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Mini Study 02 – Skills for Innovation

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Introduction

"Europe must renew the basis of its competitiveness, increase its growth potential and productivity and strengthen social cohesion…..placing the main emphasis on knowledge, innovation and the optimisation of human capital". (European Council, March 2005)

It is widely accepted that the acquisition, application and use of information and knowledge are crucial for creating and adding value in the global economy. As a consequence, the importance of certain forms of human capital and skills - especially problem solving, technical, communication and interpersonal skills, collaborative working - have increased across the spectrum of industrial sectors and public services in all developed and developing nations. However, there is widespread recognition that most industrialised countries are currently facing a shortage of highly qualified and appropriately skilled workers. Pressure on the supply of such workers is expected to intensify in Europe in the coming decades as a result of low birth rates and ageing populations.

Over the past 25 years, service industries have become the fastest growing, indeed dominant, sector in many of the world's economies. Services now account for more than 50 percent of the labour force in Brazil, Russia and, Japan and 75 percent of the labour force in the United States and much of Western Europe. Commentators suggest that this trend is changing the way that companies organise themselves, and that it is contributing to the emergence of a troubling 'skills gap' (i.e., a situation in which enterprises do not have sufficient numbers of staff with appropriate forms and levels of skills). As a result, competition for skilled workers both within and between countries is likely to intensify.

The combination of skills development (or human capital accumulation) with innovation gives rise to what has been termed the *"twin engines of growth"*[1]. These engines act together with other variables to affect both the demand for skills and the ways in which we nurture skills that are conducive to innovation. These other variables include the impacts of international trade, labour market institutions (including the minimum wage and trade unions), the domestic competitive environment, education and training and their institutional structures, public expenditure and public policy more generally, and so on.

Given that human capital is a major complement to R&D and physical capital, attracting and retaining skilled people is crucial to the stimulation of innovation and to the acceleration of productivity growth. The competitiveness of Europe is intimately linked to its innovation performance and to the skills and competences of its citizens. However, Europe is still lagging behind the US and Japan in terms of innovation (despite concerted efforts to reverse the trend), and this raises the

[1] Lloyd-Ellis, H & J. Roberts (2002), *Twin engines of growth*, Journal of Economic Growth, Vol., 7(2)

important question of just what skills and competences are required in order to improve the situation. Further important questions in the context of European competitiveness – issues that are addressed in this paper – include, 'what skills are needed to cover different types of innovation', 'what are the skills that are found in the most innovative companies and regions', 'how can innovation skills be measured' and 'what is the role of public policy in promoting skills for innovation'?

The first section of the paper deals with some general themes relating to (a) definitions and forms of skills and innovation, and (b) the role of skills in firm-level, regional and national innovation performance. Section Two examines the types of skills that are required for different types of innovation processes and activities, and for innovation in different types of organisations. Section Three focuses on how it might be possible to foster skills for innovation and examines the role of policy at various levels.

This 'mini-study' has been generated as an input to the INNO-Views Workshop on skills for innovation that is to be held in Glasgow on 27th and 28th September, 2007. It is based on a review of the latest research, policy developments and evidence relating to skills for innovation and aims to provide workshop participants with an overview of current and evolving themes.

Section 1: Defining, Conceptualising and Measuring 'Skills for Innovation'

1.1 What are Skills for Innovation?

We should first explain what is meant by "skills" and "innovation" – neither term is as simple as it at first may seem.

1.1.1 What are Skills?

Skills, in their most general sense, can be viewed as the abilities of people (including management and leadership abilities, technical, scientific and production abilities, and soft/interpersonal abilities) for which there is a demand within the formal economy. People typically acquire skills that enable them to implement existing technologies and fit-in with *current ways of doing things*. However, they also acquire skills that assist them in developing novel products or in organising work and production processes in new ways.

Tether *et al* (2005), define a 'skill' as "an ability or proficiency at a task that is normally acquired through education, training and/or experience". These authors also indicate that the term 'skill' is sometimes used synonymously with related concepts of 'competence', 'expertise', 'knowledge' or 'human capital' (see section 1.3). They suggest, there are many forms of skills and the term is used in many different contexts. For our purposes (and at a most basic level) it is useful to distinguish between different *levels* and different *types* of skills. Discussion of level implies that we consider the aptitudes, experience, credentials or abilities that are required of individuals in the performance of a task or function. With respect to 'types' of skill, here we are concerned with various classes such as engineering, technical, organisational, problem-solving, language, relationship-building, and communication skills etc.

1.1.2 What is Innovation? [2]

The OECD's *Oslo Manual* defines innovation as: "The implementation of a new or significantly improved [to the user] product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". This definition captures both the meaning of innovation as a *process* (implementation) and as a new *artefact or practice* (product, process, method, etc.). A rather more elaborate definition comes from *The Oxford Handbook of Innovation* (2004) where Fagerberg notes that:

> *"An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new*

[2] Whilst this short passage cannot hope to review the different perspectives that have been brought to bear on the notion of innovation, it is important to recognise the complex, nuanced and contested nature of the concept. An interesting and useful discussion can be found on the web pages of the UK's National Endowment for Science Technology and the Arts (NESTA) at: http://blogs.nesta.org.uk/innovation/2007/03/defining_innova.html

> *product or process, while innovation is the first attempt to carry it out into practice. Sometimes, invention and innovation are closely linked, to the extent that it is hard to distinguish one from another… In many cases, however, there is a considerable time lag between the two….. Such lags reflect the different requirements for working out ideas and implementing them. While inventions may be carried out anywhere, for example in universities, innovations occur mostly in firms, though they may also occur in other types of organizations, such as public hospitals. To be able to turn an invention into an innovation, a firm normally needs to combine several different types of knowledge, capabilities, skills, and resources. For instance, the firm may require production knowledge, skills and facilities, market knowledge, a well functioning distribution system, sufficient financial resources, and so on…."*

Definitions of innovation often stress "the *successful* exploitation of new ideas"[3] – this particular formulation is from the UK's DBERR (formerly DTI), but echoes the emphasis on success often found in the management literature. But note that "success" is ambiguous – a technical success may be a commercial disaster!

These definitions, and the wider discussions they are set in, indicate that there are different types of innovation and innovation process, varying for instance in terms of:

- types of idea and underpinning knowledge (e.g. technological ideas are emphasised to the exclusion of cultural or organisational ones[4]),
- ways of generating ideas (e.g. research and development is not prioritised as compared to innovations developed in practice or on the job),
- forms of success (e.g. economic return or social benefit and/or acclaim).
- levels of novelty, since some "new ideas" are groundbreaking while others are minor changes in established ways of doing things -– there is a classic distinction between incremental and radical innovation that reflects this, and many related concepts have been introduced such as "revolutionary innovations", "architectural innovations" "configurational innovations". In addition, innovation studies may ask whether an innovation is new to the firm, the industry, or the world.[5]

[3] See: http://www.berr.gov.uk/innovation/index.html
[4] Though "invention" is more commonly applied to technologies than to organisational or artistic ideas.
[5] Note that Fagerberg's "first occurrence" does not necessarily mean the "first occurrence" anywhere at any time of the innovation. Indeed, often the first example of an innovation does not achieve wide uptake. The diffusion process involves many users effecting their first use of the innovation.

1.1.3 What are the main types of innovation?

Four main classes of innovation that are discussed in the current literature are now used in the Community Innovation Survey:

- ***product innovation*** (usually technological), where innovation involves the development of new goods, services, machinery, equipment, components, software (or novel assemblages of these);
- ***process innovation***, involving new systems or routines of production, again with an emphasis on the tools and equipment and software used in the processes;
- ***organisational innovation***, involving where innovation relates to changing management practices or workflow structures;
- ***marketing innovation***, involving new ways of relating to customers and potential customers (including new ways of promoting products) - this is closely related to the idea of ***delivery innovations,*** targeted at transforming the ways in which products or services reach their consumers.

