
Unemployed	**L**	**M**	
Out of the labour force	**N**	**O**	

Included in total HRST

Figure 3.5

Coverage of University-level HRST in terms of Qualification (ISCED) and Occupation (ISCO-88)

	Qualification		
Occupation	ISCED Level 6+7	ISCED Level 5	Less than ISCED 5
ISCO 122+123+131	**A**	**B**	**C**
ISCO 2	**D**	**E**	**F**
ISCO 3	**G**	**H**	**I**
All other occupations (incl. armed forces)	**J**	**K**	
Unemployed	**L**	**M**	
Out of the labour force	**N**	**O**	

Included in university-level HRST

Figure 3.6

Coverage of Technician-level HRST in terms of Qualification (ISCED) and Occupation (ISCO-88)

	Qualification		
Occupation	ISCED Level 6+7	ISCED Level 5	Less than ISCED 5
ISCO 122+123+131	**A**	**B**	**C**
ISCO 2	**D**	**E**	**F**
ISCO 3	**G**	**H**	**I**
All other occupations (incl. armed forces)	**J**	**K**	
Unemployed	**L**	**M**	
Out of the labour force	**N**	**O**	

Included in technician-level HRST

3.5 Relation to other definitions

100. Concepts similar to HRST are of course in use at national and international level. Examples are "(Highly) Qualified Manpower/Personnel", "S&T Manpower/Personnel", "R&D Manpower/Personnel", "Research Scientists and Engineers", and so on. Two concepts in international use are of specific interest to HRST: "Scientific and Technical Personnel" as defined by UNESCO, and "R&D personnel" as defined by OECD. We now outline the main differences between HRST and these two. For details about both concepts, see Annexes 1 and 2.

101. UNESCO defines S&T personnel as *"....people participating directly in S&T activities in an institution or unit, and, as a rule paid for their services. This group should include scientists and engineers, technicians and auxiliary personnel...."*. *"S&T activities for their part are defined as systematic activities which are closely concerned with the generation, advancement, dissemination, and application of S&T knowledge in all fields of S&T. These include such activities as R&D, scientific and technical education and training, and the scientific and technological services"* of the kind provided by libraries, information collection, etc.

102. Comparing S&T personnel (as defined by UNESCO) and HRST (as defined in the present manual) reveals that UNESCO's concept is partly broader and partly narrower than the coverage of HRST. The UNESCO definition is based on S&T activities, i.e. an S&T occupation irrespective of level of qualification. UNESCO S&T personnel includes every person who is involved in S&T activities, whether or not he or she has a qualification at ISCED category 5, 6 or 7. As a consequence, UNESCO S&T personnel also comprise **auxiliary staff,** who are excluded from HRST (the only exceptions being people qualified at ISCED category 5 or higher and employed as auxiliary staff). The UNESCO concept of S&T personnel is far broader here. The narrower aspect, compared to HRST, is what we call **the HRST reserve:** people who are qualified at ISCED category 5 or above but not engaged in an S&T activity. These people are included in HRST, but excluded from UNESCO S&T personnel.

103. Although UNESCO issued this definition it has not proved very practical, and UNESCO actually collects and publishes data for two other groups: "potential scientists and engineers" and "potential technicians", drawn either from the total stock or the number of economically active persons who possess the necessary qualifications to be scientists, engineers or technicians. That appears very similar to the definition of HRST in this manual. Missing data on potential scientists and engineers have been estimated by UNESCO using the number of people who have completed education at ISCED levels 6 and 7; for technicians, missing data are estimated using the number who have completed education at ISCED level 5 (UNESCO Statistical Yearbook, 1992).

104. The coverage of R&D personnel is defined in the Frascati Manual as follows: *"all persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators and clerical staff."*

105. R&D personnel includes researchers, technicians and equivalent staff, and other supporting staff. R&D personnel is obviously much narrower than HRST, as it excludes all the latter who are not currently engaged in R&D activities. It thus excludes both suitably qualified persons working in non-R&D activities and suitably qualified former R&D personnel who are unemployed, retired or otherwise out of the labour force. R&D personnel is a wider concept than HRST because it includes all persons working on R&D, regardless of level of qualification or occupation, including those who do not fulfil the minimum qualification/skills requirements for inclusion in HRST. In occupation terms, such people are one of the main components of R&D "other supporting staff", i.e. skilled and unskilled craftsmen and clerical staff who will essentially be found in ISCO-88 major groups 4 ("clerks"), 6 ("skilled agriculture and fisheries workers") and 8 ("plant machine operators and assemblers").

CHAPTER 4

A BASIC FRAMEWORK FOR HRST

4.1 A schematic model

106. It is important when measuring HRST to distinguish between stocks and flows. **Stocks** generally provide a snapshot picture at a particular point in time. **Flows** relate to movements in or out of a stock (inflows and outflows) over a given period, usually a year.

107. An **HRST stock** can be defined as the number of people at a particular point in time who fulfil the conditions of the definition of HRST.

108. An example of a stock figure is the number of PhDs in physics employed in a given country and sector on a given date.

109. **HRST flows** can be defined as the number of people who do not fulfil any of the conditions for inclusion in HRST at the beginning of a time period but gain at least one of them during the period (inflow) as well as the number of people who fulfil one or other of the conditions of the definition of HRST at the beginning of a time period and cease to fulfil them during the period (outflow).

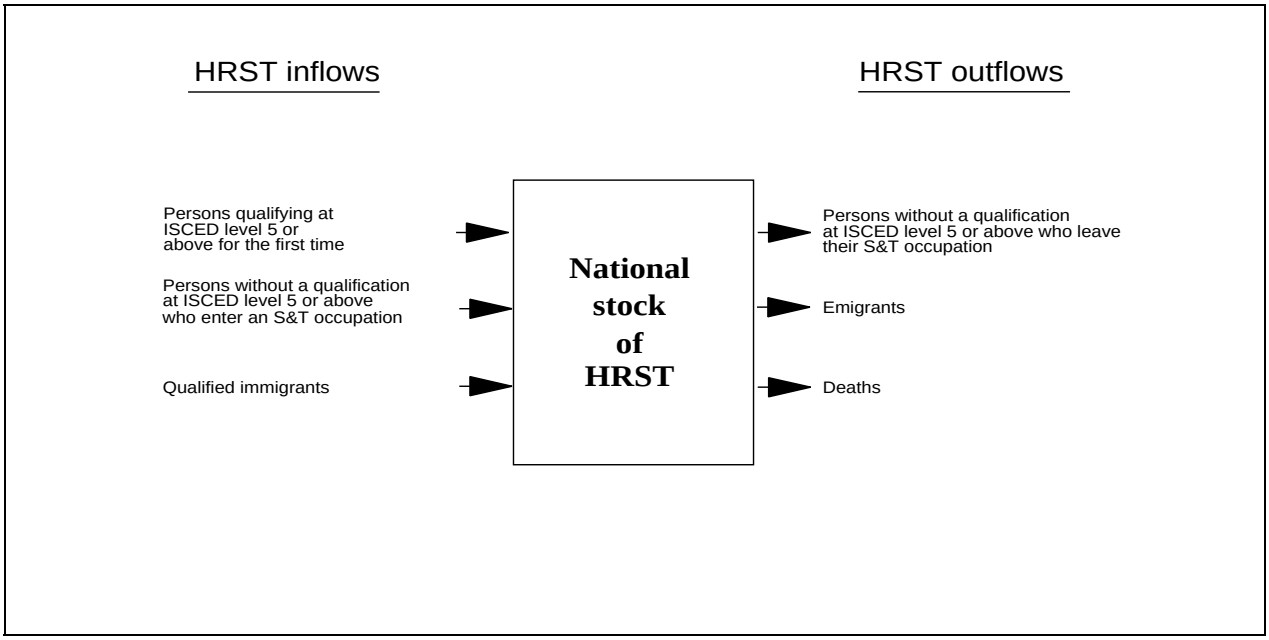
110. An example of an HRST inflow is the number of electronics engineers graduating from a country's universities in a given year.

111. In principle a flow is either into the stock or out of it. But it may also be useful to consider "internal flows", which can be defined as flows within a stock over a given time period.

112. **Internal flows** of HRST can be defined as people who are part of the HRST stock, some of whose caracteristics change during the time period considered without, however, losing the essential characteristics for inclusion in HRST.

113. Examples of internal flows of HRST are people who change their sector of employment, or achieve a qualification at a higher ISCED level.

Figure 4.1 **National stock and flows of HRST: a schematic model**



114. Stocks and flows can be illustrated in a simplified accounting framework by the following equation:

Stock (start of period$_t$)	**+ inflows** (during period$_t$)	**- outflows** (during period$_t$)	**=**	**Stock** (end of period$_t$)	**= Stock** (start of period$_{t+1}$)	**t=0,1,...**

115. Figure 4.1 illustrates the HRST stocks (of a country, for example) and the inflows and outflows, but not the internal HRST flows. This figure is illustrative only. Further subdivisions of the stocks and flows can be made showing more disaggregated levels. It is recalled that the national stock includes unemployed, inactive and retired people as well as those in work.

116. It is worth describing the inflows and outflows from the HRST stock of a country in more detail. On the day they successfully complete third-level education, people enter the HRST stock regardless of their other characteristics, such as employment status or nationality. People without such qualifications become part of the HRST stock when they are hired for an S&T occupation. A country's HRST stock can also increase through immigrants who are already qualified at ISCED level 5 (or above) on entry or who take up an S&T occupation after immigration without having the corresponding formal qualification (at least for the host country). The outflows from the HRST stock of a country are deaths, emigrants qualified at ISCED level 5 or above (regardless of their occupation or labour force status before leaving), and people not qualified at ISCED level 5 or above who leave their S&T occupation. People qualified at ISCED level 5 or above do not leave the national HRST stock because of unemployment or retirement. The coverage of some of these external flows is described further in section 4.2, which deals with the "pipeline" from the higher education sector, and in section 4.4.1, which defines the "national" aspect of national stocks and associated flows.

117. The HRST **stock** can be split according to a number of characteristics into many subsets within a country or a region, for example:

-- the stock of HRST employed in key S&T occupations, in total or by kind of occupation; examples: number of professors teaching at university; number of R&D department managers;

-- the stock of HRST at a given educational level, in total or by field of study; examples: number of PhD holders, number of economists with a PhD;

-- the stock of HRST split according to gender, age, or other personal characteristics; examples: number of female scientists aged under forty, number of female department managers.

For more detail on breakdowns of these variables, see Chapters 5 and 6.

118. Flows, like stocks, can be subdivided in many different ways, according to personal characteristics, geographical characteristics (place of departure or arrival), or type of flow. Three main categories of flows have already been identified -- inflows, outflows and internal flows -- and types of inflows and outflows were illustrated in Figure 4.1.

119. Examples of **internal flows** are:

-- previously inactive people qualified at ISCED level 5 or above, entering an S&T occupation; example: graduate engineer returning to work after taking care of his or her children for some years;

-- people qualified at ISCED level 5 or above becoming inactive; example: university professor retiring at the age of 60;

-- people qualified at ISCED level 5 or above who were employed in an S&T occupation and move to a non-S&T activity; example: general manager with a PhD in economics becoming an ambassador;

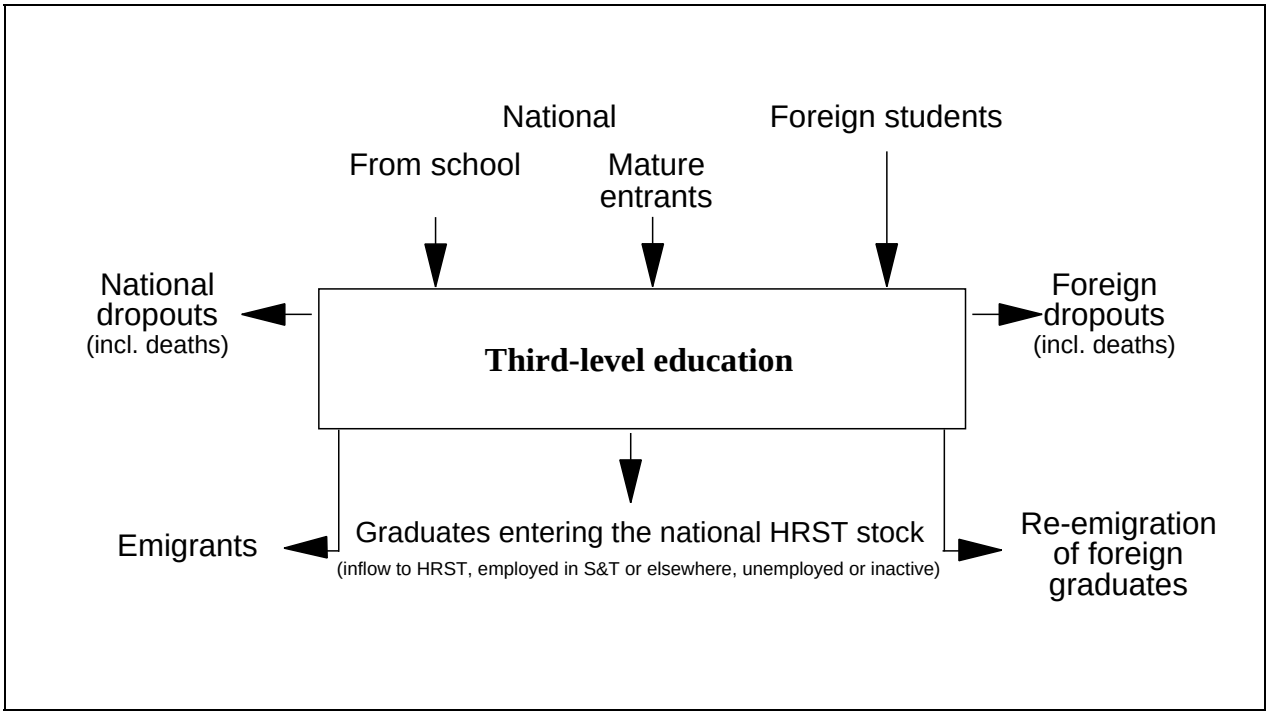
-- flows between different fields of S&T activities, different sectors of employment, or different status of employment; example: chemist who was employed as researcher in a public research institute and becomes head of the R&D department of a private company;

-- flows between ISCED levels 5, 6 and 7; example: medical assistant successfully completing university with a PhD;

-- flows between regions within countries; example: scientists leaving the new Bundesländer in Germany to work in the old Bundesländer.

For more detail on breakdowns of these variables, see Chapters 5 and 6.

Figure 4.2 **The major flows in the pipeline**



4.2 The pipeline

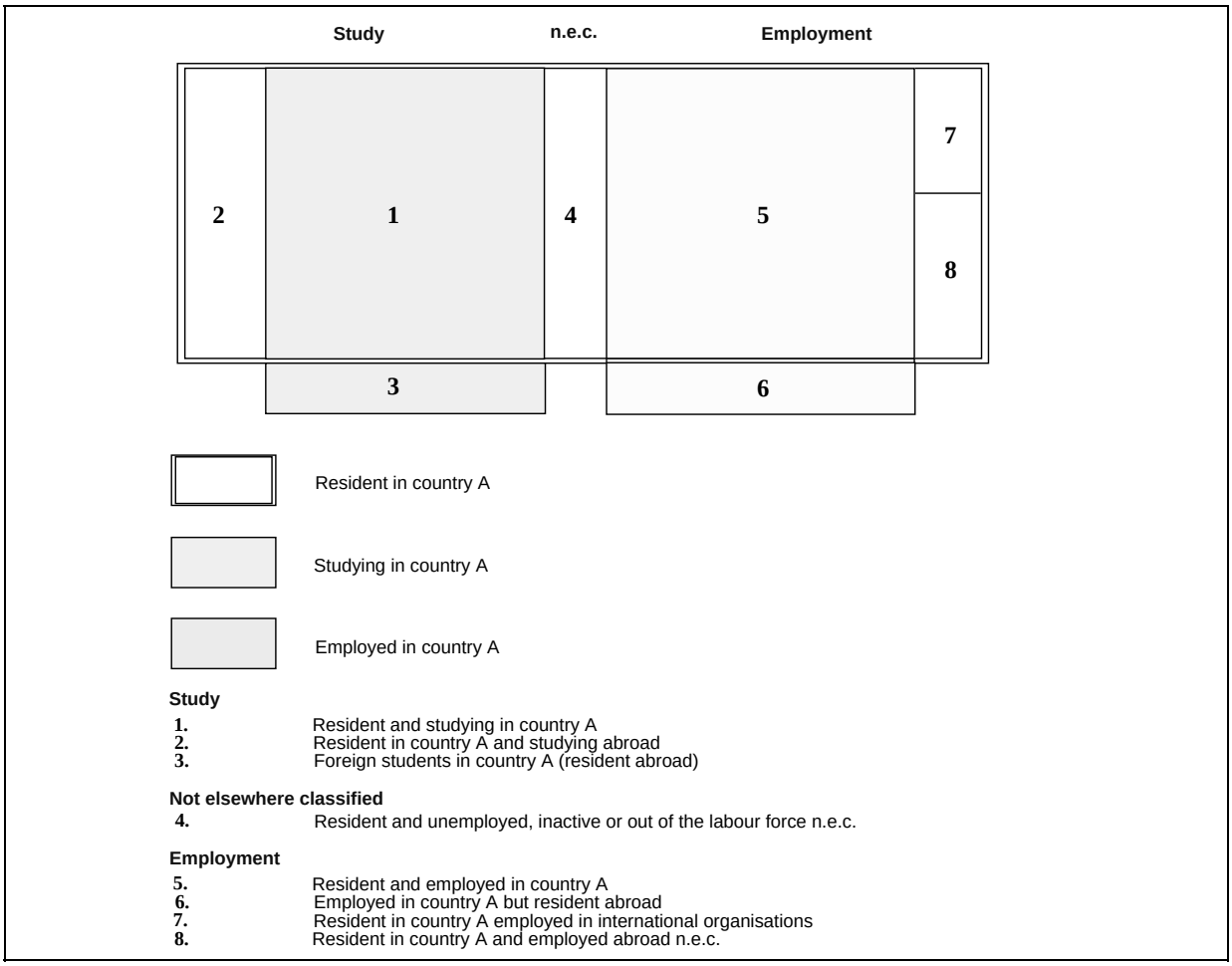
120. A leading inflow to a country's stock of HRST is the output of its higher education system. The flows into, through and out of higher education can be called the **pipeline.** Given the level of spending on this sector, which is the main supply route into national HRST stock, changes in these flows are often of keen interest to policymakers and analysts. There are a series of key flows and critical points in the pipeline, all of which can be relevant. The inflows and outflows are illustrated in Figure 4.2.

121. Again, each of these flows can be considered separately by field of S&T study, level of qualification, and in relation to personal characteristics, such as age, gender and nationality.

122. Flows of foreign students have been shown separately in Figure 4.2 for three reasons. First, removing them from the HRST figures may give a very different picture of trends in the "national" system. Second, they may be dealt with by different policy agencies (e.g. development aid) and subject to different regimes (i.e. fees) within universities or colleges, and often have visas which preclude them staying on once they have graduated. The third reason is that, for the revised System of National Accounts, they are not resident in their country of study and thus, unless they become resident upon completing their studies, do not enter the host's stock (see section 4.4.1 below).

123. Note that people entering third-level education ("inputs") or already in the pipeline ("throughputs") are not HRST until they graduate ("outputs"). All the same, information on these first two categories (student enrolments) is important since these numbers are one of the principal statistical elements for predicting the future supply of HRST. See also section 4.3 below.

Figure 4.3 **SNA concepts of residence, employment and study applied to the national stock of HRST in country A**



4.3 Forecasts, projections and estimates

124. In many countries, projections and forecasts are made of future trends and developments in both stocks and flows of HRST. Sometimes these are incorporated in regular national forecasts, of employment for example, where broad HRST or detailed subgroups are highlighted. In other cases the forecasts and projections appear on an ad hoc basis, focusing on a particular sector or occupation.

125. The methodology and approach can vary greatly and range from highly sophisticated modelling to more crude methods. Such assessments are heavily dependent on: (i) the basic data used; (ii) the forecasting model or approach to projecting used; and, most importantly, (iii) the underlying assumptions about changes in factors such as demography, attitudes, and economic, organisational and technological change. The underlying data are often partial and the choice of assumptions is critical. It is therefore important that any assessments are used with care and their methodology and coverage carefully considered, especially where assessments from different sources and countries are being compared and contrasted.