Additionally, there are many types of **Innovation Process** (this is not the same as "process innovation"!) Much discussion centres on Research and Development (R&D) as **the** way in which innovations are generated. In practice, however, innovations often come from work on the shop floor or front-office, and R&D departments are, anyway, rare outside of high-tech manufacturing (and a few high-tech services) companies. Often, major innovations are organised through project development teams. In some firms and sectors the main influences on innovation are the introduction of new machinery and software from suppliers of such tools; in some, professional associations and industry associations provide an important source of knowledge; in some the clients are a major stimulus for innovative ideas; and so on.

Finally, we should note that the innovation process is itself something that changes over time, from the first development of an idea (invention), through its development into a new product or process, the roll-out of the idea in the innovating organisation, and then the diffusion and implementation of this by further users (diffusion); at any of these stages further new ideas may be introduced, the design of the innovation may be adapted in the light of feedback as to user requirements or technical problems, and so on. Two important ideas are the "product life cycle" and the "industry life cycle". Each refers to a stylised path of development. In the **product life cycle** the picture refers to the development of an innovation from being expensive and hard to use, to being cheap and available for low-skill users (and often mass markets). The focus of innovative effort evolves from one on getting the product to work and to be well-adapted to users, to one of mass-producing it easily and cheaply. The **industry life cycle** points to the parallel phenomenon, where firms rise and decline and production may be moved from highly knowledge-intensive locations to ones characterised by cheap and less skilled labour.

These "life cycles" are useful frameworks for thinking labour product and industrial change, but there are many cases where the patterns described above are not followed with any precision.

1.1.4 What is the relationship between Skills and Innovation?

Given that there are many forms of innovation that do not always follow a defined set of stages, the relationship between innovation and skills is bound to be complicated. Skills involved in innovation will depend on:

(a) the nature of the innovation in question (incremental vs. radical; product, process or organisational etc.),
(b) the nature and distribution of skills within and available to an organisation, and
(c) the possibility of transforming and growing new skills within enterprises and the wider economy.

It is possible for an individual enterprise to go through the whole process of innovation without changing its skills set (especially if the innovation is incremental, rather than radical), although it is also likely that innovation may lead to, or require, a change (possibly of various different kinds) in the skills of the business. It is however clear that at both the level of the firm and across the economy, the various stages of innovation in manufacturing and services will at some point impact on the demand for skills and new skill composition, including those of management and leadership skills, technical and scientific skills and soft/interpersonal skills.

Following from above, we could expect that different 'types' or classes of innovation will require different types of skills (i.e., skills differing in both form and levels). These skills are needed to support development and diffusion. The configuration in Table 1 is not intended to be comprehensive (as there are of course many generic skills involved in innovation of all forms). It is only indicative, offering an overview of the types of core skills that are frequently associated with different classes of innovation.

Table 1.1.1: Classes of Innovation and Associated Core Skills[6]

Class of Innovation	Skills
Product and Technological	Scientific and Technological Engineering Design and Packaging Market and User Research
Process	Technical Project Management Organisational and Workflow Design Interaction and Relationship Management
Organisational	Opportunity Recognition Systems Design Leadership

[6] Data in the table draws upon work by Tether et al (2005), Tidd, Bessant and Pavitt (2001) and Utterback (1996)

	Communication
Marketing, Delivery and Interface	ICT & Systems Development Web Design and Content Development Data Analysis Language and Communication

We can now look in little more detail at classes of innovation and the forms of skills that are generally required to ensure their realisation[7].

1.1.5 What are the Skills for Product and Technological innovation?

This kind of innovation is commonly understood to concern the development of new goods, equipment and services which generate demand for scientific, technological, design and engineering skills (especially in the case of innovation associated with development of tangibles). Technological innovation in advanced western economies has been described as skill-biased, insofar as it is perceived to increase demand for higher level skills and reduce demand for lower-level skills. Market research skills are also necessary for the collection of data relating to the orientations and preferences of potential consumers, as are client interfacing (and communication) skills in the case of new service development and delivery. Given the 'distributed' nature of much contemporary innovation, skills for the management and coordination of team-based working are perceived to be an increasingly necessary ingredient in innovation.

1.1.6 What are skills for Process innovation?

Such innovation involves the development and commercial exploitation of a new way of producing an organisation's product(s). Much discussion in the economics of innovation literature focuses on the 'job reducing' character of process innovation: this is because much such innovation is of the kind where capital - in the form of new machinery/equipment - replaces labour (particularly where such labour is unskilled). However, process innovation can involve the use of more labour relative to capital, or the off-setting of job losses by the creation of jobs elsewhere in a company or the economy (for example, in the upstream production of new machinery). Process innovation itself is complex (and evident in many forms), and usually requires some technical and project management skills to ensure successful specification and implementation (especially where new deployment of technologies is implied). Organisational and management skills will usually be required in order to ensure successful re-design of workflow processes. Interaction and relationship management skills are also frequently necessary where introduction of a new process implies disruption to existing work routines.

1.1.7 What are skills for Organisational innovation?

Change in management practices and organisational structures - can have different effects on the demand for skills. It is closely related to process

[7] Tether *et al* (2005)

innovation (as the latter frequently requires some level of organisational change), however, at a basic level, the term implies the introduction of new management practices and/or the re-design and re-organisation of work practices and routines (i.e., new ways of 'getting the job done', or the introduction of new jobs and methods of working). Skills for the initiation of organisational innovation include an ability to recognise opportunities for (and value to be derived from) the introduction of new systems. They also include an ability to conceive of and design appropriate new systems. The management of organisational innovation frequently involves leadership and communications skills and an ability to convey a (positive) vision of change to secure the buy-in of workers affected by change.

1.1.8 What are skills for Marketing, Delivery and Interface Innovation?

Such innovation is concerned with the development of new ways of getting products and information to clients and service users. The extraordinary growth in the number and sophistication of commercial and public agency websites over the past decade is clear evidence of the efforts of contemporary organisations to create novel ways of interfacing with their users, partners and customers. Importantly, this growth also highlights the central role of ICTs in the development and realisation of interface innovations[8]. New technologies, including mobile telephony and web infrastructure have made it possible for firms and agencies to evolve novel business models (for example around e-business and remote transactions), and to use data captured via interactions with their customers in their innovation activity. Skills involved in the development of delivery and interface innovations are wide-ranging but there is a clear focus on high-level technology skills such as those associated with systems development and integration and cyber security. Web design, data analysis, creative and content development skills are also important, as are language and communication skills where delivery innovations involve the establishment of remote customer service facilities. Enhancing services – or indeed providing these through alternative delivery channels such as by phone or internet – often requires soft skills – involving oral communication, customer handling skills, local problem solving, and teamwork. These skills applied through 'emotional labour' are increasingly important for businesses seeking to compete through higher quality of service, rather than on price[9].

[8] The rise of the 'call centre' phenomenon is another example of the ways in which organisations are using technologies to enhance and streamline the delivery of public and private services. It is worth noting here too that ICTs have provided organisations with an opportunity to outsource or offshore many services, and to exploit the skills of workers in remote locations

[9] Becker, M.C, (2001), *Managing dispersed knowledge : organisational problems, managerial strategies and their effectiveness,* Journal of Management Studies, Vol. 38 (7) November 2001 and Frenkel, et al (1999) *On the front line: organisation of work in the information economy*, Cornell University Press, Ithaca, NY

1.1.9 Do Skills for Innovation vary over the Life-Cycle of Innovations and Industries?

The classes of innovation sketched above are liable to vary across the product/industry life cycle; and stages in these life cycle impacts are liable to impact on both the demand for and supply of various types of skills. Stages of the life cycle and associated skills are presented in Table 2 below.

With new product innovation, Tether *et al* reported that businesses could be expected to go through three stages, which differ in their demand for skills. During the early, 'fluid stage' of the industry, the product is ill-defined, and the key skills are those of entrepreneurs (often combined with scientific or technical specialists, and skills in marketing). Production skills at this stage tend to be more general and adaptable, rather than specific and rigid. At this stage, production workers have to adapt to rapidly changing technologies and demand. Subsequently the product of the industry tends to become more defined and standardised, and a 'dominant design' emerges. This is the 'transitional stage', in which there is a shift from product to process innovation. The emergence of a clearly defined product denotes entry into a "specific stage" where firms increasingly compete on costs and price, rather than on product quality and features. During this phase, management skills become more functional and 'scientific', whilst workforce skills become more specific and the division of labour more precise. There is often a tension between how finely honed workers skills are to a task against their ability to learn and adapt. The introduction of specialist equipment may at first augment the skills of skilled workers, but, in the long run capital (i.e. machinery, equipment, etc.) tends to replace skilled labour and during the mature phase of the industry the remaining labour force becomes increasingly unskilled.

Table 1.1.2 Characteristics of Innovation and Skills over the Product/Industry Life Cycle

Innovation	Fluid Phase *Radically new products*	Transitional Phase *Focus on process to achieve production scale efficiencies*	Specific Phase *Gradual cumulative improvements in productivity & quality*
Key Skills	*Entrepreneurial skills, coupled with high level specialists in technology and/or marketing, plus adaptive workforce, which develops more specific skills over time*	*Organised, functional "scientific management", plus development of specialist workforce skills associated with mechanisation of production*	*Small "elite" with managerial command & control skills, seeking to maintain control over a workforce with low or unspecific skills*

Source (Tether 2005)

Technological product and process innovations, then, can have different effects on the demand for skills. Process innovation is generally assumed to be of the kind where capital replaces labour, particularly unskilled labour. But the innovation could increase demand for the firm's products, stimulating employment, or jobs could be created elsewhere in the economy, such as in firms supplying capital equipment. Product innovation is generally expected to generate employment, because it can increase demand for the firm's products.

As we shall discuss later, innovation processes are also increasingly distributed or 'open', requiring clusters of firms and other stakeholders to work together rather than 'going it alone'. These distributed processes require managerial skills in forming and sustaining collaborative arrangements for innovation.

Overall, it is difficult to disentangle the skills that drive innovation from those which are demanded as a result of change brought about by innovation. The skills of the workforce and management will help determine the innovation that takes place, which will then help determine the changed demand for skills in the firm, which will influence the innovation that takes place and so on. Understanding the relationships will require modelling which is currently not yet widespread.

Nevertheless, there is enough analysis and evidence available to be able to draw many conclusions about the nature of skills for innovation and its implications for the EU. We will see how far these enable us to address the series of issues with which we have been posed, below.

1.2 How do needs for Skills and Innovation vary across Different Types of Organisations?

Most commentators agree that many companies – especially SMEs – do not put much effort into thinking about innovation, and thus they do not have articulated views about their skill needs for innovation. We might conclude that they have a need for management skills involving being more aware of the challenges and opportunities that innovation confronts their firms with! More generally, many firms will have difficulty in identifying the broader management and workforce skills required for effective innovation in their sectors and markets, and management capabilities for such strategic skills analysis are extremely important. We should also note that there is some evidence that innovative SMEs, at least, seem to see the main issue as one of developing skills in their existing workforce, rather than accessing them from external sources.

1.3 What is the link between Skills and Innovation Performance?

There is clear evidence for both national and regional economies that higher skill levels tend to be associated with higher levels of economic performance (e.g. productivity increases and/or ratings on competitiveness indices). One regional analysis concerns the UK; Boddy et al [10] (2006) conclude that the relative performance of different UK regions has much to do with differences in capital investment and in skill levels. At a cross-national level, the 2002 European Competitiveness Report reviewed studies demonstrating the positive impact of human capital formation on national economic performance. Skill shortages in the EU were seen to be related to the under-performance of most EU economies compared to US productivity growth. The study puts emphasis on the need to match skills with capital investment. Indeed, the literature here typically suggests that human capital cannot be considered in isolation – it is the combination of skills with management, capital investment, and other factors – for example transport and communications infrastructure – that is necessary for really effective performance.[11]

Higher level skill shortages have been reported[12] to have negative impact on performance through delays in innovation: the UK Technical Graduates Employers Survey (1991) in the UK found that two thirds of employers which had experienced difficulties in recruiting high-level skilled personnel reported suffering commercial problems as a result. The most common problem mentioned was delays in product development and process improvement projects, impacts which may have no immediate effect on performance but may contribute to weaker performance in later time periods. The link may not be a mechanical one – groups of skilled workers may dig their heels in to protect their jobs, working conditions, status, etc., and resist specific innovations. But there is a wide consensus that innovation is in general more prevalent where there are higher levels of workforce skills. Most of the evidence concerns skills in general, rather than "skills for innovation" specifically. A line of useful evidence comes

[10] Martin Boddy e al, ((2006) Regional Productivity Differentials Explaining the Gap, University of the West of England, Bristol

[11] It would be interesting to explore skills in the context of regional innovation systems. The RETINE project (Muller et al 2001, RETINE – Regional Typology of Innovation Needs, ISI) at http://www.isi.fraunhofer.de/r/download/retine_final_report.pdf) Investigated the innovation-related needs of firms, comparing 10 EU regions. The study led to a typology of three or four main groups of regions, reflecting different needs in the innovation process, perceptions of the regional business environment by firms, and the linkages between these. However, information on population educational attainments did not seem to strongly vary across clusters of regions.

[12] Mason, Geoff, "The Labour Market for Engineering, Science and IT Graduates: Are There Mismatches between Supply And Demand? ", Department for Education and Employment Research Report No. 112, 1999. AND Mason, Geoff, Key Issues in IT Skills Research in the UK, Report to the Department for Education and Employment. (London: National Institute of Economic and Social Research, 2000)

from innovation surveys, which ask firms about their innovative activities, and about numerous other features of the firm – including data on their employment on graduates, and on their expenditures on training associated with innovation.

We have analysed UK data from the 4th Community Innovation Survey which points to there being a strong link between skills and innovation. For readability reasons, we present data for standard economic sectors rather than individual firms. Table 1.7.1 shows that sectors where a higher proportion of workers that have received higher education are likely to be more innovative. (Note the different patterns of association for manufacturing and services). We show similar relations for "wider innovation" (organisational and marketing innovation) as for more technological (product and process) innovation (Table 1.7.2). In both cases the trend lines as drawn automatically correspond quite well to the conclusions one would draw from visual inspection. Finally, there is some limited evidence for a positive relationship between sectoral innovation propensity and the average amount of expenditure on innovation-associated training per employee (Table1.7.3), though the trend lines do not correspond anything like so well to a pattern readily ascertainable by visual inspection. It seems to be weaker, especially for services. (We might speculate that for some sectors, the cost of training staff to use new technologies might be a deterrent to innovation). All of these relations are confirmed by correlation analysis of firm-level data, too. Typically small but statistically highly significant relationships are found between the innovation and the skill/training variables. It is also interesting to note that in both the firm-level and cross-sectoral analyses, we see a positive relation between propensity to innovate and reporting that "lack of qualified personnel" is a barrier to innovation. It is the more innovative firms who experience this problem most, then, suggesting that skill shortages may be more of a barrier to further innovation and commercialisation, than something that prevents innovation initiatives altogether.