126. Nevertheless, forecasts and projections are useful. As we mentioned in Chapter 1, the lead time to train HRST is lengthy. Measures taken now will lead to desired results only many years later, if at all. Accordingly, effective HRST policy has at least partly to be based on reliable forecasts and projections of future trends and developments.

127. Models are also needed for another purpose. It is most unlikely that all the data necessary to measure all stocks and flows of HRST will be available or could be collected in the future. One way to fill the gap between the data which are needed and those which are available is to develop reliable methods to estimate the missing stocks and flows.

128. A wide range of models exist to estimate present (or past) stocks and flows. In principle, the models used for projections and forecasts can also be used here. However, having in mind our specific needs, it seems more useful to develop and apply models which are particularly appropriate for such estimations.

4.4 Geographical breakdowns

129. Most models of HRST systems are based on the concept of national stocks and flows. The coverage of "national" is not always easy to define, and it is not the only useful geographical category. The national **origins** of the individuals, especially migrants, are discussed in section 6.2.3.

4.4.1 Geographical coverage

130. The geographical coverage of the HRST stock, i.e. the assignment of HRST to a country or a region (as a subdivision of a country), must be defined in terms of a single attribute. A number of characteristics may seem appropriate: place of residence, place of work, nationality, or location of company. In fact, none of them is ideal. All characteristics related to occupation, such as place of work or location of company, are unsuitable, because not all HRST are employed (some of them are unemployed, others out of the labour force). Assignment via nationality also causes problems, for it can only be used to distinguish between countries, not between regions, and even then many people would be assigned to countries where they neither live nor work.

131. It is therefore recommended that national (or regional) stocks be defined as the number of HRST resident in the country (or region) concerned. Concepts of residence, employment and study referring to the national HRST stock are described in Figure 4.3.

132. The latest System of National Accounts gives detailed guidelines for identifying a person’s country (and hence, by analogy, region) of residence. Formally speaking, the residents of a country (or region) comprise those persons whose "centre of economic interest" is on its "economic territory". This differs from the number of people living on the geographical territory concerned in two ways. First, economic territory includes a country’s "enclaves" (embassies, military bases, tracking stations, etc.) abroad but excludes foreign "enclaves" at home (including international organisations). Persons living in these enclaves (and, by convention, all foreign staff of embassies and consulates but not employees of international organisations) are resident in their country of origin. Second, a "centre of interest" assumes a certain long-term attachment to the country concerned (usually a year), so the following are not considered to be residents: tourists or business visitors staying less than one year, migrant workers, and foreign students. In consequence, it is recommended that only immigrants and emigrants (other than foreign students) with an intended stay of one year or more be included in migration flows, and that anyone arriving or leaving

for a period of less than a year be excluded from the totals. Data on short-term mobility may, however, be of interest in their own right (see Chapter 6).

133. The use of place of residence as defined in the SNA as the overriding criterion for defining national or regional stock raises three main problems:

(i) The combination of these guidelines and the definition of HRST has the consequence that whilst foreign students will become HRST on the day they complete ISCED level 5, 6 or 7 studies, if they continue their studies in the host country (or return home), they theoretically enter their home countries' national stock and only enter the national stock of the host country if, and when, they give up their student status and stay on.

(ii) In the case of countries which are host to international organisations, their national HRST stock will include staff of such bodies who are citizens of the country and non-citizens who are employed there for more than one year, but will exclude those staying less than one year. However, since they are all working in an "enclave", none will be included in the number of HRST employed in the country.

(iii) There are other examples of people who are resident in a different country (and, more particularly, region) from the one in which they are employed, for example a software specialist on secondment to a subsidiary in another country for six months, a civil engineer working on a dam abroad for nine months or a statistician resident in Germany but commuting daily to work in Luxembourg. In theory, according to the recommendations in section 4.4.1. all should be assigned to the stock of their country of residence. In practice, where data are compiled from a range of sources, including both household and employment series, there is a serious danger of double-counting or complete omission.

134. Figure 4.3 illustrates the difference between the number of HRST resident in a country (or region), i.e. the national (or regional) stock, and the numbers who are employed or studying in the same country (or region).

135. Practical suggestions are made in sections 5.4.3 and 5.4.4 about ways to identify people who are resident in one country but are employed or studying in another, and to avoid double-counting. The treatment of overlap between study and employment is also discussed.

4.4.2 Regional breakdowns

136. Geographical mobility is one of the key flows with regard to HRST. Generally it refers to flows between countries ("brain gain", "brain drain"), but in some countries flows between regions are of importance as well. Examples are flows within the United States or between regions in the European Union, where HRST flows within individual countries and between them are of keen interest.

137. Regional classifications are necessary to break down HRST stocks by regions or to describe HRST flows between regions. For single country studies, national classifications can be used. Two international regional classifications are available: the List of Sub-Entities of the International Organization for Standardization, and Eurostat's Nomenclature of Territorial Units for Statistics, the classification of the European Union by regions.

CHAPTER 5

POSSIBLE BREAKDOWNS OF HRST USING INTERNATIONAL CLASSIFICATIONS

5.1 Introduction

138. This chapter discusses statistical breakdowns for the stocks and flows of HRST as defined in Chapters 3 and 4. Wherever possible, we draw on the principal international standard concepts and classifications. In an ideal world, information on occupations and educational qualifications would be highly detailed. In practice, some degree of detail is feasible when working at country level. For international comparisons, however, and with long time series where breaks often occur, aggregated groups will probably have to be used.

139. The scope and quality of data and their comparability over time and between countries will depend to a significant degree on the original source of the statistics. Although this manual provides a statistical framework for the measurement of HRST, it does not deal with practical data collection matters. Among suitable international guidelines are the manuals of the International Labour Office (ILO) which -- though dealing mainly with global labour and employment market issues -- are also generally relevant to HRST (see the Bibliography).

5.2 Units of classification

5.2.1 General

140. As for all statistics, it is important that a clear distinction be made between the **reporting unit** (sometimes referred to as the "unit surveyed" or the "unit of observation") and the **statistical unit** (sometimes referred to as the "unit classified"). Units will be briefly discussed both below and later, when applying the recommendations in the principal international classifications. It is essential that these units be specified when statistics are provided for international comparisons.

5.2.2 The reporting unit

141. The **reporting unit** is the entity from which the recommended items of data are collected. It will depend on the type of survey, survey resources and procedures, institutional structures, the legal limitations on data collection and dissemination, national priorities, etc. It will vary from country to country or from sector to sector.

142. In household surveys and population censuses it is the person (**individual**) who, at least in principle, reports about himself or herself. Data may also be collected from the units employing the HRST, for example establishments or enterprises. Use is increasingly made of various kinds of registers set up for public and private administrative purposes (population, social security, job placement, wage administration records, etc.).

143. Accordingly, no general recommendation can be made in this manual about the reporting unit.

5.2.3 The statistical unit

144. The **statistical unit** is the entity for which the required statistics are compiled. For HRST the statistical unit would typically be the **person** (individual), which is the standard unit in household surveys, population censuses and administrative records. But for some purposes (eg. education statistics on faculty staff or forecasts or projections) the **post** (which may be filled or vacant) may be an appropriate unit (see definition in para. 146 below). Similarly, when measuring educational output, the (numbers of) **degrees or diplomas granted** may be used as the statistical unit as a proxy for the numbers of HRST.

145. In simplified terms, one may consider that there is a parallel between "persons" (representing the supply side of the labour market) and "posts" (reflecting its demand side), or even between persons and degrees/diplomas. With increasing numbers of "shared posts" and people with multiple diplomas, however, there is not always a direct relationship between these units.

146. There is an unfortunate lack of agreement at international level on the use of the terms "posts" and "jobs" and the relationship between the two. According to the ILO Manual and the System of National Accounts, the **post** is *"a set of tasks which are (designed to be) carried out by one **person**", and the **job** is an "implicit or explicit contractual relationship between a specific person and a specific post"*. Here, each "job" represents the link between an "employed person" and a "filled post" (including self-employed persons who fill posts with themselves as employers). However, ISCO-88 uses the term "job" for what the ILO Manual and SNA define as a "post" (see also section 5.4.3 below). In the current text usage varies depending on which source is being cited.

5.3 Head-count or full-time equivalence (FTE)?

5.3.1 General

147. Two approaches are of interest when measuring human resources: head-count data and full-time equivalence (FTE) data. In the head-count series people are, in principle, counted once (at a given moment in time) and classified once according to relevant criteria. In the FTE series the headcounts of persons working part-time or on several jobs or activities are reduced to actual or normal working time.

5.3.2 Head-count

148. **Head-count** data are useful for the measurement of both stocks and flows. They allow the analysis to be related, for instance, to the educational supply data and the flows in the system, as well as to other kinds of statistics based on the individual as the statistical unit (such as demographic and employment statistics). By comparing data for several points in time this approach makes it possible to calculate net changes in the HRST stock or (for instance annual or quarterly) averages or growth rates.

149. Three options for measurement in terms of head-count can be derived from the Frascati Manual:

- -- the number of HRST on a given date (for instance end of year);
- -- the average number of HRST during the (calendar) year;
- -- the total number of HRST during the (calendar) year.

150. The first and second options appear to be most relevant for the measurement of HRST stocks (see Chapter 4), and are also those generally used for other statistics of human resources (employment, recruitment etc.) with annual or quarterly survey periodicities. The third option appears to be more suited for measuring flows (again, see Chapter 4) or for deriving flow data from stock series for persons who are HRST only by reason of their occupation. If such a person joins and leaves an S&T occupation several times within a year, he/she is counted several times in the third option but only once, if at all, in the others. Therefore, a comparison between stock figures based on options one or two and option three gives a rough idea about multiple flows, possibly more at micro levels, for measuring the HRST in specific areas with high staff mobility or turnover.

5.3.3 Full-time equivalence (FTE)

151. This approach is appropriate when one wishes to use data on HRST employment as proxies for the amount (or the volume) of activities carried out or services supplied or to deal with cases where the traditional relationship of one person per one full-time job does not apply, as in the following examples:

-- Two full-time engineers retire; they are replaced by four (previously unemployed) part-time workers. Furthermore, following the split, one of the new part-time jobs is in a different occupation. The number of persons employed in the original occupation increases by one, the number employed in the second occupation increases by one, the number of unemployed declines by four and the amount of activity remains the same.

-- A PhD student also works as a secretary. He or she appears both as a student and as an employee.

-- An unemployed HRST manages to find two part-time jobs in different occupations. One person comes off the unemployment register, two vacancies are filled.

152. In some cases, for example people with one major and one minor occupation, it may be possible to use modified head-count data by allocating individuals to their **main activity**. For example, in the case of the working student, the ILO specifies that the employment predominates. In other cases, calculation in FTE is the only efficient method.

153. The revised System of National Accounts (para. 15.102) suggests two approaches for measuring FTE:

-- total hours worked, which are the aggregate number of hours actually worked during the period in employee and self-employment jobs;

-- full-time equivalent jobs, which are total hours worked divided by average annual hours worked in full-time jobs.

154. The latter approach, referred to in the ILO working paper as "work years", can be calculated more approximately as "number of jobs on a full-time basis". At present, it is the method most commonly used in national accounts satellite tables, but it is felt that it no longer deals satisfactorily with part-time employment and the revised SNA recommends "total hours worked" as the best means for its main use of labour-input data, i.e. the measurement of productivity.

155. A more specialised use of the FTE approach is when one individual undertakes more than one activity of policy interest, within a single job/occupation. For example, a professor in an academic (university) hospital will spend part of his or her time teaching, part in specialised or routine health care, part in R&D and part in administration. Using head-count data for each of these activities would result in a serious overestimate of the resources involved. There is therefore a need to estimate the fraction of time each individual spends on the relevant activity. Such data is then added to give a measure of full-time equivalence. This is an issue where the outcome may depend on the choice of the reporting unit (institution, individual).

156. In such cases, the wording of the Frascati Manual defining the FTE of human resources devoted to R&D is also relevant to measuring the FTE of HRST in different activities:

> *"An FTE may be thought of as one person-year. Thus a person who normally spends 30 per cent of his or her time on R&D and the rest on other activities (such as teaching, university administration and student counselling) should be considered as 0.3 FTE. Similarly, if a full-time R&D worker was employed at an R&D unit for only six months, this results in an FTE of 0.5. Since the normal working day (period) may differ from sector to sector and even from institution to institution, it is impossible to actually express FTE in person-hours".*

157. Counting HRST in FTE should be based on a common approach to "time worked". The ILO working paper discusses a series of different concepts for "time worked" (including "normal time", "usual time", "time actually worked", "legal time", etc.). The question of "normal time" and "overtime" when calculating FTE is also raised in the Frascati Manual, which states that the calculation (of R&D FTE) must be based on the total working time and that, accordingly, no person can perform more than one FTE in any year (and, hence, not more than one FTE on R&D).

5.3.4 Recommendation

158. Head-count data are most commonly used because they are normally easier to collect and compare as they relate to a specific "unit", while the concept of full-time equivalence may sometimes be more subjective or less easily understood. Availability of head-count statistics may, furthermore, in some cases be a prerequisite for calculating the corresponding FTE data. The final choice between head-counts and FTE will depend on the outcome to be measured. It is therefore recommended that data collection related to people (head-counts) be given priority over that relating to full-time equivalents when measuring general HRST resources (such as, for instance, total stocks or HRST in employment). The FTE approach may still be preferable for specific issues, such as measuring R&D efforts, or when there are significant numbers of part-time jobs. For some purposes, however, both head-count and FTE data may be of interest (example: numbers of qualified scientists involved in a specific project and the combined volume of their man-years devoted to the same project during a given period).

5.4 Principal breakdowns of HRST

5.4.1 HRST by formal qualification -- ISCED

5.4.1.1 General

159. The International Standard Classification of Education (ISCED) makes a distinction between **levels of education** which is of direct relevance to defining HRST in the present manual, and supplies a

classification by **fields of study** (for more details, see Chapter 3 and Annex 3). This manual draws on the ISCED classifications for a much wider purpose than its traditional use within the higher education sector, as they are also applied to define (see Chapter 3), measure and classify a category of people outside higher education.

5.4.1.2 Units of classification

5.4.1.2.1 The reporting unit

160. In the case of education statistics ISCED specifies that no unit corresponding exactly to the "establishment" (as used in the System of National Accounts) is commonly applied but that the "institution" is the unit customarily used that most closely resembles an "establishment". However, not all data on formal qualification are collected via education statistics; they also come, for instance, from population censuses or household surveys, where the person (individual) constitutes the reporting unit.

5.4.1.2.2 The statistical unit

161. The **statistical unit** when applying ISCED will be the individual (teacher, postgraduate student, new graduate), sometimes with the diploma as a proxy.

162. ISCED classifies courses, programmes, and fields of education according to their educational content. ISCED is basically *"a classification of programmes of education, not a classification of people, sponsoring agencies, institutions (schools) or qualifications. Of course, the individuals enrolled can be shown in ISCED categories according to the kinds of programmes in which they are enrolled and the total of enrolment in each ISCED category can be distributed on other axes, according to personal characteristics such as sex, age, nationality..."*

5.4.1.3 HRST by level of education

5.4.1.3.1 General

163. In Chapter 3, ISCED was used as the main tool to define the coverage of HRST and to divide them into two categories, university-level HRST (ISCED level 6 and above) and technician-level HRST (ISCED level 5).

5.4.1.3.2 Proposed list of levels of education

164. Here a five-level breakdown of ISCED is recommended, as shown in the right-hand column of Figure 5.1. It is notably proposed to split ISCED level 7 into one upper and one lower category, the former essentially covering holders of PhDs and the latter holders of other postgraduate university degrees or equivalent. The attainment of a PhD means detailed knowledge of specific relevance to S&T (including, as a rule, an important independent R&D element) whereas lower level 7 programmes (frequently of the taught Masters type of courses -- though more specialised and varied than corresponding programmes at level 6) usually have a more general orientation of perhaps somewhat less relevance to S&T.

165. The category "Other qualifications" will, of course, apply only to persons included in HRST exclusively in terms of their occupation (see section 3.1.1).

166. A similar breakdown is recommended for R&D personnel in the revised Frascati Manual. No such split of level 7 is directly proposed by the 1976 version of ISCED; it does however suggest that more detailed lists may be used at national level, though at the risk of problems of comparability both over time and between countries.

Figure 5.1: **Proposed breakdown of HRST by level of education**

Broad HRST Classes	ISCED Levels	Proposed Breakdown
University-level Qualifications	Education at the third level, second stage, of the type leading to a postgraduate degree or equivalent	Upper part of ISCED level 7 ---------- Lower part of ISCED level 7
	Education at the third level, first stage, of the type leading to a first university degree or equivalent	ISCED level 6
Technician-level Qualifications	Education at the third level, first stage, of the type leading to an award not equivalent to a first university degree	ISCED level 5
Other Qualifications	Education at the second level (second and first stages), first level; education not definable by level	Lower than ISCED level 5 (or not specified)

5.4.1.4 HRST by field of study

5.4.1.4.1 General

167. International education statistics at the third level (higher education) as collected in common by UNESCO, OECD and Eurostat are directly based on the ISCED fields of study list, which also contains a detailed breakdown by programmes (see Table 2 of Annex 3).

5.4.1.4.2 Classification lists

168. Two classification lists are proposed in Figure 5.2 below. The short list (left-hand column) is the one we used to define core and other coverage in Chapter 3 (see section 3.2.2); the longer list (right-hand column) reproduces the 21 ISCED main fields of study used in international surveys, with an additional breakdown by principal programmes.

169. The contents of these programmes vary slightly between ISCED levels of education; furthermore, not all fields are taught at all levels (e.g. law and jurisprudence programmes only occur at ISCED levels 5 and above). For further information, see Annex III (notably Tables 2-6).

170. The summary lists of fields of S&T also vary slightly from those in various UNESCO and OECD surveys of R&D, education etc. For instance, for its surveys of S&T/R&D personnel UNESCO groups the social sciences with the humanities and uses two further categories, "other fields" and "not specified". The more detailed breakdown in Figure 5.2, separately identifying the social sciences and the humanities, is that employed for the common UNESCO/OECD/Eurostat surveys on education at the third (higher education) level. The revised Frascati Manual recommends the same breakdown by broad fields of S&T, though with a slightly different disaggregation of subcategories (see Annex III, Table 6).

5.4.1.5 Allocation problems in terms of qualification

171. When HRST have more than one qualification in different fields of study, reference to the field of the individual's highest S&T qualification is recommended. If a person has two (or more) equally high degrees (say a PhD in industrial engineering and a PhD in business administration) the most recent award may usefully be taken, in line with the practice in NSF surveys of science and engineering personnel in the United States.

172. There may be difficulties in classifying HRST by fields of study as programmes become more and more multidisciplinary. As long as such programmes stay within a single main field of study or even within main programmes they raise no problem of HRST classification. Difficulties occur when the programmes are multidisciplinary across fields of study. Several options are then available. Focus on the major field is recommended where possible but in some cases it may be necessary to classify HRST in multidisciplinary programmes as "general" or "other" programmes (i.e. in the category "other fields" above).

173. When allocating people by level (degrees, diplomas and other awards) and field of study, population censuses or household surveys are very important sources of information, especially about people who are out of the labour force. However, questions on respondents' educational attainment tend to be based on "current standards of education", whereas the attainment of the whole population, including the HRST stock, has been built up over a period of 50 years or more. When "mapping and coding" educational attainment, special efforts are therefore necessary to create links between "old" and "current" classifications of education, and with education received abroad.

Figure 5.2: **Proposed correlation between ISCED fields of S&T list and main fields of study and programmes**

FIELDS OF SCIENCE AND TECHNOLOGY	MAIN FIELDS OF STUDY AND PROGRAMMES IN ISCED
Natural sciences	**42. Natural science programmes**
	Biological science, chemistry, geological science, physics, astronomy, meteorology, oceanography, other.
	46. Mathematics and computer science programmes
	General programmes in mathematics, statistics, actuarial science, computer science.
Engineering and technology	**52. Trade, craft and industrial programmes**
	Food processing, electrical and electronics trades, metal trades, mechanical trades, heating, air-conditioning and refrigeration trades; textile techniques, graphic arts, laboratory technicians, optical lens making, other.
	54. Engineering programmes
	Chemical, civil, electrical and electronics, industrial, metallurgical, mining, mechanical, agricultural, forestry, engineering techniques, other.
	58. Architectural and town-planning programmes
	Structural and landscape architecture, town planning.
	70. Transport and communications programmes
	Air crew and ships' officer programmes, railway operating trades, road motor vehicle operation programmes, postal service (excl. electronics equipment installation and servicing), other communications programmes.
Medical sciences	**50. Medical and health related programmes**
	Medicine, surgery and medical specialities, hygiene and public health, physiotherapy and occupational therapy; nursing, midwifery, medical X-ray techniques and other programmes in medical diagnostic and treatment techniques; medical technology, dentistry, stomatology and odontology, dental techniques, pharmacy, optometry, other.
Agricultural sciences	**62. Agricultural, forestry and fishery programmes**
	General programmes in agriculture, animal husbandry, horticulture, crop husbandry, agricultural economics, food sciences and technology, soil and water sciences, veterinary medicine, forestry, forest products technology, fishery science and technology.
Social Sciences	**14. Teacher training and education science programmes**
	General teacher training, teacher training programmes with specialisation in vocational subjects, education science, other.
	30. Social and behavioural science programmes
	Social and behavioural science, economics, demography, political science, sociology, anthropology, psychology, geography, studies of regional cultures, other.

cont'd

Social sciences	**34. Commercial and business administration programmes**
	Business administration and commercial programmes, accountancy, secretarial programmes, business machine operation and electronic data processing, financial management, public administration, institutional administration.
	38. Law and jurisprudence programmes
	Law (general, international, labour, maritime, other), programmes for "notaires", local magistrates, jurisprudence, history of law, other.
	66. Home economics (domestic science) programmes
	Household arts, consumer food research and nutrition, other.
	84. Programmes in mass communication and documentation
	Journalism, programmes in radio and television broadcasting, public relations, communications arts, library science, programmes for technicians in museums and similar repositories, documentation techniques, mass communication.
Humanities	**18. Fine and applied arts programme**
	General programmes. Art studies, drawing and painting, sculpturing, handicrafts, music drama, photography and cinematography, interior design, history and philosophy of art, other.
	22. Humanities programmes
	General programmes. Languages and literature, linguistics, comparative literature, programmes for interpreters and translators, history, archaeology, philosophy, other.
	26. Religion and theology programmes
	Religion and theology.
Other fields	**01. General programmes**
	General programmes.
	08. Literacy programmes
	78. Service trades programmes
	Cooking (restaurant and hotel type), retailing, tourist trades, other.
	89. Other programmes
	Criminology, civil security and military programmes, social welfare, vocational counselling, physical education, environmental studies, nautical science. Other programmes.

Source: ISCED appendix, plus UNESCO/OECD/EUROSTAT questionnaire on statistics of education at the third level.

5.4.2 HRST by occupation -- ISCO

5.4.2.1 General

174. The International Standard Classification of Occupations of the International Labour Office (ILO) (ISCO-88) is the current basic classification for describing occupations, replacing that issued in 1968. Further details, including the ISCO-88(COM) broad list of occupations, are given in Annex 4.

175. ISCO-88 was used in Chapter 3 to identify a set of occupations which automatically made people HRST even if they did not have the appropriate qualifications. Here the aim is to make a breakdown of all HRST in the labour force by occupation, regardless of their level and field of qualification. In practice it may be possible to apply it only to HRST in employment.

5.4.2.2 Units of classification

5.4.2.2.1 The reporting unit

176. The reporting unit will necessarily be that employed in the survey (population census, household, administrative registers, etc.) from which the HRST data are drawn. No general recommendation can therefore be made here.

5.4.2.2.2 The statistical unit

177. ISCO-88 defines the "**occupation**" as "a set of jobs whose main tasks and duties are characterised by a high degree of similarity". The "**job**", in its turn, is defined as "a set of tasks and duties executed, or meant to be executed, by one person". People are classified by occupation through their relationship to a past, present or future job. The **job** is thus the statistical unit for ISCO. Normally, for HRST purposes, the statistical unit will be the person (individual) or in some cases the post (defined in section 5.2.3 above).

5.4.2.3 Proposed lists of occupations

178. Chapter 3 contains a tentative list covering HRST occupations only. Here the exercise opens up to cover all occupations. The general approach when preparing the occupation lists below has been to maintain the ISCO-88 categories without combining them and to suggest more detail for those major groups where HRST are assumed to be most numerous.

179. As with qualifications (see section 5.4.1.4.2), two lists of occupations extracted from ISCO-88 are proposed below: a minimum list (Figure 5.3.A) and a more detailed one (Figure 5.3.B). The minimum list covers the two-digit levels of ISCO major groups 1 (including three suggested 3-digit groups), 2 and 3, the total of major groups 4 to 9 combined, and finally major group 0. The second list proposes a more detailed breakdown, at ISCO 3-digit levels, together with a few 4-digit classes of specific relevance to HRST. Some of these classes, notably the breakdown of group 312 (computer associate professionals), have been identified for users interested in information technologies.

5.4.2.4 Allocation problems in terms of occupation

180. The accuracy of occupation data depends heavily on the use of appropriate coding procedures. Allocating people to ISCO categories is not always self-evident. In some cases reference is made to the HRST's field (e.g. a chemist, a physicist), in others to their activity or function (e.g. a teacher). Some professional titles, such as engineer, are understood to reflect both a person's training and his or her occupation, and they vary considerably from country to country as well.

181. It is recommended that, where individuals are involved in more than one job ("multiple job holders"), the job which accounts for the largest proportion of their time be used (see section 5.4.1.5 dealing with similar problems with qualifications).

5.4.2.5 ISCO-88 versus ISCO-68

182. While Eurostat has used a slightly modified version of ISCO-88 for its labour force surveys since 1992, the classification has not yet been widely applied and several years may pass before data are collected on this basis and issued. The earlier classification, ISCO-68, was never fully adopted by many of the OECD Member countries, which continued using country-specific occupational lists in their national surveys. The links between these national series and the data submitted to international surveys were frequently established only at rather aggregate levels. For the analysis of longer time series, for modelling purposes and so on, it may therefore be necessary to draw on rather broad categories of occupation statistics.

183. ISCO-88 contains very detailed indexes of occupational titles according to ISCO-88 and ISCO-68 classifications; at a later stage they may serve as keys for reclassifying selected HRST data into one common system.

5.4.3 HRST by labour force status

184. The main focus tends to be on HRST personnel with full-time, permanent jobs. Given developments in the HRST labour market it is also important to identify part-time workers and, if possible, people with short-term contracts (especially in the higher education sector) plus the number of unemployed. Similarly, HRST out of the labour force must be divided between those who are still "in the pipeline" (notably postgraduate students), those who have left the system (the retired) and the rest.

185. The categorisation shown in Figure 5.4 below is recommended. With the exception of the breakdown of "employees", the categories are those proposed by the ILO Manual.

186. In line with ILO recommendations, students, homemakers and retired people who undertake any economic activity, however small, during the reference period are to be treated as economically active (employed or unemployed). Only those with no economic activity at all should be treated as out of the labour force (SNA 6.19-6.22, Domestic and personal services for own final consumption within households). Accordingly, the numbers of HRST out of the labour force and attending educational institutions will not be the same as the number of HRST enrolled for full-time (let alone part-time) studies -- a point to be remembered when data are being compiled from multiple sources.

Figure 5.3.A: **Principal ISCO-88 Subgroups of HRST**

1. PROPOSED MINIMUM LIST

ISCO Major Group 1 - Legislators, Senior Officials and Managers

11 - Legislators and senior officials
12 - Corporate managers
    121 Directors and chief executives
    122 Production and operations department managers
    123 Other departmental managers
13 - General managers

ISCO Major Group 2 - Professionals

21 - Physical, mathematical and engineering science professionals
22 - Life science and health professionals
23 - Teaching professionals
24 - Other professionals

ISCO Major Group 3 - Technicians and Associate Professionals

31 - Physical and engineering science associate professionals
32 - Life science and health associate professionals
33 - Teaching associate professionals
34 - Other associate professionals

ISCO Major Groups 4 - 9 (combined)

ISCO Major Group 0 - Armed Forces

Figure 5.3.B: **Principal ISCO-88 Subgroups of HRST**

2. PROPOSED DETAILED LIST
(number of unit groups within brackets)

ISCO Major Group 1 - Legislators, Senior Officials and Managers

11 Legislators and senior officials
12 Corporate managers
121 Directors and chief executives
122 Production and operations department managers
123 Other departmental managers
    1236 Computing services department managers
    1237 Research and development department managers
    123 (not elsewhere classified)
13 General managers

ISCO Major Group 2 - Professionals

21 Physical, mathematical and engineering science professionals
211 - Physicists, chemists and related professionals (4)
212 - Mathematicians, statisticians and related professionals (2)
213 - Computing professionals (3)
214 - Architects, engineers and related professionals (9)

22 Life science and health professionals
221 - Life science professionals (3)
222 - Health professionals (except nursing) (5)
223 - Nursing and midwifery professionals (1)

cont'd

23 Teaching professionals

231 - College, university, higher education teaching professionals (1)
232 - Secondary education teaching professionals (1)
233 - Primary and pre-primary education teaching professionals (2)
234 - Special education teaching professionals (1)
235 - Other teaching professionals (3)

24 Other professionals

241 - Business professionals (3)
242 - Legal professionals (3)
243 - Archivists, librarians, related information professionals (2)
244 - Social science and related professionals (6)
245 - Writers and creative or performing artists (5)
246 - Religious professionals (1)

ISCO Major Group 3 - Technicians and Associate Professionals

31 - Physical and engineering science associate professionals

311 Physical and engineering science technicians (9)
312 Computer associate professionals (3)
3121 **Computer assistants**
3122 **Computer equipment operators**
3123 **Industrial robot controllers**

313 Optical and electronic equipment operators(4)
314 Ship and aircraft controllers and technicians (5)
315 Safety and quality inspectors (2)

32 - Life science and health associate professionals

321 Life science technicians, related associate professionals (3)
322 Modern health associate professionals (excl. nursing) (9)
323 Nursing and midwifery associate professionals (2)
324 Traditional medicine practitioners and faith healers (2)

33 - Teaching associate professionals

331 Primary education teaching associate professionals
332 Pre-primary education teaching associate professionals
333 Special education teaching associate professionals
334 Other teaching associate professionals

34 - Other associate professionals (8)

341 Finance and sales associate professionals
of which 3415 Technical and commercial sales representatives
342 Business services agents and trade brokers
343 Administrative associate professionals
of which 3434 Statistical, mathematical and related associate professionals
344 Customs, tax and related government associate professionals
345 Police inspectors and detectives
346 Social work associate professionals
347 Artistic, entertainment and sports associate professionals
348 Religious associate professionals

ISCO Major Group 4 **Clerks**
ISCO Major Group 5 **Service workers and shop and market sales workers**
ISCO Major Group 6 **Skilled agricultural and fishery workers**
ISCO Major Group 7 **Craft and related trades workers**
ISCO Major Group 8 **Plant and machine operators and assemblers**
ISCO Major Group 9 **Elementary occupations**
ISCO Major Group 0 **Armed forces**

187. The dividing line (20 hours per week) between "full-time" and "part-time" refers to "usual hours of work", i.e. the modal value of "time actually worked" over a long period (ILO) -- see section 5.3.3 above.

188. In principle this breakdown should be applied to the national (or regional) stock in terms of residence, as defined in Chapter 3. In order to do so it is necessary to ensure that the numbers in the labour force **include** persons resident in the country but employed or registered as unemployed in another, and **exclude** persons employed (or registered unemployed) in the country but not resident there.

189. Figure 5.5 shows types of data needed to build up the breakdown of national stocks illustrated in Figure 5.4.

Figure 5.4: **Suggested Breakdown by Labour Force Status**

In the labour force:

Employed:

Armed forces

Civilian employment

-- Employees

-- Full-time, permanent staff
-- Part-time, permanent staff (normally defined as under 20 hours per week)
-- Short-term contract staff (defined as contracts having a duration of less than 3 years)

-- Self-employed

Unemployed (and available for work)

Out of the labour force:

-- Attending educational institutions (for example postgraduate students not elsewhere classified)
-- Engaged in household duties (not elsewhere classified)
-- Retired or old age n.e.c.
-- Other inactive (infirmity, disablement, etc.) n.e.c.

Figure 5.5: **Relationship between National Stock of HRST and Country of Employment/Unemployment/Studies**

		Residents	Non-residents	Total
In country A (economic territory)	1. Armed forces			
	2. Civilian employment			
	3. Unemployed			
	a. Total students			
	b. Less employed students			
	4. In education institutions *(= 3a-b)*			
	5. Out of labour force nec (1)			
	Subtotal Home			
Outside economic territory of country A	6. Employed in international organisations (in country A)			
	7. Employed in foreign countries (and other international organisations)			
	8. Unemployed in foreign countries			
	a. Total studying abroad			
	b. Less employed students			
	9. In education institutions *(=8a-b)*			
	10. Out of labour force nec (2)			
	Subtotal Abroad			
	National Stock			

(1) Could be broken down into retired, engaged in household duties and other.
(2) If any.
nec not elswhere classified.

5.4.4 HRST by sector of employment

5.4.4.1 General

190. It is important to know the sector of employment in order to understand the spread of HRST across the economy. This breakdown will essentially be related to HRST in employment, due to the difficulties in classifying unemployed, and more especially those out of the labour force, by sector.

5.4.4.2 Broad sectors of employment

191. A breakdown into six broad sectors of employment is recommended:

- -- business enterprise sector;
- -- government sector;
- -- private non-profit (serving households) sector;
- -- higher education sector;
- -- international organisations located in the country;
- -- rest of the world (persons not elsewhere classified).

192. The first four categories are as defined in Chapter 3 of the revised Frascati Manual. They correspond to the sector definitions of the System of National Accounts, except that the higher education sector has been separately identified (a concordance between the Frascati Manual and the SNA sectors is

given in Annex 11 of the former). These are the four sectors for which R&D personnel data are collected and which together make up the national stock as defined in the Frascati Manual.

193. The sum of the last two categories (in para 191) corresponds to the Frascati expenditure sector "Abroad" and the SNA institutional sector "Rest of the world". International organisations located in the country have been broken out because they are both part of, but independent of, national HRST stocks. This ambiguity is reflected in their treatment in the SNA, where some of their staff are considered as resident in the country and thus part of national HRST stock (see section 4.4), although in institutional terms they are considered as being abroad (SNA 4.164). This category does not apply to all countries, only to those hosting major international organisations. "Rest of the world n.e.c." covers persons who are resident in the country concerned but employed in a unit located in another country (for example on secondment to a subsidiary in another country for less than one year, or commuters).

5.4.4.3 Industries of employment -- ISIC/NACE

194. It is recommended that the detailed sector of employment should be recorded for HRST employed in all the broad sectors outlined above using the International Standard Industrial Classification (see Figure 5.6). This breakdown -- which should be considered a "minimum list" -- is also closely harmonised and compatible with the European Union's general nomenclature of economic activities (NACE).

Figure 5.6: **ISIC Rev.3 Classification of Economic Activities**

Economic Activity	**ISIC Division**
Agriculture	01, 02, 05
Mining	10, 11, 12, 13, 14
Manufacturing (could be split)	15 through 37
Utilities	40
Construction	45
Transport, storage, communications	60, 61, 62, 63, 64
Computing and related activities	72
R&D	73
Other business activities	74
Public administration and defence	75
Education	80
Health	85
Other	50, 51, 52, 55, 65, 67, 70, 71, 90, 92, 93, 95, 99

5.4.4.4 Other possible sectoral (sub)classifications

5.4.4.4.1 Business enterprise sector

195. A more detailed breakdown by industry may be made for HRST employed in the business enterprise sector. For comparisons with employment data and other industrial variables the most useful breakdown would be that used in the OECD STAN (STructural ANalysis) database (an aggregated version of which is shown in Figure 5.7) or perhaps those used for the ANBERD series on industrial R&D (Annex 6) and OECD Industrial Structure Statistics -- ISIS (Annex 7). This OECD database is currently being rearranged in line with the recent revision of ISIC (ISIC-3).

196. The ISIC-3 list of main activities of enterprises, arranged for R&D purposes (in Annex 6), also shows the links to the corresponding ISIC Rev. 2 list (ISIC 68) and NACE Rev. 1 as proposed in the Frascati Manual and in the Oslo Manual on the measurement of innovation activities.

5.4.4.4.2 Other sectors

197. Outside the business enterprise sector, other standard classifications may be applied. The standard international breakdown for use within the government sector is the SNA Classification of Total Outlays of Government by Function (COFOG), which -- though initially intended for financial purposes -- could be adapted to classify HRST. Another SNA classification, Total Outlays of Non-Profit Institutions Serving Households (COPNI), could be applied to the private non-profit (PNP) sector. The recommended COFOG and COPNI lists are shown (slightly rearranged) in Figures 5.8.A and 5.8.B.

198. Since the higher education sector is not a standard SNA subsector it does not have a classification of its own. But the Frascati Manual and UNESCO both suggest, for their R&D/S&T surveys, an institutional breakdown by broad fields of S&T (see section 3.2.2, excluding the category "other fields"). The same breakdown may also be applied to the private non-profit sector. Whether the broad fields of S&T or the COPNI list should be preferred for practical PNP sector data collection will depend on the policy issues involved and on the availability of data.

Figure 5.7: **Industrial Classification Used in the OECD Structural Analysis (STAN) Database**

	ISIC-3	Description		ISIC-3	Description
1	3100	Food, beverages & tobacco	24	3600	Non-metallic mineral products
2	3112	Food	25	3610	Pottery & china
3	3130	Beverages	26	3620	Glass products
4	3140	Tobacco	27	3690	Non-metallic products
5	3200	Textiles, apparel & leather	28	3700	Basic metal industries
6	3210	Textiles	29	3710	Iron & steel
7	3220	Wearing apparel	30	3720	Non-ferrous metals
8	3230	Leather & products	31	3800	Fabricated metal products
9	3240	Footwear	32	3810	Metal products
10	3300	Wood products & furniture	33	3820	Machinery nec.
11	3310	Wood products	34	3825	Office & computing equipment
12	3320	Furniture & fixtures	35	3830	Electrical machinery
13	3400	Paper, products & printing	36	3832	Radio, TV & communication
14	3410	Paper products	37	3840	Transport equipment
15	3420	Printing & publishing	38	3841	Shipbuilding & repairing
16	3500	Chemical products	39	3842	Railroad equipment
17	3510	Industrial chemicals	40	3843	Motor vehicles
18	3520	Other chemicals	41	3844	Motorcycles & bicycles
19	3522	Drugs & medicines	42	3845	Aircraft
20	3530	Petroleum refineries	43	3849	Transport equipment needs
21	3540	Petroleum & coal products	44	3850	Professional goods
22	3550	Rubber products	45	3900	Other manufacturing
23	3560	Plastic products nec.	46	3000	Total manufacturing

Figure 5.8.A-B: **SNA Classifications for the Government and Private Non-Profit Sectors**

A. Classification of Total Outlays of Government by Function (COFOG)

1. General public services (incl. basic research)
2. Defence affairs and services
3. Public order and safety affairs
4. Education
5. Health affairs and services
6. Social security and welfare affairs and services
7. Housing and community amenities affairs and services
8. Recreational, cultural and religious affairs and services
9. Fuel and energy affairs and services
10. Agriculture, forestry, fishing and hunting affairs and services
11. Mining, manufacturing and construction, except fuel and energy
12. Transportation and communication
13. Other economic affairs
14. Other

TOTAL

B. Classification of Total Outlays of Non-Profit Institutions Serving Households (COPNI)

1. Research and scientific services
2. Education services
3. Health services
4. Welfare services
5. Recreational, cultural and related services
6. Religious services
7. Services of professional, labour and civic organisations
8. Miscellaneous services (not elsewhere classified)

TOTAL

Source: SNA 1993 (Tables 18.2 and 18.3).

5.4.5 Breakdown of HRST by type of activity of the National Science Foundation

199. A classification system based on functions (or activities) which is not directly comparable with any of the previous classifications is used by the National Science Foundation (NSF) in the United States in surveys of stocks and flows of all doctoral scientists and engineers. Long and short lists of functions are shown in Figures 5.9.A and 5.9.B.

200. Although no corresponding functional classification systems on which practical data collection could be based are available in other OECD countries, the NSF groupings may be of interest as checklists of functions of specific HRST relevance and policy interest, notably when data are derived or aggregated from various sources. Note that the NSF R&D classes would probably have to be consolidated, as no breakdowns are available in the OECD or UNESCO statistics of R&D personnel by type of activity (basic research, applied research, experimental development).