1.4 Can we measure Skills for Innovation?

The issue of measurement is difficult. A major problem is that the definition of skills is not uniform among European countries and is usually proxied with qualifications, which are also not uniform across Europe. This means that different methodological approaches are used. The most common definition uses both occupational skills and educational attainment (Ireland, France, the Netherlands, Poland, Finland and Rumania). The UK, in addition to this common definition uses the term "qualifications" plus trying to build on the generic skills concept (including social and personal skills) to expand the definition. Greece also applies diverse skill concepts covering generic, technical and personal skills. In Estonia, Italy and Cyprus skills are defined mainly in terms of occupations. In the Czech Republic and Germany more emphasis is put on educational attainment/qualifications. Use of ISCED as a basis for definition is being

applied in the Czech Republic, Germany and Romania. There is little evidence that countries specifically measure skills for innovation. In view of the above it would be surprising if there were a consensus on what these might be.

Tables 1.4.1 Employee Skills and Technological Innovation

Table 1.4.1 (a) Manufacturing Sectors

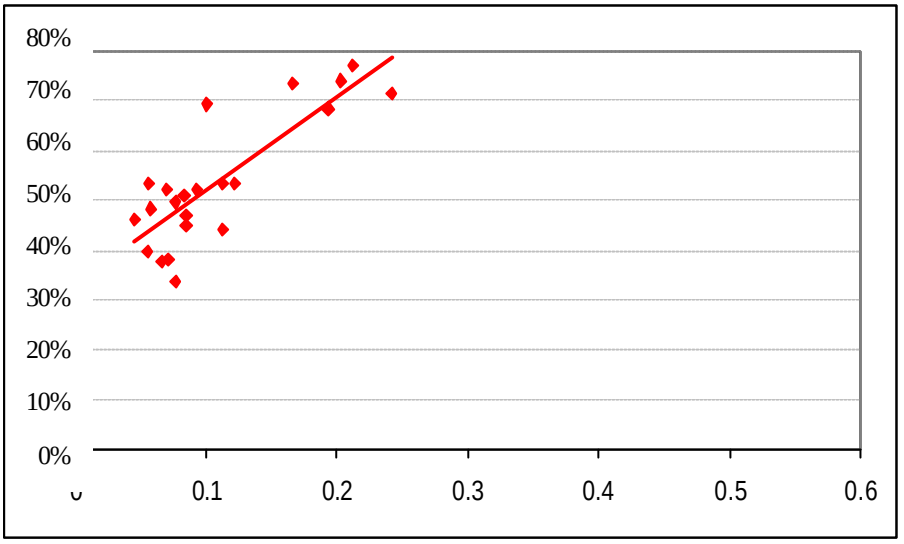
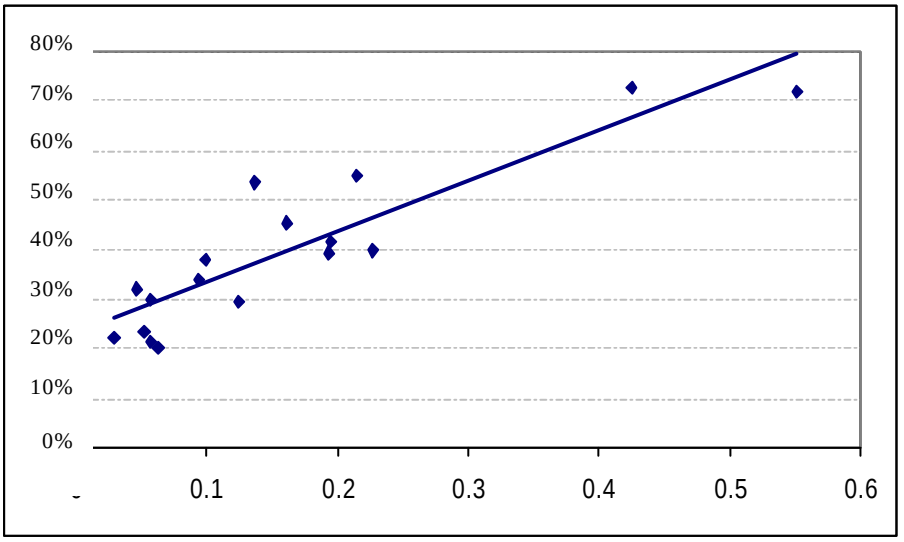


Table 1.4.1 (b) Services Sectors



(Vertical Axis: share of firms in sector undertaking product and/or process innovation; Horizontal Axis: Mean proportion of employees who are University graduates in each sector).

Tables 1.4.2 Employee Skills and Wider Innovation

Table 1.4.2 (a) Manufacturing Sectors

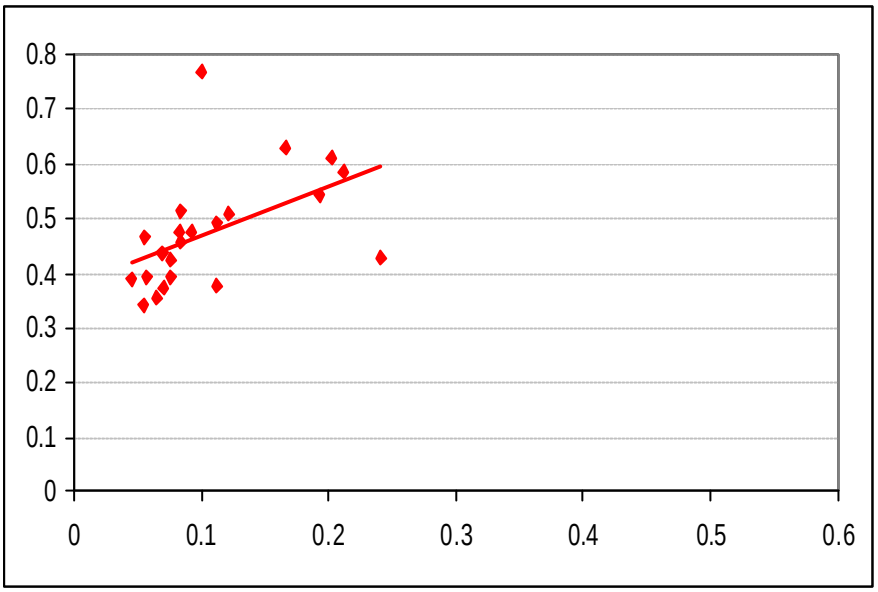
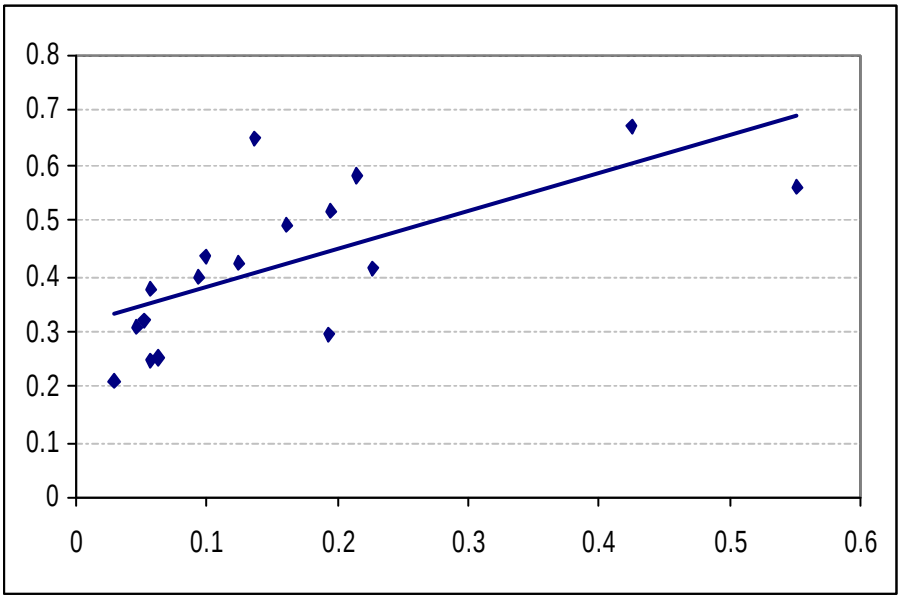


Table 1.4.2 (b) Services Sectors



(Vertical Axis: share of firms in sector undertaking “wider innovation”; Horizontal Axis: Mean proportion of employees who are University graduates in each sector).