Figure 5.9.A: **NSF's "Long List" of HRST Functions**

1. Teaching
2. Basic research (i.e. study directed towards gaining scientific knowledge for its own sake)
3. Applied research (i.e. study directed towards gaining scientific knowledge in an effort to meet a recognised need)
4. Development of equipment, products, systems
5. Design of equipment, processes, models
6. Management/administration of R&D
7. Management/administration of educational/other programmes
8. Report and technical writing, editing
9. Professional service to individuals, clinical diagnosis, psychotherapy
10. Consulting
11. Operations-production, maintenance, construction, installation
12. Quality control, testing, evaluation
13. Sales, marketing, purchasing, customer and public relations
14. Statistical work-survey work, forecasting, statistical analysis
15. Computer applications
16. Other

Figure 5.9.B: **NSF's "Short List" of HRST Functions**

- Applied research
- Basic research
- Development
- Management of R&D

  Subtotal R&D
- Other management
- Teaching
- Sales/professional services
- Consulting
- Production
- Other

CHAPTER 6

OTHER VARIABLES OF INTEREST FOR HRST ANALYSIS

6.1 General

201. Even if HRST data, expressed as absolute numbers and presented according to various classifications and criteria, may suffice to answer many of the questions outlined in Chapter 2, other variables describing specific characteristics of HRST and their environment in the context of broader trends in the labour market are of relevance to policymakers as well. Much of this information is quantitive and reasonably suitable for cross-country comparisons. Some qualitative topics may also contribute to a better understanding of the past, current and future HRST labour markets and the behaviour of the HRST workforce. A number of these variables are discussed below.

6.2 Personal characteristics of HRST

6.2.1 Gender

202. Women have traditionally had a low representation in many fields of S&T, particularly in the applied sciences, engineering and technology. Men, on the other hand, have typically been attracted to particular specialisations like engineering. Data on gender in stocks and flows and in the education pipeline may be useful to examine detailed participation rates and will show the potential rate of improvement of participation. They will assist analysis of the stages where women's representation starts to fall away, e.g. at entry to higher education. Such data are also extremely important when measuring pools of under-utilised resources and considering the effectiveness of equal opportunities policies and programmes.

203. It is recommended that, wherever possible, HRST data should be subdivided by gender.

6.2.2 Age

204. It is important to determine the age profile of HRST where possible, in particular identifying the "young" who potentially provide vitality and ideas ("new blood") for S&T, and the "old" nearing the end of their careers and soon due to retire.

205. Different levels of disaggregation may be used, depending for instance on whether interest centres on the analysis of stocks or of flows. With stocks the need for a very detailed age breakdown is probably smaller than for an analysis of flow data, especially on future HRST still in the education pipeline.

206. A breakdown into six categories is recommended for **stock** data:

-- less than 30 years;
-- 30-39 years;
-- 40-49 years;
-- 50-59 years;
-- 60-69 years, and
-- 70 years and over.

207. This is based on the breakdown in the UNESCO Manual for Statistics on S&T Activities, adjusted to make a break at 70 years in line with the proposal in Chapter 3. Information on age of the (HRST) stock is typically drawn from population censuses, household surveys or administrative registers, and the above categories are compatible with those recommended in the United Nations Provisional Guidelines on Standard International Age Classifications or the ILO Sources and Methods Volumes for Population Censuses and Household Surveys.

208. The same categories should also be used for most **flow** data. However, particular problems arise when making international comparisons of flows through the education pipeline (section 4.2). For example, the age of qualification from higher education and entry to the stock of HRST can range from about 21-22 years in the United Kingdom and United States up to 27-28 years in Germany.

209. For such pipeline flows, a more detailed breakdown, currently used in the common UNESCO/OECD/Eurostat questionnaires on statistics of education at the third level, is recommended (age of students in completed years):

-- under 16 years,
-- individual years from 16 to 29,
-- 30-34 years,
-- 35-39 years,
-- 40 years and over (together with a class "age unknown").

6.2.3 National origin

210. A prime interest for a host nation is its dependency on foreign workers and migration flows; this can be relevant to HRST. In some occupations there is concern that foreigners may displace nationals in the labour market.

211. The criterion for inclusion in a country's stock is that the HRST should be resident there (section 4.4). A further criterion is required to determine whether resident HRST should be regarded as being of "national" or "foreign" origin, and to which countries the foreigners should be allocated.

212. A number of criteria can be used for classification by national origin: country of birth, country of previous residence, country of highest qualification, citizenship. The least ambiguous of these are birth and citizenship. While focusing on country of birth may seem appropriate for those in the higher education pipeline, for people further into their careers a more critical question may be where they received their education and training. For many who migrated early in life, this will not be in their country of birth. Likewise, breaking the stock down by citizenship will hide that proportion who have entered as immigrants

and acquired host nationality. Citizenship is recommended as the main criterion, with country of birth as a subsidiary.

213. Given the recommendation that the national stock be based on residence, slightly different guidelines, provided by UNESCO, should be applied in the case of foreign students. In the UNESCO surveys on statistics of education at the third level, "*a **foreign student** is a person enrolled at an institution of higher education in a country of which he is not a permanent resident. Accordingly country of origin is the country in which the student is permanently resident (home country)..."*

214. As far as practical data collection is concerned, the origins of migrants may have to be determined from the specifications used in immigration statistics or work permit records. For example, in the NSF surveys of graduate students and post-doctorates in science and engineering in the United States, foreign students are defined as "those holding temporary visas" (whereas applicants for US citizenship holding "green cards" are reported as US citizens). Immigration and work permit arrangements vary from country to country, of course, and in any case with the increasing liberalisation of travel many of these traditional sources of information on the international mobility of HRST will cease to be available.

6.2.4 Ethnicity

215. Data on ethnicity are most likely to be used at national level for monitoring equal opportunities policies and assessing pools of under-utilised skills. Each country will identify different minority groups for attention. Given that such groups are likely to be both small and locally focused (one country's minority being another's majority), the data are of limited use for international comparisons and this manual makes no recommendations about collection procedures.

6.3 Contextual data affecting the HRST system

6.3.1 General

216. A number of other factors affect the HRST system. Some are general and concern other personnel categories as well; others are specific to HRST. For some of these topics, data are only collected on an ad hoc basis; serious problems of comparability also arise. The Eurostat/OECD inventory provides some information about the availability of data in each of these categories; it does not, however, address definitions or data reliability (see also Chapter 7). Some of the main variables are considered briefly below.

6.3.2 Recommended general variables

6.3.2.1 Demographic data, including population projections

217. These data can provide indicators of future potential inflows into higher education, and broader benchmarks regarding the participation of women and minorities. They are essential for consideration of ageing and retirement.

6.3.2.2 Overall numbers and trends in the education system

218. These data provide indicators of future flows (for example by reference to changing participation in S&T in secondary schooling) and benchmarks of changing participation rates and numbers in S&T fields. Data on students in pre-HRST levels of education are needed to evaluate future flows and stocks of HRST.

"Mature students", i.e. persons entering the higher education pipeline at above the general age for new students, form another category of interest for HRST. Before taking up their third-level studies many of these "mature" people may already have acquired solid professional experience of specific relevance to their future activities as HRST.

6.3.2.3 Overall employment levels and characteristics

219. This information, including unemployment levels (see definitions in Annexes V and VIII) and activity rates, would enable analyses to be made of current and changing trends in relevant branches and in the densities of HRST in specific areas of interest.

6.3.2.4 Vacancies

220. Vacancy data can be seen as complementary to unemployment figures as a measure of the general state of the labour market. ILO considers that a **vacant post** exists *"if an employer .... has taken concrete steps to find a suitable person to carry out a specific set of tasks* (= a "job") *and would have taken on ... such a person if she/he had been available during the reference period".* See also Annex 5.

221. It is virtually impossible to design surveys which can cover all "vacancies" for which "unemployed persons" may apply. The normal operation of the labour market means that there will often be vacancies that are in the process of being filled; these will not always be of the same degree of interest as vacancies which have been outstanding for many months and have been a long-term constraint on the organisation or country. The sharpest interest usually focuses on those vacancies that are "hard to fill" in prevailing market circumstances. Unfortunately, even this is an imprecise measure as it takes no account of quality or price. An organisation might be able to fill its vacancies by lowering the entry standard or increasing the salary on offer, while a country could relax its immigration restrictions. Without taking account of such factors, a simple count of vacancies means little.

222. Reference is sometimes made to statistics on vacancies advertised or notified to national job placement agencies. The coverage is of course incomplete, and in themselves these statistics provide at best a partial picture. Where they are of more value is when time series data are available from a single source. Other measures are based on surveys of businesses. Given the diversity and ad hoc nature of most vacancy statistics, there are major problems if attempts are made to make comparisons across countries. Their value is greatest when tracing time series and trends within countries.

6.3.3 HRST-specific variables

6.3.3.1 Unemployment among HRST

223. Basic information on unemployment in the national HRST stock should be collected via the labour force breakdown proposed in section 5.4.4. Ad hoc studies may be valuable sources of more detailed information on specific fields or occupations, or on unemployment at the key points identified in Chapter 4, such as recent graduates. When using such data, differences in the definitions of unemployment should be taken into consideration (see also Annexes 5 and 8).

6.3.3.2 Salaries

224. Relative salaries (especially starting salaries), and changes therein, can be indicators of market conditions for HRST. Fields where demand exceeds supply are likely to show higher salaries. The best use of salary data is within national data sets. International comparisons can be beset by problems, to do with the comparability of occupations for instance, exchange rates and purchasing power parities, and employment-related items such as pensions, holidays and social security and the way their funding is shared between government, employers and employees.

6.3.3.3 Retirement ages

225. Information here can be useful as an indicator of likely future losses from the pool of HRST. However, retirement ages are often fixed only in the public sector, and variations may be found even there. Given the trend to more flexible retirement patterns, part-time working may be involved, making data collection in this area problematic. Here, as elsewhere, the growth of consultancy blurs the borderline between the employed and the economically inactive.

6.3.3.4 Training and retraining

226. This is an issue of growing importance, given the rapid rate of change in S&T and in the skills that HRST require. Training may be formal or informal, undertaken on the job (which is hard to measure) or off the job, or away from the workplace (which can be easier to measure). Reliable statistics are not always available on training and retraining activities. It may notably be of interest to identify "persons in education and training" other than full-time students.

227. A first step towards establishing a conceptual framework for the collection of data on this subject was taken when a draft Guide to Statistics on Lifelong Training of Scientists, Engineers and Technicians was discussed at UNESCO; this was issued in 1989, but has not been followed up by any regular collection of data. Lifelong education and training was understood as a process which occurs throughout a person's working life to adjust to constant developments in his/her area of specialisation ("updating") or to achieve competence in another field ("reconversion").

228. Under the aegis of the OECD Education and Employment, Labour and Social Affairs Committees an expert group was established in 1989 with, as one of its tasks, the development of a manual to guide national authorities in the collection and analysis of training statistics. The general scope of this project is much broader than that of HRST, but it is hoped that future versions of the present manual will be able to draw on relevant sections of this forthcoming training statistics manual.

6.3.3.5 Public attitudes to S&T

229. Changing attitudes towards S&T studies and careers, particularly among the young, are extremely important indicators of the likely future supply of HRST. Any data will of course be qualitative, and their value is greatest when considering changes over time and between fields and careers. Because definitions and circumstances may vary greatly between countries, their main value is in examining national or regional trends. They can also be useful in helping to analyse global supply trends in HRST as international flows become increasingly important. Differences between countries can be interactive.

CHAPTER 7

DATA SOURCES

7.1 Introduction

230. This chapter deals with international and national sources of information which are or may be relevant for the HRST area. Much of the information presented here is based on the material collected during a joint inventory carried out by OECD and Eurostat for the 1993 report on Availability of Methodology and Data on Human Resources in Science and Technology in the OECD and EU Member States. We propose to update it at regular intervals to reflect experience gained in working with data sources on HRST. It is intended as a guide to the advantages and disadvantages of the various types of sources and surveys.

231. New data collection exercises are usually expensive to implement. Existing sources of information, international and national, should hence be used to the full before embarking on further collection exercises. Although justified from a cost-benefit angle, this approach creates problems with methodology and sampling methods when data from different origins need to be compared. Some of these problems are pointed out below.

7.2 International sources of data

232. Very few data sets are in fact collected at international level. Actual collection is normally the responsibility of national authorities -- the statistical office in most cases, or some other institution which runs specialist surveys. This is true of the surveys mentioned in this section.

233. A survey is "international" if countries' data are put together and adjusted using a common methodology. Adjustment may be national or central, but the procedure will usually be agreed upon beforehand. The important thing is that the final data are immediately comparable at international level.

234. Both OECD and Eurostat have databases which store **contextual data** of relevance to the HRST area. Examples are:

OECD:

-- quarterly and annual labour force statistics;
-- annual national accounts: employment by kind of activity;
-- main economic indicators: earnings, disputes, jobs, hours of work, etc;
-- industrial structure statistics: employment, employees, wages and salaries.

Eurostat:

-- general statistics, economy and finance, population and social conditions;
-- regional statistics.

These databases are all permanent and regularly updated.

7.2.1 Education statistics

235. UNESCO, OECD and Eurostat have for a number of years assembled data on third-level education using a common questionnaire (UOC3). ISCED is the international classification used and numbers are collected on the following items of relevance for HRST:

- -- students by sex, age and ISCED levels 5/6/7;
- -- students at the third level by sex, field of study, and ISCED levels 5/6/7;
- -- students graduating by sex, field of study and ISCED levels 5/6/7;
- -- new entrants at the third levels by sex, study time and type of institution;
- -- new entrants at the third levels by sex, field of study and ISCED levels 5/6;
- -- number of types of institution at the third level;
- -- number of teachers at the third level by sex, work time and type of institution.

236. Eurostat has assembled further data for the European Union countries since 1990/1991. These are:

- -- number of students by sex, study time and type of higher-level institutions;
- -- foreign students at the third level by sex, country of origin and region.

237. The data on ISCED third-level education and fields of study ought to be immediately comparable at international level, but experience over recent years shows that this is not always the case. The main reason is that national authorities do not allocate individuals to the ISCED levels in the same way. Interpretation problems thus arise with ISCED level 5 and with levels 6/7. The problem with level 5 is the practical interpretation of the wording "...an award not equivalent to a first university degree". In many countries this often entails examining specific regulations and forming a judgment. In addition, national authorities are not always in a position to provide data separately for levels 6 and 7. In any case, as with ISCED level 5, there seem to be diverging views on how to interpret the definitions of levels 6 and 7; some countries do not allocate any of their students or graduates to level 7. Fewer problems appear to occur with the allocation of studies to the 21 ISCED main fields of study, although the introduction of new courses and multidisciplinary programmes within the last decade means that some fields are outdated, or "missing" from the ISCED classification.

7.2.2 R&D statistics

238. OECD manages a database containing internationally comparable data on research and experimental development (R&D) personnel. The following sets of data, all expressed as full-time equivalents, are available:

- -- total R&D personnel by sectors of the economy;
- -- researchers by sector;
- -- technicians by sector;
- -- other supporting staff by sector;
- -- university graduates by sector;
- -- other post-secondary education qualified personnel by sector;
- -- secondary education qualified personnel by sector;
- -- unspecified qualifications by sector;

-- business enterprise personnel by industrial branch and by occupation and qualification; and
-- R&D personnel in the higher education and private non-profit sectors by broad field of science and by occupation and qualification.

Some series in the database date back to 1965, but the fullest coverage is from the 1970s onwards.

239. The OECD Frascati Manual is the international methodology for the collection of R&D statistics. The latest version of the Manual recommends the collection of headcount data as well as full-time equivalence data. Implementation of this recommendation will mean that the R&D data will be comparable with other series measured in headcounts (see Annex II).

7.2.3 Labour force statistics

240. The education and R&D data are in theory comparable for all the OECD Member countries. In contrast, the Eurostat labour force survey provides comparable data only for the 12 European countries (it is planned by 1996 to extend the survey to those EFTA countries wishing to participate). This is a sample survey in which data are collected at approximately the same time every year, using an agreed methodology and terminology (see Annex 8). Prior to 1992 occupational and educational data from the labour force survey were not internationally comparable. The older versions of the survey are thus of little interest for the HRST area.

241. The labour force survey was revised at the beginning of the 1990s and 1992 was the first year for which data were collected using the revised recommendations and procedures. The new version uses larger samples, so there is optimism about the possibility of using the data for HRST purposes. No field of study data are available, but otherwise most HRST stock dimensions could in theory be covered by the survey. The advantage is that the data are directly comparable. Depending on the size of the sample for each HRST-relevant subgroup, reliability may forever be a problem.

7.3 National sources of data

242. A number of regular data collection exercises are carried out in the OECD and EU countries, as well as some *ad hoc* surveys. For further information, see the report on the OECD/Eurostat inventory. The main types of data sources and surveys that may be available in individual countries are outlined below.

7.3.1 Registers

243. Some countries, especially the Nordic ones, have a tradition of centrally co-ordinated registration of characteristics of individuals. Broad administrative registers are held by government departments dealing with areas such as social security and taxation. These registers may be used to produce statistics and, subject to confidentiality constraints, certain tabulations for broad groups of HRST may be possible. Registers of more specific relevance to HRST are also kept in the Nordic countries. Norway has a register of educational attainment of its population which can be combined for the production of statistics, with a register of employers and their employees. There is also a register of persons engaged in R&D. Finland has established a register of completed degrees.

244. The advantage of such central registers is that statistics can easily be derived in many different ways, subject only to the limitations of the variables included and the constraints set by confidentiality considerations. Both coverage and data quality should, however, be carefully considered. Coverage may be a problem if the registration authority in practice cannot reach all the institutions or individuals supposed to be registered, e.g. all enterprises engaged in R&D activities, or if the intended coverage is limited e.g. to persons obtaining degrees from national institutions. The validity of the variables and the reliability of their recorded values will depend on the administrative needs which the register is supposed to serve.

7.3.2 Censuses

245. **Censuses of population** are based on the total population or defined subpopulations, and yield broad population data. They are usually carried out on a five- or ten-year cycle (countries vary), and may have been run for several decades. Most countries conduct censuses if they do not have a register system covering the whole population.

246. Censuses often provide detailed information about HRST, thanks to complete coverage, and the structure of the information is often the same over time. They rely on self-definition by the respondents, and this can be problematic with questions about qualifications and occupations. Another disadvantage is that in many cases the results are not available until several years later. Accordingly, census data will often be of limited use for immediate policy purposes, but will be useful for medium- and long-term projections.

7.3.3 Specific surveys

247. Some of the most common surveys carried out in individual countries are mentioned below. Part of this information will often be available at international level as well but in more aggregated form, for example the Eurostat labour force data or OECD R&D data. National classifications and methodologies are commonly used. Some kind of harmonisation may thus be required if the data are to be used for international purposes.

248. **Household surveys** investigate features of a household. They are usually sample surveys, with much smaller coverage than population censuses, but data are often collected for more parameters. As with censuses, the replies often depend on self-definition. Many are carried out on an annual basis or at even shorter intervals (quarterly, monthly) and the results are usually available within a few months, so they can be a most useful source of information.

249. **Annual employment/labour force surveys** are carried out (quarterly, monthly) in most countries. They focus on the employment and occupational characteristics of individuals. Some of them are employer-based and can yield broad trend data but, unless there is a special focus on HRST, the level of disaggregation available about HRST is usually limited. The labour force surveys carried out in the European Union countries are sample surveys where households or individuals are interviewed.

250. **Migration statistics** yield information about a country's patterns of emigration and immigration. There are a number of problems with comparisons of migration data at international level, because the statistics are often collected to meet specific needs. Some countries measure both emigration and immigration, some measure only one or the other. The underlying definition of national origin often depends on the purpose of the exercise: it may be citizenship, country of birth, nationality, etc. The level of detail collected by countries varies greatly, and in many cases disaggregations within the broad area of S&T are not feasible. Specialised analysis of population census data or specially constructed surveys may be other alternatives to assess information on migration.

251. **Annual education statistics** are based on registers in some countries and on surveys in others. The basis is normally registrations and data is usually collected via departments of education or central statistical offices. Such data provide a wealth of information about student numbers and related variables at the third level. The data are normally reliable, as they are often the basis for financial obligations between students, the educational institutions and the public authorities. The main dilemma concerning use of educational data at international level is, as mentioned before, that the allocation of levels and fields of study from national classifications to ISCED causes problems.

252. Data on enrolments of students and graduates are widely collected, giving a good picture of flows in the pipeline. Projections and trends of student numbers are often available, as well as first-destination surveys providing valuable data about the flows from higher education into employment. Fairly complete information regarding educational stocks and flows thus seems to be readily available for analysis.

253. **National earnings surveys,** which can provide important earnings data, and supplementary surveys focused on particular professions or sectors, are often available.

254. **R&D surveys** are carried out in all OECD countries but it should be remembered that normally they by no means cover the whole range of S&T activities. The data are collected using the same methodology (the Frascati Manual) in most countries and should as a rule be internationally comparable.

7.3.4 Other sources

255. **Trade and professional bodies** often compile data via their registers, and carry out membership surveys providing further data. These registers and surveys will usually cover only certain parts of a given group of HRST, and the response rates to membership surveys is often low. It may be difficult to gain access to this kind of data.

256. **Ad hoc surveys** may be carried out by private and academic and related groups on specialist topics. The surveys will have variable coverage and reliability, the results are not always publicly available, and they are usually of limited utility for international comparisons.

257. A number of countries have undertaken **cohort or longitudinal studies**. These will follow the careers of a group of HRST over a considerable period. They can yield a wealth of data, although they are expensive to mount and it takes some years to provide time series information. In some cases response rates decline over time.

7.4 Checklist

7.4.1 General

258. This section is intended as a checklist to be consulted when HRST data from different sources are compiled, compared and analysed. The items mentioned below are meant to be a preliminary outline which will be updated as soon as more experience is obtained.

7.4.2 Time period

259. Different data sets are often compiled at different points in the calendar year; this can make for difficulties when comparing two or more sets. For example, data on education enrolments are sometimes compiled at the start of the academic year; in other cases they are compiled as at 1 January or another accounting date. The totals may then differ, as slightly different populations have been measured. Similar problems may be found with flow data. Some data on unemployment, for example, may show strong seasonal variations. Finally, data sets from different countries may only be available for periods a year or more apart; it must then be seen whether circumstances have changed between these time periods.

7.4.3 Time frames

260. Some data sets are collected annually or biannually, while for others the time intervals between data collection may be as much as ten years, as is the case with many population censuses. When making comparisons, possible changes in circumstances relating to these data between the relevant reference dates have to be borne in mind.

261. For many of the issues related to HRST, the rate of change tends to be gradual. If new data collection exercises are being considered, it is therefore recommended that they be carried out regularly, perhaps every other year. This would help retain timeliness while avoiding heavy workload and costs for data collection.

7.4.4 Publication dates

262. Data may well become available or be published only several years after collection; this is particularly true in the case of international data sets. It is hence necessary to check that data are timely and still relevant.

7.4.5 Population

263. Careful consideration should be given to the population included in each data set; it may vary from source to source, and the population which a single source covers can change over time. For example, data on employment often omit the self-employed and/or people in the armed forces, while countries' data sets on education may or may not include "foreign" or "non-national" students. Treatment of part-time and temporary categories of students and workers may also vary greatly from one source to another. These points are covered further, with relevant definitional points, in Chapters 4, 5 and 6.

7.4.6 Sample

264. Data sets are frequently based on subsamples of the population (see section 4.6). If the sample is small, then there can be problems with the reliability of disaggregated data and analyses. Account also has to be taken of the response rates to sample surveys: are the respondents representative, who are the non-respondents? Survey findings often rest on response rates of just 10-20 per cent or even less; the validity of the results must then be checked with extreme care.

7.4.7 Definitions and classifications

265. As we have seen at various points in this manual, definitions of HRST abound and the same word may well be used in quite different ways by different countries and collection agencies. The most notable example is the range of meanings given to "science" and the inclusion or exclusion of the social sciences and the humanities under this heading. As we noted in Chapter 5, confusion may also arise over key terms such as "jobs", "occupations", "posts", and so on. In some data collection exercises and sources it is not always clear which definitions have been used. When comparing data from different sources, or indeed for different time periods, the classifications used should always be checked as they can vary significantly.

ANNEX 1

THE UNESCO APPROACH TO MEASURING HRST

1. General

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is together with the OECD the world's leading agency for the development of concepts for standardising the collection of S&T statistics. The two principal UNESCO sources of information and guidelines for the measurement of S&T activities are the *Recommendation concerning the International Standardization of Statistics on Science and Technology*, adopted by the General Conference at its twentieth session, Paris 27 November 1978, and the UNESCO *Manual for Statistics on Scientific and Technological Activities* (UNESCO Division of Statistics on Science and Technology, Office of Statistics ST-84/WS/12). The *International Standard Classification of Education - ISCED* is also a UNESCO responsibility (see Annex 3).

The *Manual* constitutes a practical supplement to the *Recommendation* and gives broad definitions of and guidelines for the measurement of scientific and technological activities (STA).

The UNESCO definitions of S&T activities are of direct interest to the HRST Manual, notably those (see section 3 below) which refer to the coverage of various categories of human resources and related variables.

2. Scientific and Technological Activities (STA)

2.1 General

STA are defined in the Recommendation as *"systematic activities which are closely concerned with the generation, advancement, dissemination, and application of scientific and technical knowledge in all fields of science and technology. These include such activities as R&D, scientific and technical education and training (STET), and the scientific and technological services (STS)..."*

2.2 Research and Experimental Development (R&D) Activities

As far as R&D activities are concerned, UNESCO's definitions are essentially identical with those laid down in the OECD *Frascati Manual* (see Annex 2).

2.3 S&T Education and Training (STET) at Broadly the Third Level

UNESCO defines STET as follows:

> *"all activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training, and organized life-long training for scientists and engineers. These activities correspond broadly to ISCED levels 5, 6 and 7.*"

2.4 Scientific and Technological Services (STS)

STS are defined as:

"activities concerned with research and experimental development and contributing to the generation, dissemination and application of scientific and technical knowledge;

(i) S&T services provided by libraries, archives, information and documentation centres, reference departments, scientific congress centres, data banks and information-processing departments;

(ii) S&T services provided by museums of science and/or technology, botanical and zoological gardens and other S&T collections (anthropological, archaeological, geological, etc.);

(iii) Systematic work on the translation and editing of S&T books and periodicals (with the exception of textbooks for school and university courses);

(iv) Topographical, geological and hydrological surveying; routine astronomical, meteorological and seismological observations; surveying of soils and of plants, fish and wildlife resources; routine soil, atmosphere and water testing; the routine checking and monitoring of radioactivity levels;

(v) Prospecting and related activities designed to locate and identify oil and mineral resources;

(iv) The gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics, e.g. population census; production, distribution and consumption statistics, social and cultural statistics, etc.

(vii) Testing, standardization, metrology and quality control; regular routine work on the analysis, checking and testing, by recognized methods, of materials, products, devices and processes, together with the setting up and maintenance of standards of measurement;

(viii) Regular routine work on the counselling of clients, other sections of an organization of independent users, designed to help them to make use of scientific, technological and management information. This activity also includes extension and advisory services organized by the State for farmers and for industry but does not include the normal activities of project planning or engineering offices;

(ix) Activities relating to patents and licences; systematic work of a scientific, legal and administrative nature on patents and licences carried out by public bodies."

3. UNESCO Definitions with Relevance to HRST

3.1 General

Chapter 3, Scientific and Technical Personnel, of the UNESCO Manual discusses various issues of HRST, first by defining the characteristics for inclusion of individuals in different S&T personnel

categories, various measures of S&T personnel, classifications by education (level and field of study), occupation and by nationality, age and sex. A special section (see section 4 below) is also devoted to the Scientific and Technical manpower potential (total stock of qualified manpower and number of economically active qualified manpower).

3.2 Scientific and Technical Personnel

3.2.1 Definition

UNESCO defines "**Scientific and Technical Personnel**" as:

> *"... the total number of people participating directly in S&T activities in an institution or unit, and, as a rule paid for their services. This group should include scientists and engineers, technicians and auxiliary personnel..."*

3.2.2 Subcategories of S&T Personnel

The constituent categories, of which the first two classes -- but not the third ("auxiliary personnel") -- appear to be of relevance to the OECD/Eurostat HRST Manual, are defined as:

3.2.2.1 Scientists and engineers *refer to persons who, working in those capacities, use or create scientific knowledge and engineering and technological principles, i.e. persons with scientific or technological training who are engaged in professional work on S&T activities, high-level administrators and personnel who direct the execution of S&T activities. (In the case of R&D activitites, "scientists" are synonymous with researchers and assistant researchers engaged both in the natural sciences and in social sciences and humanities.)*

3.2.2.2 Technicians *refer to persons engaged in that capacity in S&T activities who have received vocational or technical training in any branch of knowledge or technology.*

3.2.2.3 Auxiliary personnel *refer to persons whose work is directly associated with the performance of S&T activities, i.e. clerical, secretarial and administrative personnel, skilled, semi-skilled and unskilled workers in the various trades and all other supporting personnel.*

3.2.3 Conditions for Inclusion in the STP Categories

3.2.3.1 General

The guidelines below are based on ISCED levels (see Annex 3). They are limited to people working actively in S&T activities but exclude all persons who -- though qualified -- are not necessarily engaged in S&T work.

3.2.3.2 Scientists and Engineers

According to UNESCO, personnel should be classified in the category of *scientists and engineers* if they have either:

(i) completed education at the third level leading to an academic degree; or

(ii) received third-level non-university education (or training) not leading to an academic degree but nationally recognized as qualifying for a professional career, or

(iii) received training, or acquired professional experience, that is nationally recognized as being equivalent to one of the two preceding types of training (e.g. membership of a professional association or the holding of a professional certificate or licence).

3.2.3.3 Technicians

Personnel should be classified in the category of *technicians* if they have either:

(i) completed the second stage of second-level education. These studies are in many cases followed by one or two years' specialized technical studies, which may or may not lead to a diploma;

(ii) received at least three years' vocational or technical education (whether leading to a diploma or not) following completion of the first stage of second-level education;

(iii) received on-the-job training (or acquired professional experience) that is nationally recognized as being equivalent to the levels of education defined under (i) or (ii) above.

3.2.4 Unit of Measure for S&T Personnel (STP)

3.2.4.1 General

UNESCO mentions that STP may be measured both by number of persons engaged in STA and in terms of working time devoted to such STA but that both aspects may be combined. Three concepts may be used for the measurement of human resources: full-time (FT), part-time (PT) and full-time equivalent (FTE), which are defined below.

Note: The OECD *Frascati Manual* further uses the concept of **"working mainly on R&D"** (= 50-90 per cent of time) -- see Annex 2.

3.2.4.2 Personnel Working Full-time (FT)

Full-time (FT) S&T personnel are defined as "*those personnel who devote all or almost all their working time to a given scientific and technological activity"*. The UNESCO manual specifies that, in practice, those staff who devote more than 90 per cent of their working time to a given STA should be classified as FT personnel.

3.2.4.3 Personnel Working Part-time (PT)

Part-time (PT) S&T personnel are defined as *"those personnel who devote only part of their working time to a given scientific and technological activity"*. For reasons of symmetry with the previous definition, the UNESCO manual specifies that, in practice, only those staff who devote between 10 and 90 per cent of their working time to a given STA should be classified as PT personnel whereas staff who spend less than 10 per cent should be excluded altogether.

3.2.4.4 Full-time Equivalent (FTE)

The concept of FTE is based on the measurement unit representing one person working full-time for a given period; it should be used to convert figures relating to the number of part-time workers into the equivalent of full-time workers. The UNESCO manual specifies that the concept is based on two components: the actual number of persons working PT, and the percentage of working time devoted by the personnel involved to the given activity.

3.3 Other Variables

Besides the general recommendations on data collection for RSEs and technicians in terms of education/field of study and occupation, and FT and PT numbers, UNESCO also recommends that all personnel data be classified by sex, and RSEs and technicians furthermore by nationality, merely showing nationals separately from non-nationals (i.e. expatriates or foreigners) and by age. The following age groups are recommended: less than 30, 30-39, 40-49, 50-59, 60 years and over.

4. UNESCO's Scientific and Technical Manpower Potential

For the measurement of aggregated totals of S&T personnel UNESCO suggests a breakdown of the S&T manpower potential by 1) the **total stock of qualified manpower** and 2) the number of **economically active qualified manpower**.

Given their specific interest to the HRST Manual these UNESCO concepts are reproduced *in extenso* below.

Extracts from the UNESCO manual for Statistics on Scientific and Technological Activities.

(6.) Scientific and technical manpower potential

The planning and formulation of science policy requires the knowledge, especially in developing countries, of the total numerical strength of the most qualified human resources, namely the total stock and the number of the economically active persons who possess the necessary qualifications to be scientists, engineers and technicians.

(6.1) Total stock of qualified manpower

> ***Total stock of qualified manpower*** *comprises the total number of persons with the necessary qualifications for personnel in categories "scientists and engineers" and "technicians", regardless of economic activity (production, S&T activities, the professions, no gainful employment, etc.), age, sex, nationality or other characteristics, present in the domestic territory of a country at a given reference date.*

It should be noted that in the definition of total stock (and also in the following definition for economically active qualified manpower), the criterion of inclusion is merely the "necessary qualification" whereas the definition of scientists and engineers and of technicians (see items 2.1 and 2.2) is limited to

those who are actually "working in those capacities", i.e. those working as scientists and engineers or as technicians. This limited definition will not produce an inventory of all qualified manpower (i.e. potential scientists, engineers and technicians) in a given country. Frequently, individuals trained in science and engineering or with technical or vocational training are not working in S&T activities for a variety of reasons, varying from unavailability of such positions to a change in interest. They are, however, still part of a reservoir which can be used as a source of personnel for S&T activities.

(6.2) Number of economically active qualified manpower

> ***Number of economically active qualified manpower*** *comprises the total number of persons with the necessary qualifications for personnel in categories "scientists and engineers" and "technicians" who are engaged in, or actively seeking work in, some branch of the economy at a given reference date.*

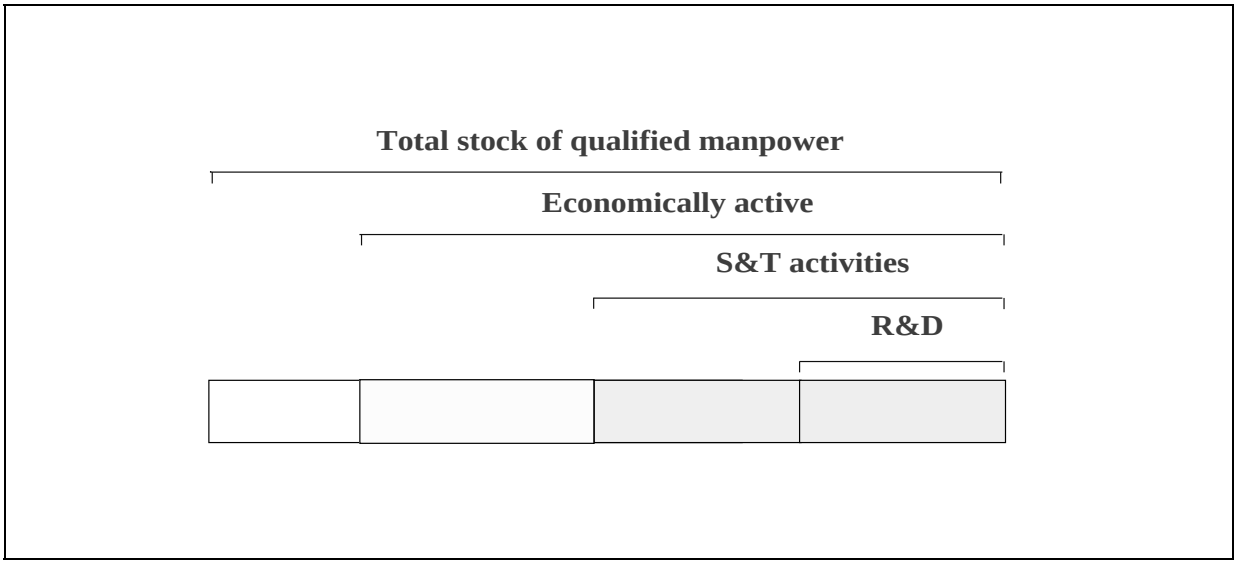
If, for practical reasons, a problem of mutual exclusion arises in the collection of data, the second definition is preferable.

In order to illustrate the difference in coverage of the two definitions, it may be said that the ***total stock of qualified manpower*** *identifies all persons resident in the country (regardless of their nationality or country of origin) who have the* ***necessary qualification*** *(although for the latter this is not always measurable, see below) achieved either in the educational system or through professional experience- to work as scientists, engineers and technicians (with the underlying concept of potentiality).*

The ***number of economically active qualified manpower*** *is that part of the total stock which is* ***either employed or actively seeking work*** *(according to the definition nationally used in labour statistics).*

In the Recommendation concerning the International Standardization of Statistics on Science and Technology, the terms "Total stock of scientists and engineers and technicians (SET)" and "number of economically active SET" are used to denote, respectively, what we call here "Total stock of qualified manpower" and "number of economically active qualified manpower."

The following scheme illustrates the relationship between these two aggregates and the group of SET actually engaged in S&T activities.



The blank area indicates those persons who, even though possessing the necessary requisites, are outside the labour market (e.g. housewives, retired persons); the light shaded area denotes those persons employed in all the branches of the economy (except those occupied in S&T activities) or actively seeking work; the darker areas indicate that part of the total stock actually engaged in S&T activities (some persons working full-time and others part-time) of which a share is devoted to R&D.

The data on the total stock of qualified manpower and on the number of economically active scientists, engineers and technicians cannot be collected by the national survey on S&T activities but will normally be obtained through a periodical population census or through manpower surveys as well as other national sources (register of professional associations, publications, ad hoc inquiries, special studies, files of employment agencies, etc.). It should be remembered that, since data requested will be derived from the different sources mentioned above which adopt their own standards and definition, the arrangement of these data cannot be expected to correspond exactly to the definitions proposed for personnel engaged in S&T activites. Close co-operation between S&T statisticians and the census authorities is therefore essential. If the national concepts differ from those suggested above (for example, concerned only with those employed in the national economy, or not including unemployed persons) and these are followed when reporting information at the international level, this should be specified and noted accordingly.

It will be particularly difficult to identify those "scientists and engineers" who have received training and acquired professional experience equivalent to formal qualification at the third level of education, or those "technicians" who have undergone on-the-job training and acquired professional experience equivalent to formal qualification at the second level of education. The figures from those sources will, in any case, represent estimates which by definition are subject to some margin of error.

5. Fields of Science and Technology

For details on UNESCO’s approach to the use of fields of S&T and relevant detailed qualifications, see Annex 3 (ISCED).

ANNEX 2

TREATMENT OF HUMAN RESOURCES DEVOTED TO R&D IN THE OECD FRASCATI MANUAL

1. Introduction

The *Frascati Manual -- Proposed Standard Practice for Surveys of Research and Experimental Development* was the first in the OECD family of manuals on the measurement of resources devoted to S&T activities. The history of the Frascati Manual (FM) goes back to the early 1960s and the 1993 version is its fifth edition. The basic FM guidelines on measuring expenditure and personnel "inputs" to R&D have been adopted by other international agencies, such as UNESCO and Eurostat. The definitions of R&D activities (expenditure and personnel) proposed by UNESCO in its *Recommendation concerning the International Standardization of Statistics on Science and Technology* (1978) and *Manual for Statistics on Scientific and Technological Activities* (1984) (see Annex 1) are nearly identical with those found in FM-1980.

As far as R&D personnel is concerned, all FM editions prior to FM-93 recommended that data be collected only in full-time equivalence (FTE) though the option of collecting head-count data was mentioned. OECD surveys of R&D used to collect FTE data only. Head-count data were first collected for the year 1991.

2. Specific Borderline Problems for R&D Personnel

R&D is part of the broader concept of S&T activities (for which the UNESCO definition is given in Annex 1). FM discusses and suggests guidelines on how to tackle a number of borderline problems referring both to the R&D activity as such (boundaries between R&D and non-R&D) and to the different categories of personnel involved. Typical examples in the first case are R&D *vs* education and administration in the higher education sector, or the distinction between R&D and a number of industry-related activities in enterprises, and, in the second case, the treatment of administrative and support staff, postgraduate students, etc. For further information, see FM-93, Chapter 2.