Tables 1.4.3 Relations between Training and Innovation

Table 1.4.3 (a) **Manufacturing Sectors**

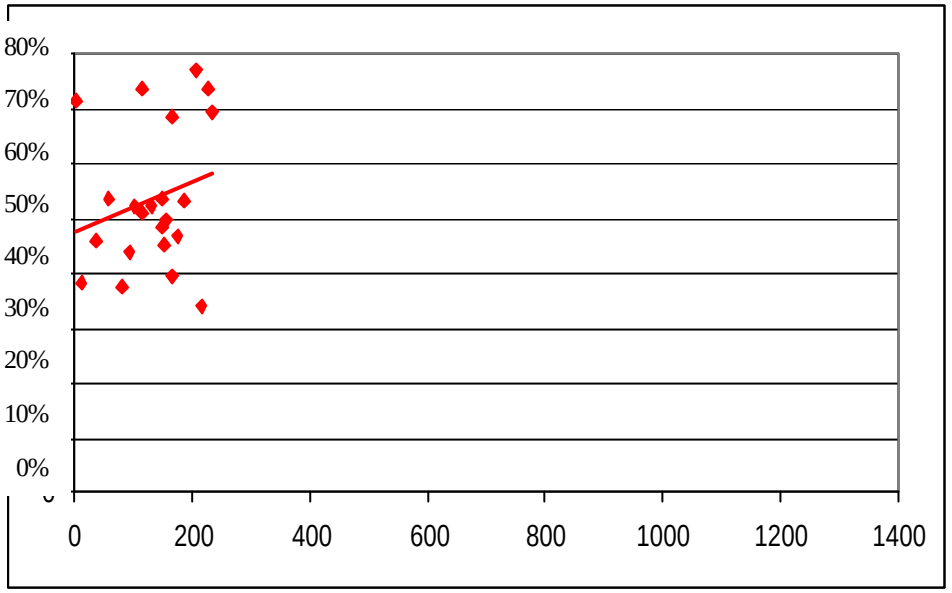
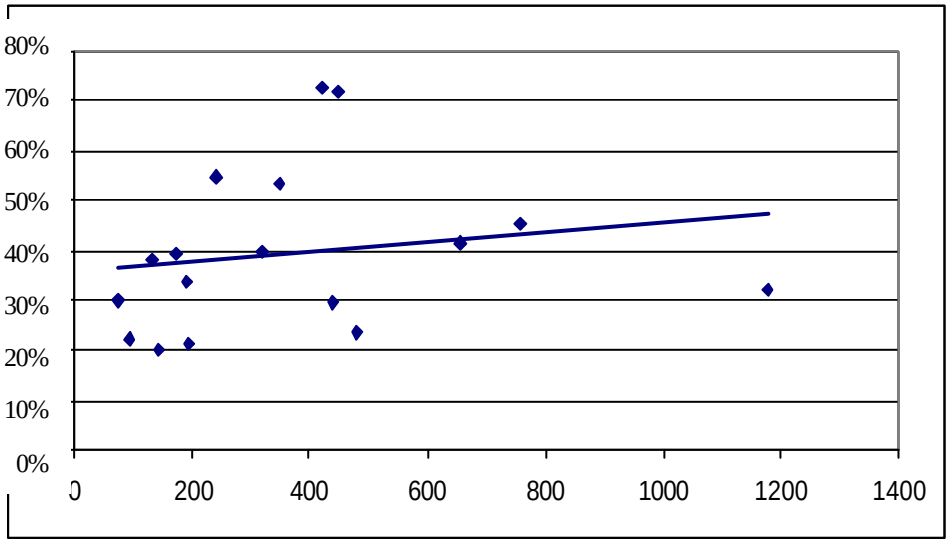


Table 1.4.3 (b) Services Sectors



Source: data from UK CIS4 survey

(Vertical Axis: proportion of firms in sector undertaking products and/or process innovation; Horizontal Axis: Mean expenditure on innovation-associated training per employee in each sector).

The proposals embodied in the Lorenz Indicators[13] go some way towards identifying a set of indicators for skills and innovation. The approach is posited on the evidence that suggests that firms that combine science-based learning and skills development with experience-based learning tend to be more innovative than those that are biased towards only one of the forms of learning, and it is important to recognise that national systems differ in terms of how learning is organised in both of these dimensions. These factors call for a broad definition of skills for innovation. Lorenz and Lundvall (2004) proposed an STI-mode and DUI-mode characterisation of skills development. The STI (science, technology and innovation) mode is characterised by a formal science approach and includes engineering training and skills. The DUI (learning by doing, using and interacting) mode refers to experience-based learning and skills that are tacit, embedded in routines and embodied in people. A Composite Skills for Innovation Index is proposed comprising:

- 4 STI-mode indicators
- 4 DUI-mode indicators
- skills maintenance indicators
- foundation skills indicators

This configuration can be helpful in aiding thinking with respect to indicators for skill and innovation: further details relating to 'indicator subsets' can be found in annex 1.

[13] outlined in Report prepared for the European Commission's Trend Chart Programme (2006)

Section 2: Context Dependent Skills for Innovation

2.1 What Skills are required in the Innovation Process?

2.1.1 What are the Main Subsets of Skills?

Considering the different types of innovation skills that are needed at different stages of the innovation process requires that we first examine the ways in which this process has been characterised. Attempts to 'unpack' and describe innovation activity are many and varied[14] but most identify four or five broad stages in the process[15]. Though differences in emphasis and delineation exist between commentators and theorists, stages of the innovation process are frequently cast in the following terms:

1. Sourcing and selection of ideas
2. Development of ideas and experimentation with alternative configurations, assemblages and processes
3. Testing, stabilisation and commercialisation
4. Implementation and/or diffusion

Whilst this four stage characterisation probably captures the main steps in the innovation process for a majority of firms, it is important to recognise that different organisations and sectors (manufacturing, private services and public services etc.) are likely to demonstrate sometimes sharply differing approaches to the organisation and operationalisation of innovation. Such differences (or 'specificities') remain a subject of research and debate[16] but relate closely to the constraints, operating and market conditions, assumptions and routines that are found across different firms and sectors. Differences will clearly impact on perceived and actual skills needs for innovation, as will the classes of innovation activity (i.e., product, process, organisational or delivery-oriented) that are pursued within individual firms and organisations.

2.1.2 What are Generic innovation management skills?

It is clear that some generic skills are central to the management of innovation throughout and across the various steps of the process sketched above. An ability to coordinate activities, select appropriate (and appropriately skilled) individuals, assemble teams, motivate and inspire, resolve problems and disputes, generate a creative (and protected) environment, communicate up and down the supply/value

[14] These are often connected with efforts to improve the management and measurement of innovation, see for example Desouza (2007)
[15] See Zaltman *et al* (1973); Rogers (1983); Tidd, Besant and Pavitt (2001); Miles and Boden (2001); Christensen and Raynor (2003)
[16] Rubalcaba (2006); INSEE, ZENTRUM, IFS (2005)

chain, and provide focus and leadership are just some of the skills that are required of managers and innovation leaders in contemporary organisations[17]. Beyond these, management of the innovation process requires the confidence to take decisions to 'kill' ailing projects (or to identify and pursue more viable alternatives)[18], and an ability to manage and maintain the complex of intra- and inter-organisational relationships that frequently characterise both large and more modest innovation projects[19].