Given that many people devote only part of their working time to R&D (faculty staff, for instance) the FM recommendations to prefer FTE to head-counts are still valid, with a view to measuring the "real volume" of R&D performed. The new recommendations of measuring head-counts are made in line with the increased interest in HRST and with a view to improving the analytical tools for comparing R&D personnel statistics with other data series, such as education and employment statistics. Head-count data are also better indicators than FTE for the measurement of variables like gender, age, nationality, etc.

In FM-93 a separate chapter is for the first time devoted to the measurement of R&D personnel (Chapter 5).

3. Coverage of R&D Personnel

The initial coverage of R&D personnel is defined (FM para 279) as follows:

> *All persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators, and clerical staff.*

4. Measurement of R&D Personnel

4.1 Head-count Data

For reporting head-count numbers, FM-93 (paras 289-294) suggests three options:

-- number of persons engaged in R&D at a given date (for instance, end of period);
-- total number of persons engaged in R&D during the (calendar) year;
-- average number of persons engaged in R&D during the (calendar) year.

It is suggested that head-count data could usefully be divided between persons:

-- working full-time on R&D (90 per cent or more);
-- working mainly on R&D (50-90 per cent of time);
-- working part-time on R&D (less than 50 per cent of time),

with persons working less than 10 per cent on R&D excluded.

4.2 Full-time Equivalence (FTE)

4.2.1 General

FM-93 discusses the FTE concept as follows.

4.2.2 Measurement in Person-Years

Extracts from FM-93 (section 5.3.3):

[296] One FTE may be thought of as one person-year. Thus, a person who normally spends 30 per cent of his or her time on R&D and the rest on other activities (such as teaching, university administration, and student counselling) should be considered as 0.3 FTE. Similarly, if a full-time R&D worker was employed at an R&D unit for only six months, this results in an FTE of 0.5. Since the normal working day (period) may differ from sector to sector and even from institution to institution, it is impossible to express FTE in person-hours.

[297] Theoretically, the reduction to FTE should be made for all R&D personnel initially included. In practice, it may be acceptable to count all persons spending more than 90 per cent of their time on R&D (e.g. most persons in R&D laboratories) as one FTE and, correspondingly, to completely exclude all persons spending less than 10 per cent of their time on R&D.

4.2.3 FTE on a Fixed Date

Extracts from FM-93:

[299] In some cases it may be more practical to survey the FTE of R&D personnel as of a specific date. If, however, there are significant seasonal variations in R&D employment (e.g. temporary staff hired by governments at the end of the university teaching year), allowance should be made for these variations in order to permit comparison with data based on FTE during a period. Where the fixed-date approach is used and data is collected annually for the first or last day of the expenditure period, it is recommended that two-year moving averages should be used for comparisons with R&D expenditure data.

4.3 Categories of R&D Personnel

4.3.1 General

FM uses two approaches for classifying R&D personnel: by occupation and/or by level of formal qualification -- see below.

4.3.2 Classification by Occupation

Extracts from FM-93 (section 5.4.2):

[310] The standard international classification in this field is the International Standard Classification of Occupations (ISCO) (ILO 1968; ILO 1991). The main definitions of occupations which follow are especially designed for R&D surveys. However, they can also be described in terms of ISCO-88 (ILO 1990) as shown in Annex 7.

[5.4.2.2] ***Researchers (RSE)***

[311]

> *Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.*

[312] Researchers are all persons in ISCO-88 Major Group 2 "Professional Occupations" plus "Research and Development Department Managers" (ISCO-88 1237). By convention, any members of the Armed Forces with similar skills performing R&D should also be included in this category.

[313] Included are managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work. They are usually of a rank equal to or superior to that of persons directly employed as researchers and will often be former or part-time researchers.

[314] Professional titles may vary from institution to institution, from sector to sector, and from country to country.

[315] Postgraduate students engaged in R&D should be considered as researchers, and should be reported separately. Where they are not a separate category (see section 2.3.2.2) and are treated as employed as technicians as well as researchers, this may cause inconsistencies in the researcher series.

[5.4.2.3] ***Technicians and Equivalent Staff***

[316]

> *Technicians and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences, or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers. Equivalent staff perform the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities.*

[317] Technicians and equivalent staff comprise persons in ISCO-88 Major Group 3 "Technicians and Associate Professionals", notably in Sub-major Groups 31 "Physical and Engineering Science Associate Professionals" and 32 "Life Science and Health Associate Professionals" plus "Statistical, Mathematical and Related Associate Professionals" (ISCO-88, 3434). Any members of the Armed forces working on similar tasks should be included in this category.

[318] Their tasks include:

- *carrying out bibliographic searches and selecting relevant material from archives and libraries;*
- *preparing computer programmes;*
- *carrying out experiments, tests and analyses;*
- *preparing materials and equipment for experiments, tests and analyses;*
- *recording measurements, making calculations and preparing charts and graphs;*
- *carrying out statistical surveys and interviews.*

[5.4.2.4] ***Other Supporting Staff***

[319]

> *Other supporting staff include skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.*

[320] Other R&D supporting staff will be found essentially in ISCO-88 Major Groups 4 "Clerks", 6 "Skilled Agricultural and Fishery Workers", and 8 "Plant and Machine Operators and Assemblers".

[321] Included under this heading are all managers and administrators dealing mainly with financial and personnel matters and general administration, insofar as their activities are a direct service to R&D. They will mainly be found in ISCO-88 Major Group 2 and Minor Group 343 "Administrative Associate Professionals" (except 3434).

The proposed standard key between Frascati categories of R&D personnel by occupation and ISCO-88 classes is shown in Table 1 below (extracts from MF-93 Annex 7).

4.3.3 Classification by Level of Formal Qualification

Extracts from FM-93 (section 5.4.3):

[322] The International Standard Classification of Education (ISCED) provides the basis for classifying R&D personnel by formal qualification. Five classes are recommended for the purposes of R&D statistics. They are defined exclusively by level of education, regardless of the field in which personnel are qualified.

[5.4.3.2] ***Holders of University PhD Level Degrees (ISCED level 7 upper part)***

[323] Holders of doctorate degrees of university level or equivalent in all fields of the upper part of ISCED level 7. This category includes holders of degrees earned at universities proper and also at specialised institutes of university status.

[5.4.3.3] ***Holders of Basic University Degrees Below the PhD Level (ISCED level 7 lower part and level 6)***

[324] Holders of third-level degrees below the PhD level in all fields at ISCED level 7 lower part and level 6. This category includes holders of degrees earned at universities proper and also at specialised institutes of university status.

[5.4.3.4] ***Holders of Other Post-Secondary Diplomas (ISCED level 5)***

[325] Holders of third-level diplomas not equivalent to a university degree in all fields (ISCED level 5). Studies are typically specialised in subject matter, presented at a level that requires the equivalent of full

secondary level education for their mastery. They provide a more practically oriented education than the universities. Many of the courses are offered in part-time, evening, sandwich and refresher programmes.

[5.4.3.5] ***Holders of Diplomas of Secondary Education (ISCED level 3 and below)***

[326] Holders of diplomas at the second level, second stage (ISCED level 3). This class includes not only all ISCED level 3 diplomas obtained within the academic school system but also the equivalent level 3 vocational diplomas obtained from other types of educational establishments.

[5.4.3.6] ***Other Qualifications***

[327] Includes all those with secondary diplomas at less than ISCED level 3 or with incomplete secondary qualifications or education not falling under any of the other four classes.

The proposed standard key between ISCED level categories and Frascati classes for R&D personnel by formal qualification is shown in Table 2 below (extracts from FM-93 Annex 7).

4.4 National Aggregates of R&D Personnel

Extracts from FM-93 (section 5.5):

[328] The recommended aggregate is for total person-years spent in the performance of R&D on national territory for a given 12 month period. This should be broken down by sector and by occupation and/or formal qualification as shown in Table 5.2(a) and Table 5.2(b). The other institutional classifications (and sometimes the functional distributions) are applied within this framework.

[329] It would be desirable to have a single measure of all high-level personnel working on R&D. Unfortunately, because of the continued existence of alternative classifications by occupation and by qualification this is not possible.

4.5 Other Personnel Classifications

Extracts from FM-93 (section 5.7):

[332] In order to understand more about the R&D labour force, and how it fits in the wider pattern of total scientific and technical personnel, it is also useful to collect the following types of data on a head-count basis:

- *researchers (or holders of university-level degrees) by field of highest qualification;*
- *technicians (or holders of post-secondary degrees and diplomas) by field of highest qualification;*
- *researchers (or holders of university-level degrees) by age, gender, national origin, length of service, etc.*

5. Fields of S&T

The revised OECD list of broad fields of S&T and sub-categories for use in surveying R&D (FM-93 Table 3.2) is reproduced for information in Table 6 of Annex 3 on ISCED.

Table 1. CORRESPONDENCE BETWEEN FRASCATI CATEGORIES OF R&D PERSONNEL BY OCCUPATION AND ISCO-88 CLASSES
(FM-93 Annex 7, Table 2)

The International Standard Classification of Occupations (ISCO) consists of ten major groups at the top level of aggregation, subdivided into 28 sub-major groups (and 116 minor groups and 390 unit groups).

"RESEARCHERS" -- ISCO-88 CLASSES
(sub-major and minor groups):

21 **Physical, mathematical and engineering science professionals**
- 211 Physicists, chemists and related professionals
- 212 Mathematicians, statisticians and related professionals
- 213 Computing professionals
- 214 Architects, engineers and related professionals

22 **Life science and health professionals**
- 221 Life science professionals
- 222 Health professionals (except nursing)

23 **Teaching professionals**
- 231 College, university and higher education teaching professionals

24 **Other professionals**
- 241 Business professionals
- 242 Legal professionals
- 243 Archivists, librarians and related information professionals
- 244 Social science and related professionals

plus Unit group 1237
Research and development department managers

"TECHNICIANS AND EQUIVALENT STAFF" -- ISCO-88 CLASSES
(sub-major and minor groups):

31 **Physical and engineering science associate professionals**
- 311 Physical and engineering science technicians
- 312 Computer associate professionals
- 313 Optical and electronic equipment operators
- 314 Ship and aircraft controllers and technicians
- 315 Safety and quality inspectors

32 **Life science and health associate professionals**
- 321 Life science technicians and related associate professionals
- 322 Modern health associate professionals (except nursing)

plus Unit group 3434
Statistical, mathematical and related associate professionals

"OTHER SUPPORTING STAFF" -- ISCO-88 CLASSES
(major groups):

- 4 **Clerks**
- 6 **Skilled agricultural and fishery workers**
- 8 **Plant and machine operators and assemblers**

plus Minor group 343
Administrative associate professionals (except Unit group 3434)[1]

- 1 **Legislators, senior officials and managers n.e.c.**

(1) Statistical, mathematical and related professionals (here included in "technicians and equivalent staff").

Table 2. **KEYS BETWEEN ISCED LEVEL OF EDUCATION CATEGORIES AND FRASCATI CLASSES FOR R&D PERSONNEL BY FORMAL QUALIFICATION**
(FM-93 Annex 7 - Table 1)

The International Standard Classification of Education (ISCED) comprises seven categories of education, based upon three level categories, plus a residual category for education not definable by level. Note that code numbers 4 and 8 have not been used.

Levels		Level Categories	General Coverage	OECD R&D Classes
	0	Education preceding the first level	Pre-primary	Not relevant
I	1	Education at the first level	Primary	
				Other qualifications
II	2	Education at the second level, first stage		
			Secondary	
	3	Education at the second level, second stage		Holders of diplomas of secondary education
III	5	Education at the **third level,** first stage, of the type that leads to an award not equivalent to a first university degree		Holders of other post-secondary diplomas
	6	Education at the **third level,** first stage, of the type that leads to a first university degree or equivalent	Post-secondary	Holders of university level degrees at less than PhD level
	7	Education at the **third level,** second stage, of the type that leads to a postgraduate university degree or equivalent		Holders of university degrees at PhD level
	9	Education not definable by level		Other qualifications

ANNEX 3

THE INTERNATIONAL STANDARD CLASSIFICATION OF EDUCATION -- ISCED

1. General

The International Standard Classification of Education -- ISCED is the generally adopted standard classification providing guidelines for education data collection, reporting and analysis. The ISCED concepts are widely used at both international and national levels.

As described in more detail below, ISCED discusses these issues in terms of **level categories** of education and **fields of study** (broken down by programmes).

A revision of ISCED is currently under way, notably with reference to its different levels of education but less so concerning the fields of study.

The following extracts are drawn from the introduction to ISCED (para. 6). It is specified that

> "... **education** is taken to comprise **organized and sustained communication designed to bring about learning",** with further descriptions of what is meant by *"communication" (... a relationship between two or more persons involving the transfer of information), "organized" (... planned in a pattern or sequence with established aims or curricula), "sustained" (... that the learning experience has the elements of duration and continuity) and "learning" (... any change in behaviour, information, knowledge, understanding, attitudes, skills or capabilities which can be retained...).*

2. Description of the ISCED Structure

ISCED categories have been based upon two principal educational criteria: the **level** of education and the subject-matter **content** of study. In the ISCED system, the most detailed unit of education considered is a **course.** A selection of one or more courses, called a **programme,** constitutes the smallest unit for classification. Related programmes are grouped into **programme groups**. The programme groups are further aggregated into **fields** (made up of programme groups related to the same general subject matter or area). The **fields** and **programme groups** are designated within **levels** which consist of categories representing broad steps of educational progression from very elementary to more complicated learning experience (para. 10).

The ISCED is therefore a three-stage classification system providing successive sub-divisions from **level** to **field** to **programme group** (para. 10).

3. ISCED Levels of Education

3.1 Level Categories and Linkage to HRST

Seven categories of education, based upon level (plus two residual classes) are incorporated into the ISCED structure (see **Table 1** below). For the purpose of measuring HRST we are primarily interested in persons with qualifications at ISCED levels 6 and 7 which, cross-classified with occupational criteria, would correspond to the ISCO-88 class "Professionals". We are also interested in people qualified at ISCED level 5, which would correspond to the ISCO class "Technicians and associate professionals" (for further discussion of ISCO, see Annex 4).

Table 1 - ISCED LEVELS OF EDUCATION (ISCED para. 12)

0	Education preceding the first level
1	Education at the first level
2	Education at the second level, first stage
3	Education at the second level, second stage
(4	Not attributed)
5	**Education at the third level, first stage, of the type that leads to an award not equivalent to a first university degree**
6	**Education at the third level, first stage, of the type that leads to a first university degree or equivalent**
7	**Education at the third level, second stage, of the type that leads to a postgraduate university degree or equivalent**
(8	Not attributed)
9	Education not definable by level

3.2 Coverage of ISCED Level Categories

The coverage of the ISCED levels of specific interest for HRST is described as follows:

ISCED level 5 generally refers to education which begins at the age of 17 or 18 and lasts about four years. An abridged ISCED version gives the following description of this level:

> *"The core programmes at this level tend to parallel those for which university degrees are granted in terms of subject-matter categories, but are usually shorter and more "practical" in orientation. The programmes are typically specialized in subject-matter; many are part-time; evening courses are common. Refresher courses and general-interest courses are important segments of this level of education".*

ISCED levels 6 and 7 both refer to education which also begins at the age of 17 or 18 and lasts about three, four or more years.

The abridged ISCED version describes ISCED **level 6** as follows:

> *"The core at this level consists of programmes of education for those who have completed requisite programmes at the second level, second stage, and who choose to continue their education in a type of programme that is generally provided by a university. As a general guide, it may be said that the level of programmes of study is the important criterion and not the educational history of the individual student."*

Level 7 is described as follows:

> *"The core at this level consists of programmes of education for those who have completed requisite programmes at the third level, first stage, and who choose to continue their education towards a higher degree or equivalent award. The theoretical and philosophical aspects of the subjects studied are emphasised even more at this level than for the first university degree".*

4. ISCED Fields of Study and Programmes

ISCED's structure by levels, fields of study and programmes is described in **Table 2** below and the breakdown of present ISCED fields of study by level of education in **Table 3.** Most of the fields of study -- but not all -- are relevant to all levels of education, notably those where the HRST categories would be found.

These lists by fields of study serve in the common OECD, UNESCO and Eurostat questionnaires on statistics of education at the third level, where the third level is defined as requiring *"... as a minimum condition of admission the successful completion of education at the second level, or evidence of the attainment of an equivalent level of knowledge or to fulfil specific conditions of age and/or working experience".*

5. The ISCED Fields of Study Classification used as a Fields of S&T List

Whereas the fields of study list is essentially intended to classify individuals according to their educational background, other lists drawing on the same ISCED classification are being used for different purposes.

For instance, the list by broad fields of S&T used by OECD for institutional breakdowns in the R&D surveys of the Higher Education and Private Non-Profit sectors (and by UNESCO for its R&D surveys of higher education and the general service sector) are derived from ISCED. A similar breakdown is also used in UNESCO's R&D questionnaires to collect data on "Qualified Human Resources" ("total stock of qualified manpower and the number of those economically active by highest level of education attained and field of study").

Table 2. **ISCED'S STRUCTURE BY LEVELS OF EDUCATION, FIELDS OF STUDY AND PROGRAMMES**

Levels		Fields of Study	Programmes
5,6,7	14	EDUCATION SCIENCE AND TEACHER TRAINING	General teacher training, teacher training programmes with specialization in vocational subjects, education science.
5,6,7	22, 26	HUMANITIES, RELIGION AND THEOLOGY	Languages and literature, linguistics, comparative literature, programmes for interpreters and translators, history, archaeology, philosophy. Religion and theology.
5,6,7	18	FINE AND APPLIED ARTS	Art studies, drawing and painting, sculpturing, handicrafts, music, drama, photography and cinematography, interior design, history and philosophy of art.
5,6,7	38	LAW	Law, programmes for 'notaires', local magistrates, jurisprudence.
5,6,7	30	SOCIAL AND BEHAVIOURAL SCIENCE	Social and behavioural science, economics, demography, political science, sociology, anthropology, psychology, geography, studies of regional cultures.
5,6,7	34	COMMERCIAL AND BUSINESS ADMINISTRATION	Business administration and commercial programmes, accountancy, secretarial programmes, business machine operation and electronic data processing, financial management, public administration, institutional administration.
5,6,7	84	MASS COMMUNICATION AND DOCUMENTATION	Journalism, programmes in radio and television broadcasting, public relations, communication arts, library science, programmes for technicians in museums and similar repositories, documentation techniques.
5,6,7	66	HOME ECONOMICS (domestic science)	Household arts, consumer food research and nutrition.
5	78	SERVICE TRADES	Cooking (restaurant and hotel type), retailing, tourist trades, other service trades programmes.
5,6,7	42	NATURAL SCIENCE	Biological science, chemistry, geological science, physics, astronomy, meteorology, oceanography.
5,6,7	46	MATHEMATICS AND COMPUTER SCIENCE	General programmes in mathematics, statistics, actuarial science, computer science.
5,6,7	50	MEDICAL SCIENCE AND HEALTH RELATED	Medicine, surgery and medical specialities, hygiene and public health, physiotherapy and occupational therapy; nursing, midwifery, medical X-ray techniques and other programmes in medical diagnostic and treatment techniques; medical technology, dentistry, stomatology and odontology, dental techniques, pharmacy, optometry.
5,6,7	54	ENGINEERING	Chemical engineering and materials techniques, civil engineering, electrical and electronics engineering, surveying, industrial engineering, metallurgical engineering, mining engineering, mechanical engineering, agricultural and forestry engineering techniques, fishery engineering techniques.
5,6,7	58	ARCHITECTURE AND TOWN PLANNING	Architecture, town planning, landscape architecture.
5	52	TRADE, CRAFT AND INDUSTRIAL PROGRAMMES	Food processing, electrical and electronics trades, metal trades, mechanical trades, air-conditioning trades; textile techniques, graphic arts, laboratory technicians, optical lens making.
5	70	TRANSPORT AND COMMUNICATIONS	Air crew and ships' officer programmes, railway operating trades, road motor vehicle operation programmes, postal service programmes.
5,6,7	62	AGRICULTURAL, FORESTRY AND FISHERY PROGRAMMES	General programmes in agriculture, animal husbandry, horticulture, crop husbandry, agriculture economics, food science and technology, soil and water sciences, veterinary medicine, forestry, forest products technology, fishery science and technology.
6	01	GENERAL PROGRAMMES	General programmes.
5,6,7	89	OTHER PROGRAMMES	Criminology, civil security and military programmes, social welfare, vocational counselling, physical education, environmental studies, nautical science. Other programmes.

Source: UNESCO/OECD/Eurostat Questionnaire on Statistics of Education at the Third Level.