2.1.3 What are Stage Specific Innovation Skills?

Stage Specific Innovation Skills are clearly more difficult to identify and delineate than generic skills; and they are to some extent conditioned by sector and 'class' of innovation as noted above. Some recent work has started to grapple with the issue of stage-specific skills[20] and we now see the emergence of ideas relating to the competencies and capabilities that are required to drive innovation through the various steps of the emergence of a new product or process.

- **Sourcing and selection of ideas** – skills requirements here are connected centrally with the identification, collection and filtering of ideas for innovation[21]. Innovation managers (and employees) will ideally have an awareness of existing sources for innovation both within and outside their organisations, and an ability to 'scan the horizon' for - and develop relationships that will lead to - new sources of ideas and stimuli for innovation. An ability to interpret data (from market, consumer and competitor research etc.) and to evaluate the viability of innovation ideas is also crucial. Knowledge of and an ability to apply relevant IP protection mechanisms constitutes a further important skill. Once an innovation idea is selected for possible progression to development stage, skills in arguing for its viability and potential value – often in the face of strong competition from competing projects – become paramount.

- **Development of innovation ideas** – upon securing financial support for progression of an innovation idea, attention is directed to the practicalities of development. Here, skills connected with the assemblage of development teams, allocation and management of budgets and resources, generation of appropriate spaces and conditions for experimentation, sourcing and specifying complementary inputs, and establishing networks and partnerships are called into play. In the development of new artefacts/technologies, the sourcing of technical and design skills is often a central concern.

[17] Klein and Sorra (1996); Deschamps (2005)
[18] Danneels and Kleinschmidt (2001)
[19] Hagel and Singer (1999)
[20] Tether *et al* (2005); Desouza (2007)
[21] Sundbo (1997)

- **Testing, Stabilisation and Commercialisation** – a key skill at the 'stabilisation' stage is evaluation of risks and benefits of continued experimentation. Cost effective innovation requires an ability to recognise the optimal point at which to call a halt to prototyping and the comparison of competing alternatives. It also requires a good knowledge of the preferences and requirements of the intended user/consumer base and an understanding of the ways in (and extent to) which an innovative product or process will meet with anticipated needs. An understanding of the ability of potential users to derive benefits from an innovation (i.e., their 'absorptive capacity') is also necessary. Stabilisation and commercialisation requires that an innovating company has the skills in place to ensure reproducibility of an artefact or service at an acceptable cost and price (technical, engineering, design and marketing skills are often at the fore here). Commercialisation also requires that attention is afforded to 'capturing value' from an innovation – here, skills associated with managing risk and deriving appropriate roll-out strategies are foregrounded.

- **Implementation and diffusion** – marketisation, implementation and diffusion are frequently understood to be connected intimately with project management and technology transfer skills. Beyond these, skills in managing and coordinating value and supply-chain relationships, and in evaluating innovation practise and performance are crucial. Reflexivity is becoming an increasingly important component of innovation practise as firms recognise that collection and evaluation of data (i.e., knowledge management and intelligence generation) can result in the development of improved innovation processes.

2.1.4 How do Innovation Skills vary over the Product Life Cycle?

Another useful way of thinking about skills for innovation at different stages of the innovation process (and in associated value chains) derives from the study of the 'product life cycle'[22]. Introducing the notion of *circularity*, Tether (2005) indicates that it is problematic to distinguish between the skills that facilitate and support innovation within an organisation from those that are required because of changes brought about by innovation. Tether suggests that the management and workforce skills that are present within an organisation will have a major influence on the nature and style of its innovation. The process of 'doing innovation' in the firm will trigger changes in skills demands, and the emergent skills profile of the organisation will in turn shape the direction and form of subsequent generations of innovation activity.

Tether et al link this idea to the notion of product life cycle and indicate that the latter can provide clues with respect to the ways in which innovation involves shifts in demand for skills throughout the development

[22] We should note here that Product Life Cycle theory derives principally from the study of manufacturing innovation and is normally applied at industry rather than firm level. For further details see Cawson, Haddon and Miles (1995).

stages of a new product[23]. Employing a three phase model, Tether argues that in the first phase, 'conception', where product attributes and characteristics are still weakly defined, key skills requirements revolve around entrepreneurism, scientific and technical expertise and market research and development. In the second phase, 'transition', where the shape of a standard or 'dominant product design' has emerged, the skills focus tends to shift from product to process innovation: here, more operational, functional, and scientific management skills (and sometimes, specialist workforce skills) are foregrounded as firms gear-up for production and distribution. In the third phase, 'stabilisation and incremental development' - where attention is directed towards reduction of production costs - managerial 'command and control skills' tend to be highlighted alongside relatively low level and often non-specific workforce skills. Beyond this however, where firms target product development, or strive to respond to low-cost competition via iterative improvement, movement into markets for higher quality goods, or product differentiation, technical, design, branding and marketing skills are likely to take-on increasing importance.

2.2 How do Skills relate to Different Forms of Innovation?

It is clear that innovation (a) has many forms, (b) takes place in widely differing sectors and locations, and (c) can be initiated and undertaken by actors across a broad range roles and functions. This raises important questions about the skills that are necessary with respect to different types of innovation and the skills that are required in different industrial settings. Whilst this short section cannot attempt to provide comprehensive coverage of all the different classes of innovation and their associated skills-needs, some common 'innovation dichotomies'[24] are compared in the tables below. Whilst each table provides some examples of the key skills that are associated with each category of innovation, it is important to note that many generic skills will be applied across categories (see 2.1 above).

The comparisons that follow (in a set of tables) highlight some useful distinctions between classes of innovations in different sectors and point to the different types and levels or skills that are required in pursuit of innovation, but it is important to acknowledge the important overlaps that exist across classes. This is particularly true in the case of manufacturing and service sector innovation. Beyond the bundling of services and artefacts in combined packages, it is notable that many manufacturing organisations are home to a range of service functions and service workers (designers, market researchers, sales staff etc.) Thus

[23] In essence, Tether recommends that we consider the ways in which skills for successful innovation change over the product life cycle
[24] Binary distinctions appear frequently in the innovation literature: these constitute a useful heuristic but frequently conceal the significant overlaps that exist between classes

manufacturers can be important producers of service innovations (and they will be important loci of organisational and process innovations).

Table 2.2.1 What about the differences between Radical and Incremental innovation?

Innovation Type	Features	Associated Skills
Radical	***Radical innovation***, sometimes also described as 'breakthrough', 'revolutionary' or 'disruptive' innovation, is normally associated with major scientific and technological developments that result in highly significant and far-reaching changes across industries, markets and consumption behaviours[25]. Radical innovations are perceived to bring about dramatic shifts, often ushering in whole new classes of products, new methods of production and even new industries or industrial sectors. Radical innovations can be many years in gestation and frequently result from a scientific or technological discovery or breakthrough (for example, steam power, isolation of DNA, and development of computers). Radical innovations are relatively sporadic and rare – sometimes the result of long-term effort in R&D and university labs - and often require much complementary effort and innovation before marketable products emerge	• Very highly qualified and expert science and technology skills (computing, medicine, biology, physics etc.) • Synthesising skills (bringing together ideas and knowledge from disparate disciplines and domains) • Knowledge translation and transfer skills • Lobbying and negotiation skills (especially where long-term development funding and social acceptance are required, and licensing agreements are in play) • Opportunity recognition skills • Market development skills • Coordination skills (especially where the realisation of an innovation or class of innovations requires much distributed, complementary effort

[25] Harvard Business School (2000)

Incremental	***Incremental innovation*** is much more common than its radical counterpart and involves the inception of relatively minor improvements or enhancements to goods, processes and services that are (usually) already in existence in one form or another. Such innovations are often managed and effected by actors who work on an ongoing basis with existing technologies, equipment, methods or processes[26]. In essence, incremental innovation involves taking steps forward along a recognised technology or organisational trajectory and such innovation is not likely to result in major changes to business operations, product ranges or markets. Although incremental innovations targeted at relatively minor upgrading of organisational routines or product characteristics and functionalities. Such innovations often require the input of science and technology specialists and are frequently developed within R&D departments. An important characteristic of incremental innovation is that it often relies heavily on feedback and inputs from users or consumers.	• Science and technology skills • Engineering skills • Design skills • Process management and technical skills • Coordination skills • Market research and analysis skills (and competitor analysis skills) • Business and product positioning skills • Strategic analysis skills • ICT skills (especially in the case of services where the producer-consumer relationship is electronically mediated

[26] von Hippel (2005)

Table 2.2.2 What about the differences between Technological and Organisational innovation?

Innovation Type	Features	Associated Skills
Technological	***Technological innovation*** – as noted in section 1.1, technological innovation is generally understood to concern the development of new equipment, goods, services and software. OECD[27] describes technological product and process (TPP) innovations as those that "comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organisational, financial and commercial activities."	• Science and technology skills • Software development skills • Systems development and integration skills (especially in the domain of technological process development) • Engineering and design skills • Negotiation, coordination and communication skills (especially where licensing, royalties and distribution agreements, production partnerships and outsourcing, and organisation of complementary inputs are concerned) • Value-chain organisation skills • Professional skills (for example, accounting and finance, marketing, sales, IP protection and legal skills)

[27] OECD Oslo Manual (2005)

Organisational	***Organisational innovation*** involves the creation of transformation of commercial/business and public sector agency structures, models, routines and practices. Such innovation can embrace business model and marketing innovation and frequently involves the implementation of new production and interfacing processes. Organisational innovation often accompanies business re-positioning and strategy development – and, in the public sector in particular, has been triggered by government modernisation and public service renewal agendas. Organisational innovation is commonly targeted at securing increased efficiency and effectiveness and has been implicated in major off-shoring and outsourcing programmes that have been witnessed in the past decade. Whilst it can be conceived and managed internally, it is not uncommon for major organisational innovation to be designed and implemented by external agencies.	• Strategy development and business modelling skills • Procurement and negotiation skills (especially where innovation involves the contracting of external consultants) • Communication skills (especially where innovation implies major changes to work practices and impacts on employees) • Workflow and job design skills • Professional skills (especially Human Resources) • ICT and systems design skills (where re-organisation is reliant on ICTs or involves re-location or off-shoring of work)

Table 2.2.3 What about the differences between Manufacturing and Services innovation?

Innovation Type	Features	Associated Skills
Manufacturing	***Innovation in the manufacturing sector*** concerns the development or improvement of tangible products. Much manufacturing innovation is incremental by nature, involving (a) the gradual replacement of products or product lines, or (b) the introduction of new or enhanced functionalities to existing products and equipment. Though manufacturing innovation goes beyond mere re-styling, design and engineering has an important role. Much manufacturing innovation is triggered by competition: this is especially true in relation to established technologies or goods where attention has been directed increasingly over time towards the reduction of production costs. Iterative product development can assist manufacturers in their efforts to compete with low cost commodity producers and stay ahead of the pack (where this is feasible and desirable).	• Engineering and design skills • Science and technology skills • Market and competitor research skills (and data analysis skills) • Customer interfacing skills • Process organisation and management skills • Business development and positioning skills

Service	***Service innovation*** refers to the creation, marketisation and diffusion of service products (for example, insurance policies or health information programmes). Whilst service innovations are often perceived to be less dependent on scientific and technological knowledge than manufacturing/goods innovations, many are heavily reliant on developments in ICTs (connected as they are with information processing, communication and interaction)[28]. However, a key resource for innovation in services is close contact with customers and many service innovators are eager to exploit the detailed data that they derive from ongoing interactions with clients, partners and service users[29]. The organisation of innovation in the services sectors rarely resembles that in manufacturing where formalised processes for sourcing and development of new products is common. Service innovation is frequently managed by *ad hoc* teams rather than specific R&D divisions and dedicated budgets for development activity in services are rare. Service innovation is clearly a concern for service firms and agencies, however, much service innovation is also found in manufacturing organisations[30] as the latter increasingly bundle service packages with their goods (for example, finance packages with car sales).	• Client interfacing and communication skills • ICT skills (especially systems design and integration) • Data management and analysis skills • Market research and analysis skills • Team assembly, co-ordination and management skills • Ideas harvesting skills (gathering ideas for innovation from service workers, partners and service users) • Procurement and coordination skills (especially where service development involves partnership projects, complementary innovation and technological components) • Professional skills (legal, policy analysis and translation, Human Resources)

[28] Miles (2005)
[29] For example, major food retailers are able to collect detailed transaction data and deploy this in customer profiling activities. Similarly, health service providers are able to collect data on patients and service costs and deploy this in the development of health promotion campaigns
[30] Miles (2000)

2.3 What Skills for Innovation are required in Evolving Contexts?

Efforts at various levels (policy, industry, firm etc.) to understand the mechanics of innovation and its relationship with competitiveness and growth have contributed to a significantly heightened profile for innovation and its impacts. Partly in response to policy and industrial concerns, the academic study of innovation has intensified in the past decade and a wider range of disciplinary perspectives has been brought to bear. This has led to an 'opening-out' of ideas and theories relating to innovation and to increased curiosity with respect to the nature, sources, varieties, organisation, measurement and future(s) of the phenomenon. Whilst new innovation-related concepts and innovation typologies are emerging constantly[31], two recently developed and evolving concepts, namely, 'open' and 'society-driven' innovation[32] have attracted significant interest and will be considered here, specifically with respect to their implications for skills needs and skills development.

2.3.1 … in the Context of Society Driven Innovation?

First, what is Society-Driven Innovation (SDI)? This relatively new piece of terminology has yet to acquire a precise meaning. Much innovation takes place in a commercial context, with competition forming a major driver for firms to develop new products and processes. Much innovation policy is addressed to improving competitiveness and economic growth, though these are really not ends in themselves. (They are means for achieving aims such as security, quality of life, etc.) The SDI concept has been introduced to take account of the fact that innovation can be driven by aims other than improving competitiveness in the market.

Various stakeholders in our economies may attempt to influence the course of innovation – citizen groups, private foundations, and so on. But most often, SDI will be a matter of deliberate government policy. Here, then, the point arises that innovation-related policy may go beyond the narrow economic aims of competitiveness and economic growth. Broader goals will typically be public goods such as increasing environmental quality, public health, social cohesion and inclusion, and so on, are the focus of SDI. Policies for SDI range from promotion of relevant R&D, through use of public procurement and investment in social and environmental programmes which apply the innovations, to the use of regulations and standards, and of economic instruments.