Table 3. **PRESENT ISCED FIELDS OF STUDY BY LEVEL OF EDUCATION**

Extract: The table below summarizes the cross-classification of levels and fields. Note that some fields are not included under all levels of education.

Field of study		Level of education							
		0	1	2	3	5	6	7	9
01	General programmes	x	x	x	x		x		x
08	Literacy programmes		x						
14	Teacher training and education science programmes			x	x	x	x	x	x
18	Fine and applied arts programmes				x	x	x	x	x
22	Humanities programmes					x	x	x	x
26	Religion and theology programmes		x	x	x	x	x	x	x
30	Social and behavioural science programmes					x	x	x	x
34	Commercial and business administration programmes		x	x	x	x	x	x	x
38	Law and jurisprudence programmes					x	x	x	x
42	Natural science programmes					x	x	x	x
46	Mathematics and computer science programmes					x	x	x	x
50	Medical and health-related programmes		x	x	x	x	x	x	x
52	Trade, craft, and industrial programmes		x	x	x	x			x
54	Engineering programmes				x	x	x	x	x
58	Architectural and town-planning programmes					x	x	x	x
62	Agriculture, forestry and fishery programmes		x	x	x	x	x	x	x
66	Home economics (domestic science) programmes		x	x	x	x	x	x	x
70	Transport and communications programmes			x	x	x			x
78	Service trades programmes		x	x	x	x			x
84	Programmes in mass communication and documentation					x	x	x	x
89	Other programmes		x	x	x	x	x	x	x

Source: ISCED (UNESCO 1976) -- Appendix.

Table 4. **CORRELATION BETWEEN UNESCO'S FIELDS OF S&T LIST AND ISCED MAIN FIELDS OF STUDY**

The classification by broad **field of study** in science and technology should be correlated with the following groups of ISCED fields.

Fields of science and technology	**Main fields of study in ISCED**
Natural sciences	42. Natural science programmes
	46. Mathematics and computer science programmes
Engineering and technology	52. Trade, craft and industrial programmes, n.e.c.
	54. Engineering programmes
	58. Architectural and town-planning programmes
	70. Transport and communications programmes
Medical sciences	50. Medical and health programmes
Agricultural sciences	62. Agriculture, forestry and fishery programmes
Social sciences and humanities	14. Teacher training and education science programmes
	18. Fine and applied arts programmes
	22. Humanities programmes
	26. Religion and theology programmes
	30. Social and behavioural science programmes
	34. Commercial and business administration programmes
	38. Law and jurisprudence programmes
	66. Home economics (domestic science) programmes
	84. Programmes in mass communication and documentation
Other fields	01. General programmes
	08. Literacy programmes
	78. Service trades programmes
	89. Other programmes (e.g. military programmes)

The six broad fields of science and technology correspond to regroupings of the 21 fields of study in ISCED which may be found in relation to the categories of education (based upon levels). It should be noted, however, that some fields do not exist at every one of the seven ISCED levels, e.g. law and jurisprudence programmes are not found at level categories 2 or 3 while literacy programmes occur only at level category 1.

Source: UNESCO Manual for Statistics on Scientific and Technological Activities.

The UNESCO and OECD approaches are broadly identical although the UNESCO broad "fields of S&T" list aggregates the social sciences with the humanities (whereas they are requested separately in the OECD surveys) and distinguishes a residual class "Other fields/Field unspecified" which is not used in the OECD concepts.

The correlation between UNESCO's Fields of S&T and the ISCED Main Fields of Study list is shown in **Table 4** and the detailed contents of the same S&T fields in **Table 5**. For the FM-93 revision a new, more detailed breakdown of the broad S&T fields has been prepared. It is reproduced for information in **Table 6** below.

Table 5. **UNESCO'S S&T CLASSIFICATION: BROAD S&T FIELDS AND SUBFIELDS**

In institutions belonging to the *higher education sector* and to the *general service sector* the human and financial resources devoted to S&T activities, and in particular to R&D, should be subdivided by *field of science and technology* as follows:

(i) *Natural sciences*, including: astronomy, bacteriology, biochemistry, biology, botany, chemistry, computer sciences, entomology, geology, geophysics, mathematics, meteorology, mineralogy, physical geography, physics, zoology, other allied subjects.

(ii) *Engineering and technology*, including: engineering proper, such as chemical, civil, electrical and mechanical engineering, and specialized subdivisions of these; forest products; applied sciences such as geodesy, industrial chemistry, etc.; architecture; the science and technology of food production; specialized technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile, technology, other allied subjects.

(iii) *Medical sciences*, including: anatomy, dentistry, medicine, nursing, obstetrics, optometry, osteopathy, pharmacy, physiotherapy, public health, other allied subjects.

(iv) *Agricultural sciences*, including: agronomy, animal husbandry, fisheries, forestry, horticulture, veterinary medicine, other allied subjects.

(v) *Social science and humanities*, comprising: Group I- Social sciences, including: anthropology (social and cultural) and ethnology, demography, economics, education and training, geography (human, economic and social), law, linguistics (excluding studies of language based on set texts, which should be classified in Group II under "Ancient and modern languages and literature"), management, political sciences, psychology, sociology, organization and methods, miscellaneous social sciences and inter-disciplinary, methodological and historical S&T activities relating to the subjects of this group. Physical anthropology, physical geography and psychophysiology should normally be classified within the natural sciences.

Group II- Humanities, including: arts (history of the arts and art criticism excluding artistic "research" of any kind), letters (ancient and modern languages and literature), philosophy (including the history of science and technology), prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, paleography, etc., religion, other fields and subjects pertaining to the humanities and interdisciplinary, methodological, historical and other S&T activities relating to the subjects in this group.

Source: UNESCO Manual for Statistics on Scientific and Technological Activities

The above classification overlaps with the classification by field of study (i.e. fields of study corresponding to groups of ISCED fields) illustrated in Chapter 3, item 4.2, of the UNESCO manual (with the exclusion of the "other fields").

Table 6. **OECD'S REVISED LIST OF BROAD FIELDS OF S&T AND SUB-CATEGORIES**

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified with the engineering fields)];

1.2 Physical sciences (astronomy and space sciences, physics, other allied subjects);

1.3 Chemical sciences (chemistry, other allied subjects);

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences);

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences);

2. ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects);

2.2 Electrical engineering, electronics (electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects);

2.3 Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, *e.g.* systems analysis, metallurgy, mining, textile, technology, other allied subjects);

3. MEDICAL SCIENCES

3.1 Basic medicine; (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology);

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology);

cont'd

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects);

4.2 Veterinary medicine;

5. SOCIAL SCIENCES

5.1 Psychology;

5.2 Economics;

5.3 Educational sciences (education and training and other allied subjects);

5.4 Other social sciences (anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S&T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences);

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.);

6.2 Languages and literature (ancient and modern languages and literatures);

6.3 Other humanities [philosophy (including the history of science and technology), arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S&T activities relating to the subjects in this group];

Source: Frascati Manual 1993 -- Proposed Standard Practice for Surveys of Research and Experimental Development (Table 3.2).

ANNEX 4

THE INTERNATIONAL STANDARD CLASSIFICATION OF OCCUPATIONS - ISCO-88

1. INTRODUCTION

ISCO-88 is the current standard classification of occupations. It replaces the 1968 version of ISCO which was reprinted for the fifth time in 1986. The ISCO-88 guidelines are currently being implemented whereas most HRST-relevant statistics available are still reported in line with previous ISCO concepts.

This annex presents the general ISCO-88 approach and a number of its principal variables of interest to the HRST Manual. Sections in *italics* are direct extracts from ISCO-88.

2. GENERAL ISCO APPROACH

2.1 Basic concepts: "Job" and "Skill"

ISCO-88 discusses the linkage between "**jobs**" (*defined as a set of tasks and duties occupied by one person.*.) and "**skills**" (*the ability to carry out the tasks and duties of a given job)".*

2.1.1 "Job"

The "job" is the ISCO-88 statistical unit classified. *A set of jobs whose main tasks and duties are characterised by a high degree of similarity constitutes an* ***occupation****. Persons are classified by occupation through their relationship to a past, present or future job.*

2.1.2 "Skill"

ISCO-88 defines *two dimensions* of "skill":

-- the ***Skill level*** *-- which is a function of the complexity and range of the tasks and duties involved; and*

-- the ***Skill specialisation*** *-- defined by the field of knowledge required, the tools and machinery used, the materials worked on or with, as well as the kinds of goods and services produced.*

2.2 Skill Levels

Four broad operational skill levels are defined (see below) in terms of ISCED educational categories and levels where the necessary occupational skills are acquired through formal education and/or vocational training.

For HRST, ISCO **skill levels three and four** are of specific relevance.

(a) ***The first ISCO skill level*** *was defined with reference to ISCED category 1, comprising primary education which generally begins at the age of 5, 6 or 7 and lasts about five years.*

(b) ***The second ISCO skill level*** *was defined with reference to ISCED categories 2 and 3, comprising first and second stages of secondary education. The first stage begins at the age of 11 or 12 and lasts about three years, while the second stage begins at the age of 14 or 15 and lasts about three years. A period of on-the-job training and experience may be necessary, sometimes formalised in apprenticeships. This period may supplement the formal training or replace it partly or, in some cases, wholly.*

(c) ***The third ISCO level*** *was defined with reference to ISCED category 5, (category 4 in ISCED has been deliberately left without content) comprising education which begins at the age of 17 or 18, lasts about four years, and leads to an award not equivalent to a first university degree.*

(d) ***The fourth ISCO skill level*** *was defined with reference to ISCED categories 6 and 7, comprising education which also begins at the age of 17 or 18, lasts about three, four or more years, and leads to a university or postgraduate university degree, or the equivalent.*

2.3 ISCO-88 Groups and Related Skill Levels

2.3.1 General

The conceptual approach for ISCO-88 consists of *a "pyramid" with ten major groups, subdivided into 28 sub-major groups, 116 minor groups and 390 unit groups.*

The table below (extracts from ISCO-88 Table 1) presents the linkage between major professional groups with the above-mentioned "skill levels". Here, **major groups 2 ("Professionals") and 3 ("Technicians and associate professionals")** appear to be of specific HRST interest although HRST may also be found also in **major group 1 ("Legislators, senior officials and managers")** and **major group 0 ("Armed forces")**.

For **major groups 1** (Legislators, etc.) **and 0** (Armed Forces), *the skill level approach has not been applied given that skills for executing tasks and duties of these occupations vary to such an extent that it is impossible to link them with any of the above four broad levels.*

ISCO-88 MAJOR GROUPS AND RELATED "SKILL LEVELS"

	Major Groups	ISCO Skill Level
1.	**Legislators, senior officials and managers**	--
2.	**Professionals**	**4th**
3.	**Technicians and associate professionals**	**3rd**
4.	Clerks	2nd
	Service workers and shop and market sales workers	2nd
	Skilled agricultural and fishery workers	2nd
	Craft and related trades workers	2nd
	Plant and machine operators and assemblers	2nd
	Elementary occupations	1st
0.	**Armed forces**	**--**

3. Principal ISCO Categories of Relevance to HRST

3.1 Major Group 2 Professionals

3.1.1 Coverage

The ISCO-88 major group 2 **Professionals** is described as:

This major group includes occupations whose main tasks require a high level of professional knowledge and experience in the fields of physical and life sciences, or social sciences and humanities. The main tasks consist of increasing the existing stock of knowledge, applying scientific and artistic concepts and theories to the solution of problems, and teaching about the foregoing in a systematic manner. Most occupations in this major group require skills at the fourth ISCO skill level.

ISCO-88 furthermore specifies:

Tasks performed by professionals usually include: conducting analysis and research, and developing concepts, theories and operational methods, and advising on or applying existing knowledge related to physical sciences including mathematics, engineering and technology, and to life sciences including the medical profession, as well as to social sciences and humanities; teaching the theory and practice of one or more disciplines at different educational levels; teaching and educating handicapped persons; providing various business, legal and social services; creating and performing works of art; providing spiritual guidance; preparing scientific papers and reports. Supervision of other workers may be included.

3.1.2 Principal Subgroups of "Professionals"

ISCO-88 classifies occupations of the "Professionals" major group 2 into the following sub-major groups (which are classified into minor groups with unit groups):

-- *21 Physical, mathematical and engineering science professionals;*
-- *22 Life science and health professionals;*
-- *23 Teaching professionals; and*
-- *24 Other professionals*

3.1.3 Detailed Subclassification of "Professionals"

The tasks of persons in subclasses of major group 2 "Professionals" are described as follows:

-- 21 Physical, mathematical and engineering science professionals

who *".... conduct research, improve or develop concepts, theories and operational methods, or apply scientific knowledge relating to fields such as physics, astronomy, meteorology, chemistry, geophysics, geology, mathematics, statistics, computing, architecture, engineering and technology".*

"Occupations in this sub-major group are classified into the following minor groups" (with number of unit groups):

*211 -- Physicists, chemists and related professionals (*4*)*
*212 -- Mathematicians, statisticians and related professionals (*2*)*
*213 -- Computing professionals (*3*)*
*214 -- Architects, engineers and related professionals (*9*)*

-- 22 Life Science and health professionals

who *".... conduct research, improve or develop concepts, theories and operational methods, or apply scientific knowledge relating to fields such as biology, zoology, botany, ecology, physiology, biochemistry, microbiology, pharmacology, agronomy, and medicine".*

"Occupations in this sub-major group are classified into the following minor groups" (with number of unit groups):

*221 -- Life science professionals (*3*)*
*222 -- Health professionals (except nursing) (*5*)*
*223 -- Nursing and midwifery professionals (*1*).*

-- 23 Teaching professionals

who *"...teach the theory and practice of one or more disciplines at different educational levels, conduct research and improve or develop concepts, theories and operational methods pertaining to their particular discipline, and prepare scholarly papers and books".*

"Occupations in this sub-major group are classified into the following minor groups" (with number of unit groups):

231 -- *College, university and higher education teaching professionals* (1)
232 -- *Secondary education teaching professionals* (1)
233 -- *Primary and pre-primary education teaching professionals* (2)
234 -- *Special education teaching professionals* (1)
235 -- *Other teaching professionals (3)*

-- 24 Other professionals

who *".... conduct research, improve or develop concepts, theories and operational methods, or apply knowledge relating to information dissemination and organisation of business, as well as to philosophy, law, psychology, politics, economics, history, religion, languages, sociology, other social sciences, and to arts and entertainment".*

"Occupations in this sub-major group are classified into the following minor groups" (with number of unit groups):

241 -- *Business professionals (3)*
242 -- *Legal professionals (3)*
243 -- *Archivists, librarians, related information professionals (2)*
244 -- *Social science and related professionals (6)*
245 -- *Writers and creative or performing artists (5)*
246 -- *Religious professionals* (1).

3.2 Major Group 1 - Legislators, Senior Officials and Managers

3.2.1 Coverage

ISCO-88 **major group 1** is defined as follows:

This major group includes occupations whose main tasks consist of determining and formulating government policies, as well as laws and public regulations, overseeing their implementation, representing governments and acting on behalf, or planning, directing and co-ordinating the policies and activities of enterprises and organisations, or departments. Reference to skill levels has not been made in defining the scope of this major group, which has been divided into three sub-major groups, eight minor groups and 33 unit groups, reflecting differences in tasks associated with different areas of authority and different types of enterprises and organisations.

3.2.2 Principal Subgroups

ISCO-88 classifies occupations of the "Legislators, senior officials and managers" major group 1 into the following sub-major groups (which are classified into minor groups with unit groups):

-- 11 Legislators and senior officials
-- 12 Corporate managers
-- 13 General Managers

Persons with HRST status are likely to be found within several of sub-major groups 122, 123 and 131:

122 Production and Operations Department Managers:

-- *in agriculture, hunting, forestry and fishing (1221);*
-- *in manufacturing (1222);*
-- *in construction (1223);*
-- *in wholesale and retail trade (1224);*
-- *in restaurants and hotels (1225);*
-- *in transport, storage and communications (1226);*
-- *in business services (1227);*
-- *in personal care, cleaning and related services (1228);*
-- *not elsewhere classified (1229)*

123 Other Department Managers:

-- *Finance and administration department managers (1231);*
-- *Personnel and industrial relations department managers (1232);*
-- *Sales and marketing department managers (1233);*
-- *Advertising and public relations department managers (1234);*
-- *Supply and distribution department managers (1235);*
-- *Computing services department managers (1236);*
-- *Research and development department managers (1237);*
-- *not elsewhere classified (1239).*

131 General Managers:

-- *in agriculture, hunting, forestry and fishing (1311);*
-- *in manufacturing (1312);*
-- *in construction (1313);*
-- *in wholesale and retail trade (1314);*
-- *of restaurants and hotels (1315);*
-- *in transport, storage and communications (1316);*
-- *of business services (1317);*
-- *in personal care, cleaning and related services (1318);*
-- *not elsewhere classified.*

3.2.3 R&D Department Managers

The group **Research and development department managers** (1237) is one of those of specific interest to HRST and notably R&D statistics. The professional tasks of this category are defined as:

Research and development managers plan, direct and co-ordinate the research and development activities of the enterprise or organisation, under the broad guidance of the directors and chief executives, and in consultation with managers of other departments or sections. Tasks include:

(a) planning, directing and co-ordinating research and development activities, in-house or commissioned from external research organisations, to develop new or improved technical processes, products or utilisation of materials for the enterprise or organisation;

(b) planning the overall research and development programme of the enterprise or organisation, specifying goals and budgetary requirements;

(c) controlling expenditure and ensuring the efficient use of resources;

(d) establishing and directing operational and administrative procedures;

(e) planning and directing daily operations;

(f) overseeing the selection, training and performance of staff;

(g) representing the department in its dealings with other parts of the organisation or with outside bodies;

(h) performing related tasks;

(i) supervising other workers.

3.3 Major Group 0 - The Armed Forces

ISCO-88 major group 0 is defined as follows:

Members of the armed forces are those personnel who are currently serving in the armed forces, including auxiliary services, whether on a voluntary or compulsory basis, and who are not free to accept civilian employment. Included are regular members of the army, navy, air force and other military services, as well as conscripts enrolled for military training or other service for a specified period, depending on national requirements. Excluded are persons in civilian employment of government establishments concerned with defence issues; police (other than military police); customs inspectors and members of border or other armed civilian services; persons who have been temporarily withdrawn from civilian life for a short period of military training or retraining, according to national requirements, and members of military reserves not currently on active service. Reference to a skill level has not been used in defining the scope of this major group.

3.4 Specific cases

3.4.1 Information Technology Professionals

If HRST surveys are to feed into information, computers and communication (ICC) surveys it would be desirable to break out persons working in computer and communications occupations. This would essentially involve minor group 213 **Computing professionals** (and presumably also **Computing services department managers** (1236)).

3.5 Major Group 3 - Technicians and Associate Professionals

3.5.1 ISCO-88 Coverage

ISCO-88 major group 3 **Technicians and associate professionals** is described as follows:

*This major group includes occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities. The main tasks consist of carrying out **technical work** connected with the application of concepts and operational methods in the above-mentioned fields, and in teaching at certain educational levels. Most occupations in this major group require skills at the third ISCO skill level.*

3.5.2 Breakdown

The ISCO-88 "technicians etc." occupations are classified as follows (with number of unit groups):

31 -- Physical and engineering science associate professionals

*311 Physical and engineering science technicians (*9*)*
*312 Computer associate professionals (*3*)*
*313 Optical and electronic equipment operators(*4*)*
*314 Ship and aircraft controllers and technicians (*5*)*
*315 Safety and quality inspectors (*2*)*

32 -- Life science and health associate professionals

321 Life science technicians and related associate professionals (3)
322 Modern health associate professionals (exc. nursing)(9)
323 Nursing and midwifery associate professionals (2)
324 Traditional medicine practitioners and faith healers (2)

33 -- Teaching associate professionals (4)

34 -- Other associate professionals (8)

but

of which 3415 *Technical and commercial sales representatives*
and
343 Administrative Associate Professionals
of which 3434 *Statistical, mathematical and related associate professionals*

3.5.3 Specific Cases

3.5.3.1 The Armed Forces

See section 3.3 above. No specific "technicians category" is defined by ISCO-88 but the possibility of uniformed technicians should be mentioned.

3.5.3.2 Computer and Communications Technicians

In line with the treatment of computing professionals (see section 3.4.1 above) for ICC (information, computors and communication) survey purposes, it might be worthwhile also suggesting that category 312 **Computer associate professionals** be separately broken out. This category, which is subdivided into three unit groups:

-- **Computer assistants** (3121)
-- **Computer equipment operators** (3122), and
-- **Industrial robot controllers** (3123)

is described as follows:

Computer associate professionals provide assistance to users of micro-computers and standard software packages, control and operate computers and peripheral equipment and carry out limited programming tasks connected with the installation and maintenance of computer hardware and software.

ANNEX 5

NATIONAL ACCOUNTS: BASIC CONCEPTS AND DEFINITIONS RECOMMENDED BY THE INTERNATIONAL LABOUR OFFICE (ILO), OECD AND THE UNITED NATIONS

The definitions below are extracted from various ILO, OECD and UN publications (see list of references at the end of the annex) and are also used for the Eurostat labour force surveys (see Annex 8):

1. **The Total Population**: All nationals present in or temporarily absent from the country and aliens permanently settled in the country.

Including the following categories:

National armed forces stationed abroad;
Merchant seamen at sea;
Diplomatic personnel located abroad;
Civilian aliens resident in the country;
Displaced persons resident in the country.

Excluding the following categories:

Foreign armed forces stationed in the country;
Foreign diplomatic personnel located in the country;
Civilian aliens temporarily in the country.

2. **The Economically Active Population**: All persons of either sex who furnish the supply of labour for the production of economic goods and services as defined by the United Nations systems of national accounts and balances, during a specified time-reference period.

Two useful measures of the economically active population are the **"usually active population"** measured in relation to a long reference period such as a year, and the **"currently active population"**, or, equivalently, the "labour force", measured in relation to a short reference period such as one week or one day.

2.1 The **Usually Active Population**: All persons above a specified age whose main activity status, as determined in terms of number of weeks or days during a long specified period (such as the preceding 12 months or the preceding calendar year) was "employed" or "unemployed" (see below).

2.2 The **Total Labour Force** or **Currently Active Population**: All persons who fulfil the requirements for inclusion among the employed or the unemployed as defined below.

3. **The Armed Forces**: cover personnel from the metropolitan territory drawn from the total available labour force who were serving in the armed forces during the period under consideration; whether stationed in the metropolitan territory or elsewhere.

The following are excluded from the armed forces:

-- personnel drawn from areas outside the metropolitan territory of the country concerned;

-- security forces, excepting forces such as mobile gendarmerie units and armed border patrols which receive training in military tactics, are equipped like the military forces and are liable to be placed under military command;

-- reservists recalled for a period of training of less than one month.

4. **The Civilian Labour Force**: comprises the Total Labour Force *excluding* the Armed Forces.

5. **The Total Employment**: Persons in employment, comprising those in civilian employment **plus** the armed forces, include all those employed as defined below.

6. **The Employed** comprise all persons above a specified age who during a specified brief period, either one week or one day, were in the following categories:

6.1 **Paid Employment**:

6.1.1 **At work**: persons who during the reference period performed some work for wage or salary, in cash or in kind;

6.1.2 **With a job but not at work**: persons who, having already worked in their present job, were temporarily not at work during the reference period and have a formal attachment to their job. This formal job attachment should be determined in the light of national circumstances, according to one or more of the following criteria: (1) the continued receipt of wage or salary; (2) an assurance of return to work following the end of the contingency, or an agreement as to the date of return; (3) the elapsed duration of absence from the job, which, wherever relevant, may be that duration for which workers can receive compensation benefits without obligations to accept other jobs.

Members of the armed forces should be included among persons in paid employment. The armed forces should include both the regular and the conscripts (as specified in ISCO-88).

6.2 **Self-employment**:

6.2.1 **At work:** persons who during the reference period performed some work for profit or family gain, in cash or in kind;

6.2.2 **With an enterprise but not at work:** persons with an enterprise, which may be a business enterprise, a farm or a service undertaking, who were temporarily not at work during the reference period for any specific reason.

For operational purposes, the notion of "some work" may be interpreted as work for at least one hour.

Persons temporarily not at work because of illness or injury, holiday or vacation, strike or lock-out, educational or training leave, maternity or parental leave, reduction in economic activity, temporary disorganisation or suspension of work due to such reasons as bad weather, mechanical or electrical breakdown, or shortage of raw materials or fuels, or other temporary absence with or without leave should be considered as in paid employment provided they have a formal job attachment.

Employers, own account workers and members of producers' co-operatives should be considered as in self-employment and classified as **at work** or **not at work**, as the case may be.

Students, homemakers and others mainly engaged in non-economic activities during the reference period, who at the same time were in paid employment or self-employment as defined above should be considered as employed on the same basis as other categories of employed persons and be identified separately, where possible.

7. Unemployment

The Unemployed: All persons above a specified age who during the reference period were:

-- **without work**, i.e. were not in paid employment or self-employment, as defined above;

-- **currently available for work**, i.e. were available for paid employment or self-employment during the reference period; and

-- **seeking work**, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment.

Persons temporarily absent from their jobs with no formal job attachment who were currently available for work and seeking work should be regarded as unemployed in accordance with the standard definition of unemployment.

Students, homemakers and others mainly engaged in non-economic activities during the reference period who satisfy the criteria laid down above should be regarded as unemployed on the same basis as other categories of unemployed persons and be identified separately, where possible.

8. The Population Not Economically Active: All persons, irrespective of age, including those below the age specified for measuring the economically active population who were not "economically active", as defined above.

8.1 The Population Not Currently Active or, equivalently, **Persons Not in the Labour Force**: All persons who were not employed or unemployed during the brief reference period and hence not currently active because of (a) attendance at educational institutions; (b) engagement in household duties; (c) retirement or old age; or (d) other reasons such as infirmity or disablement, which may be specified.

8.2 The Population Not Usually Active: All persons whose main activity status during the longer specified period was neither employed nor unemployed. It comprises the following functional categories:

(a) students; (b) homemakers; (c) income recipients (pensioners, rentiers, etc.); and (d) others (recipients of public aid or private support, children not attending school, etc.) as defined by the United Nations *Principles and Recommendations for Population and Housing Censuses* (1980).

9. Underemployment

9.1 **Underemployment** exists when a person's employment is inadequate, in relation to specified norms or alternative employment, account being taken of his or her occupational skill (training and working experience). Two principal forms of underemployment may be distinguished: visible and invisible.

9.1.1 **Visible Underemployment** is primarily a statistical concept directly measurable by labour force and other surveys, reflecting an insufficiency in the volume of employment. For operational reasons, the statistical measurement of underemployment may be limited to visible underemployment.

Two elements of the measurement of visible underemployment should be distinguished:

-- the number of persons visibly underemployed;
-- the quantum of visible underemployment.

Persons **visibly underemployed** comprise all persons in paid or self-employment, whether at work or not at work, involuntarily working less than the normal duration of work determined for the activity, who were seeking or available for additional work during the reference period.

For the purpose of classifying persons as visibly underemployed, normal duration of work for an activity should be determined in the light of national circumstances as reflected in national legislation to the extent it is applicable, and usual practices in other cases, or in terms of a uniform conventional norm.

A composite estimate of the **quantum of current unemployment and visible underemployment** may be compiled on the basis of the labour-time disposition of all persons in the labour force, by accounting for the the total labour time potentially available for each person in the labour force in terms of time employed, time available for employment and time not available for employment during the reference period. It can be measured for simplicity either in units of working days or half-days, or, more fully, in hours where feasible.

9.1.2 **Invisible Underemployment** is primarily an analytical concept reflecting a misallocation of labour resources or a fundamental imbalance as between labour and others factors of production. Characteristic symptoms might be low income, under-utilisation of skill, low productivity. Analytical studies of invisible underemployment should be directed to the examination and analysis of a wide variety of data, including income and skill levels (**disguised underemployment**) and productivity measures (**potential underemployment**).

Sources: *Current International Recommendations on Labour Statistics* (Geneva, 1988)
Surveys on Economically Active Population, Employment, Unemployment and Underemployment- An ILO Manual on Concepts and Methods (Geneva, 1990)
Labour Force Statistics/Statistiques de la population active 1971-1991 (OECD Paris, 1993).

ANNEX 6

REVISED INDUSTRIAL CLASSIFICATION FOR RESOURCES DEVOTED TO R&D IN THE BUSINESS ENTERPRISE SECTOR IN THE OECD 1993 R&D QUESTIONNAIRE AND CORRESPONDENCE WITH ISIC Rev.3, ISIC Rev.2 AND NACE/Rev.1

(** Correspond to items in 1989 ISIC Rev.2 Industry List arranged for R&D purposes)*

	Title	ISIC Rev.3 Division/Group/Class	Approximante correspond. ISIC Rev. 2 Div./Group/Class	Corresponding NACE Rev. 1 Div./Group/Class
1.	**AGRICULTURE, HUNTING & FORESTRY***	**01+02+05**	**1**	**01=02+05**
2.	**MINING**	**10 thro' 14**	**2**	**10 thro' 14**
3.	**MANUFACTURING***	**15 thro' 37**	**3**	**15 thro' 37**
4.	Food, Beverages & Tobacco	**15+16**	**31**	**15+16**
5.	**Food Products & Beverage**	**15**	**311 thro' 313**	**15**
6.	**Tobacco Products**	**16**	**314**	**16**
7.	**Textiles, Wearing Apparel, Fur & Leather***	17 thro' 19	32	17 thro' 19
8.	Textiles	17	321	17
9.	Wearing Apparel & Fur	18	)	18
10.	Leather Products & Footwear	19	)322 thro' 324	19
11.	**Wood, Paper, Printing, Publishing**	20 thro' 22	331+34+3832 (part)	20 thro' 22
12.	Wood & Cork (not Furniture)	20	331	20
13.	Pulp, Paper & Paper Products	21	341	21
14.	Publishing, Printing & Reproduction of Recorded Media	22	342+3832 (part)	22
15.	**Coke, Petroleum, Nuclear Fuel, Chemicals & Products, Rubber & Plastics**	23 thro' 25	35	23 thro'25
16.	Coke, Refined Petroleum Products & Nuclear Fuel	23	353+354	23
17.	Chemicals & Chemical Products	24	351+352	24 less 24.4
18.	Chemical Products (less Pharmaceuticals)*	24 less 2423	351+352 less 3522	24.4
19.	Pharmaceuticals*	2423	3522	25
20.	Rubber & Plastic Products*	25	355+356	
21.	**Non-Metallic Mineral Products ("Stone, Clay & Glass")***	26	36	26
22.	**Basic Metals**	27	37	27
23.	Basic Metals, Ferrous*	271+2731	371	27.1 thro' 27.3+27.51/52
24.	Basic Metals, Non-Ferrous*	272+2732	372	
25.	**Fabricated Metal products (except Machinery & Equipment)***	28	381	28
26.	**Machinery Equipment, Instruments & Transport Equipment**	29 thro' 35	38 less 381 & 3832 (part)	29 thro' 35
27.	Machinery, nec*	29	382 less 3825+3829 (part)	29
28.	Office, Accounting & Computing Machinery*	30	3825	30
29.	Electrical Machinery*	31	383 less 3832	31
30.	Electronic Equipment (Radio, TV & Communications)*	32	3832 (part)	32
31.	Electronic Components (includes Semiconductors)	321		32.1
32.	Television, Radio & Communications Equipment	32 less 321		32 less 32.1
33.	Medical, Precision & Optical Instruments, Watches clocks (instruments)*	33	385	33
34.	Motor Vehicles*	34	3843	34
35.	Other Transport Equipment	35	384 (part)+3829(part)	35
36.	Ships*	351	3841	35.1
37.	Aerospace*	353	3845+3829(part)	35.3
38	Other Transport nec*	352+359	3842+3844+3849	36.9
39.	**Furniture, Other Manufacturing nec**	36	332+39	36
40.	Furniture	361	332	36.1
41.	Other Manufacturing nec	369	39	36.9
42.	**Recycling**	**37**	NA	37
43.	**ELECTRICITY, GAS 7 WATER SUPPLY (UTILITIES*)**	**40+41**	4	40+41
44.	**CONSTRUCTION**	**45**	5	45
45.	**SERVICE SECTOR**	**50 thro' 99**	6 thro' 9	50 thro' 99
46.	**Wholesale, Retail Trade & Motor Vehicle etc. Repair**	**50 thro' 52**	61+62+6(part)	50 thro' 52
47.	**Hotels & Restaurants**	**55**	63	55
48.	**Transport & Storage**	**60 thro' 63**	71	60 thro' 63
49.	**Communications***	**64**	72	64
50.	Post	641		64.1
51.	Telecommunications	642		64.2
52.	**Financial Intermediation (including Insurance)**	**65 thro' 67**	81+82	65 thro' 67
53.	**Real Estate, Renting & Business Activities**	**70 thro' 74**	83+932	70 thro' 74
54.	Computer & Related Activities	72	8323	72
55.	Software Consultancy	722		72.2
56.	Other Computer Services nec	72 less 722		72 less 72.2
57.	Research & Development	73	932	73
58.	Other Business Activities nec	70+71=74	83(part)	70+71+74
59	**Community, Social & Personal Service Activ., etc.[a]**	**75 thro' 99**	**9 less 932**	75 thro' 99
60	**GRAND TOTAL**	**01 thro' 99**	**1 thro' 9**	01 thro' 99

a. Activities carried out in these industries by the Business Enterprise sector only. Figures are expected to be negligible: the heading is included as an *aide-mémoire*.

ANNEX 7

INDUSTRIAL CLASSIFICATION USED IN THE OECD INDUSTRIAL STRUCTURE STATISTICS (ISIS)

ISIC Rev.2

31	Food, Beverages & Tobacco
3112	Food
313	Beverages
314	Tobacco
32	Textiles, Apparel & Leather
321	Textiles
3213	Knitting, Mills
322	Wearing Apparel
323	Leather & Products
324	Footwear
33	Wood Products & Furniture
331	Wood Products
332	Furniture & Fixtures
34	Paper, Paper Products & Printing
341	Paper & Products
3411	Pulp, Paper & Board
342	Printing & Publishing
35	Chemical Products
351	Industrial Chemicals
3511	Basic Industrial Chemicals
3512	Fertilizers & Pesticides
3513	Synthetic Resins
352	Other Chemicals
3521	Paints, Varnished & Lacquers
3522	Drugs & Medicines
3523	Soap & Cleaning Preparations
3529	Chemical Products, nec.
353	Petroleum Refineries
354	Petroleum & Coal Products
355	Rubber Products
356	Plastic Products, nec.
36	Non-Metallic Mineral Products
361	Pottery, China, etc.
362	Glass & Products
369	Non-Metal Products, nec.
37	Basic Metal Industries
371	Iron & Steel
372	Non-Ferrous Metals
38	Fabricated Metal Products
381	Metal Products
3813	Structural Metal Products
382	Machinery, nec.
3821	Engines & Turbines
3822	Agricultural Machinery
3823	Metal & Wood-Working Machinery
3824	Special Industrial Machinery
3825	Office & Computing Machinery
3829	Machinery & Equipment, nec.
383	Electrical Machinery
3831	Electrical Industrial Machinery
3832	Radio, TV & Communication Equipment
3833	Electrical Applicances & Housewares
3839	Electrical Apparatus, nec.
384	Transport Equipment
3841	Shipbuilding & Repairing
3842	Railroad Equipment
3843	Motor Vehicles
3844	Motorcylcles & Bicycles
3845	Aircraft
3849	Transport Equipment, nec.
385	Professional Goods
3851	Professional Equipment
3852	Photographic & Optical Goods
3853	Watches & Clocks
39	Other Manufacturing nec.
3901	Jewellery
3000	Total Manufacturing
1000	Agric., Hunt., Forest., Fishing
2000	Mining and Quarrying
21	Coal Mining
22	Crude Petroleum & Natural Gas
23.9	Other Mining
3000	Total Manufacturing
4000	Electricity, Gas & Water
5000	Construction
6.9	Services
0000	Grand Total

ANNEX 8

EUROSTAT LABOUR FORCE SURVEY

The following paragraphs of interest to the HRST exercise are extracted from the Eurostat Labour Force Survey, Methods and Definitions, 1992 Series. The definitions proposed are largely inspired by the corresponding ILO, OECD and UN/SNA guidelines -- see Annex 5.

Basic concepts and definitions

The main statistical objectives of the labour force survey are to divide the population of working age (15 years and above) into three mutually exclusive and exhaustive groups-- persons in employment, unemployed persons and inactive persons -- and to provide descriptive and explanatory data on each of these categories.

Respondents are assigned to one of these groups on the basis of the most objective information possible obtained through a survey questionnaire, which principally relates to their actual activity within a particular reference week.

The definitions of employment and unemployment used in the Community Labour Force Survey closely follow those adopted by the 13th International Conference of Labour Statisticians.

The relevant parts of the "ILO definitions" are:

Employment

9.(1) The employed comprise all persons above a specified age who during a specified brief period, either one week or one day, were in the following categories:

(a) "**paid employment**";

(a1) "**at work**": persons who during the reference period performed some work for wage or salary, in cash or in kind;

(a2) "**with a job but not at work**": persons who, having already worked in their present job, were temporarily not at work during the reference period and had a formal attachment to their job. This formal job attachment should be determined in the light of national circumstances, according to one or more of the following criteria:

(i) the continued receipt of wage or salary;

(ii) an assurance of return to work following the end of the contingency, or an agreement as to the date of return;

(iii) the elapsed duration of absence from the job which, wherever relevant, may be that duration for which workers can receive compensation benefits without obligations to accept other jobs.

b) **"self-employment"**

(b1) "**at work**": persons who during the reference period performed some work for profit or family gain, in cash or in kind;

(b2) "**with an enterprise but not at work**": persons with an enterprise, which may be a business enterprise, a farm or a service undertaking, who were temporarily not a work during the reference period for any specific reason.

9.(2) For operational purposes, the notion of "**some work**" may be interpreted as work for a least one hour.

Unemployment

10.(1) The "**unemployed**" comprise all persons above a specified age who, during the reference period, were:

(a) "**without work**", i.e. were not in paid employment or self-employment, as defined in paragraph 9;

(b) "**currently available for work**", i.e. were available for paid employment or self-employment during the reference period;

(c) "**seeking work**", i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment.

In applying these definitions to the Community Labour Force survey, Eurostat and the Working Party on the survey have agreed on some minor departures from their precise meaning:

(i) Persons on lay-off, who, according to ILO definitions, should be classified as employed, are included in the unemployed on the grounds that their willingness to supply labour services is apparent in their expectation of returning to work. This very small group amounts to only about 0.2 per cent of total Community unemployment. The same argument is applied to those persons who have already found a job to start at a later date.

(ii) For persons intending to set up their own business or professional practice neither active job-seeking nor immediate availability is required, as both conditions are difficult to measure; job-seeking activities are of a particular nature for this group, while testing on immediate availability would be completely hypothetical.

(iii) It has been decided that in paragraph 10(b) "currently available" should mean available to start work within two weeks of the reference period. In paragraph 10(c) the "specified

recent period" is the four weeks preceding the survey interview, the reason being that delays inherent in job search (for example, periods spent awaiting the receipt of results of earlier job applications) require that the active element of looking for work may be measured over a period greater than one week if a comprehensive measure of job-seeking is to be obtained.

Unemployed persons can be classified by reason for unemployment into four major groups:

(1) job-losers are persons whose employment ended involuntarily and immediately began looking for work;

(2) job-leavers are persons who quit or otherwise terminated their employment voluntarily and immediately began looking for work;

(3) re-entrants are persons who previously worked, but were inactive or on compulsory military service before beginning to look for work;

(4) first job-seekers are persons who have never worked in a regular job.

Labour force

The labour force comprises persons in employment and unemployed persons.

Inactive persons

All persons who are not classified as employed or unemployed are defined as inactive. Apart from showing pupils and students separately, no further breakdown is provided for this group.

Conscripts on compulsory military or community service are excluded from the compilation of the survey results.

The above groups are used to derive the following measures:

(a) *Activity rates*

Activity rates represent the labour force as a percentage of the population of working age (15 years or more).

(b) *Employment/population ratios*

Employment/population ratios represent persons in employment as a percentage of the population of working age (15 years or more).

(c) *Unemployment rates*

Unemployment rates represent unemployed persons as a percentage of the labour force.

The above rates are usually calculated for sex-age groups and are sometimes further cross-classified by other demographic variables such as marital status or nationality.

Duration of unemployment is defined as the shorter of the following two periods:

(a) the duration of search for work, or
(b) the length of time since last employment.

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