[31] An incomplete list of innovation types appears at: http://en.wikipedia.org/wiki/Innovation. This should be treated with caution but it is useful in the current context insofar as it draws attention to the different conceptualisations and categorisations of innovation

[32] Service innovation is another important and evolving issue, however, this is covered above in section 2.2

In policymaking, the skills that will be required include:

(1) Those involved in the ability to evaluate and shape programme proposals, which will mean ability to combine domain-specific, technology-specific, and administrative expertise. In particular, it is important to be able to balance the claims of proponents of specific technology solutions as to the efficacy of these solutions with a broader understanding of the nature of the problems that are to be tackled. Serious planning will require assessment of possible impacts, rate of uptake, and the scope for deploying a policy mix of different instruments in order to attain desired goals.

(2) Those involved in the design and management of programmes – these may range from fairly fundamental research programmes through to promotion of diffusion and best-practice implementation of innovations. Since SDIs often require bringing together of knowledge from various domains – different technology fields, different social/environmental/biomedical fields, etc. – there is a need for all parties to have capabilities to communicate across professional and disciplinary boundaries, and for managers to be able to coordinate and integrate different types of professional work and worker. Skills may be needed to establish new teams and new procedures for interrelations teams and quite possibly members of different organisations. (Here, recent work on the management of innovation in "complex product systems" and large projects may provide particularly useful insights.

(3) Those involved in liaising with and keeping abreast of the (changing) needs of the intended user community, since SDIs will often have to be rolled out to a large number of users whose motivation to participate whole-heartedly is vital (e.g., to schools, hospitals, nature reserves, small firms).

2.3.2 … in the Context of Open Innovation?

The concept of "Open Innovation" is particularly associated with the analyses of Henry Chesbrough, an American management professor (and Executive Director of the Center for Open Innovation at the Institute of Management, Innovation & Organization, Haas School of Business, UC Berkeley). The basic ideas have been echoed – and explicated before his work – in numerous other studies, with other terms also being used (for example, distributed innovation systems, networks of innovators).

The basic notion here is that there are changes underway in the way in which innovation is typically conducted. A sketchy (and rather simplistic) historical account is that in the past (say until the later part of the 20th century) most firms based their innovations on work carried out in their own R&D laboratories. They would protect them by secrecy till they were ready to launch them onto markets, and only share knowledge when absolutely necessary.

As inventions and innovations accumulate and are built upon each other, so the portfolio of knowledge that is required to master many new products and processes grows. The scope of knowledge that is required to bring a new idea to fruition may be much wider than heretofore; the sorts of knowledge that may be called on for each innovation may be different in many respects. Few, if any, organisations can hope to have all of the relevant sorts of expertise at their fingertips. It becomes necessary to collaborate with other parties. This may involve active collaboration in the process of research and development, or in acquiring processes or inventions from other companies (e.g. buying or licensing the products themselves, the underlying knowledge in the form of patents or even members of staff). It may involve collaboration in establishing standards and formats, in market preparation, liaising with regulatory bodies, and marketing. Organisations are also finding that other actors need their knowledge and intellectual capital for innovations, so they may find themselves in the business of licensing products and patents or forging joint ventures. Some of their capabilities may be spun-off in one way or another.

Additionally, new Information Technologies make it easier to share information and collaborate across large distances), and there is also much greater ongoing communication about innovation and electronic monitoring of activities such as patenting. These trends make closed innovation more difficult and facilitate open innovation.

Clearly the skills that will be required here overlap with those discussed in the case of Society-Driven Innovation (see above), though there will be more focus on firm-level skills than on those in the public sector. In addition, there will need to be systematic development of skills such as:

(1)Scanning of the business environment, examining trends and strategies of competitors and potential collaborators (who may be the same parties!), identifying suitable partners in terms of competence, capability, trustworthiness, etc.

(2)Negotiating business relationships through contractual and other arrangements – the need for legal skills to be fused with other strategic capabilities is vital here (contracts are critical, but usually it is most important to attend to and nurture the spirit behind the contract is a relationship is to flourish).

Section 3: Fostering Skills for Innovation

3.1 How can we Foster Skills for Innovation Management?

Current models of innovation and innovation diffusion accept the notion that all levels of skills are important, and that a sound basic education is the foundation upon which all adaptive innovation-related skills are based. The development and fostering of innovation management skills is linked to notions of how innovation shapes competitiveness, industrial organisation and economic development. Learning the skills that are associated with managing innovation, innovation processes and diffusion of innovations (and thereby accelerating the development of creative performance) appear to be a crucial consideration for European economies and firms that are facing the challenges of global production and markets.

There is, however, an absence of evidence and indicators to tell us what are successful innovation management skills, and indeed, how to rate the quality of managers. Arundel and Hollanders (2006)[33] report that Venture capitalists and Technology Transfer Officers at universities and research institutes frequently complain that the problem in Europe is not a lack of ideas for the formation of innovative new firms, but a lack of experienced managers that can guide the development of an invention through to commercialization. They state that they are not aware of any indicators that cover the availability or quality of such managers. The World Economic Forum Global Competitiveness Report, (2005)[34], includes an indicator for the quality of national management schools, but this does not provide an indicator for the supply of high quality management. Tether *et al* (2005) also note that little appears to be known about how UK firms manage innovation processes, and moreover whether a 'formal training' in innovation management improves performance.

There is increasing recognition across the European Community of the importance of innovation management and a number of national initiatives contain approaches to enhancing innovation management skills. In Germany the Pro Mittelstand[35], programme consists of six different elements of which one is the innovation initiative for SMEs (Innovationsinitiative Mittelstand). This initiative aims at:

- Promoting the cross-linking of small and middle-sized enterprises with research;
- Adjusting R&D promotion in favour of innovative growth carriers; and,

[33] Trend Chart Methodology Report: Searching the forest for the trees: "Missing" indicators of innovation" MERIT
[34] The World Economic Forum (2005), Global Competitiveness Report
[35] See: http://www.promittelstand.com

- Promoting vocational training and the development of human capital

Some evidence with respect to what enterprises consider to be the knowledge domains and skills that innovation managers actually need is available from a recent EU funded Leonardo project (INNOMAN E/02/F/99/115860). The results from surveys of SMEs conducted across Germany, UK, Spain and Romania indicated that, in general, a broad range of knowledge and expertise is seen as desirable. Whilst this broad sweep is unlikely to be manifested in particular individuals, it may be available at enterprise or collective level. Areas of knowledge and experience (for managers) that were perceived to be of particular importance appear in annex 2.

3.2 What policy issues are raised around Innovation skills?

3.2.1 What are the Policies and initiatives for skills and innovation?

One of the most comprehensive recent reviews of policy and initiatives relating to skills for innovation was that conducted for the European Trend Chart on Innovation[36]. Undertaken in 2004, the review was based on a survey that included 29 European Countries[37] (a combination of EU member states, and accession and associate countries). The survey was designed to elicit information relating to the development and delivery of programmes and initiatives targeted at improving skills and human capital, and by extension, innovation capacity at national level. The survey document included questions relating to:

- policies for innovation (and the priority given to skills at national level);
- responsibilities of various agencies for managing, administering and promoting the take-up of skills development initiatives;
- the aims, orientation and delivery of various programmes; and,
- the role afforded to networks, trade associations and standards setting bodies in planning and coordinating programme design and delivery

The survey found that more than two-thirds of countries have a national organisation that is afforded responsibility for 'on the job' (vocational) training (see Annexe 3) for a list with details of the various agencies). Most of these organisations are connected with a National Ministry of Labour, though some are autonomous or semi-autonomous. In a minority of cases, responsibility is shared across public and private agencies.

[36] Cunningham, P. 2004, 'Ensuring Policy Coherence By Improving the Governance of Innovation Policy' [Background Paper for European TREND CHART on Innovation Policy Review Workshop]

[37] Representatives from a total of 33 countries were invited to contribute: those from Ireland, Bulgaria, Denmark and Israel did not respond

Importantly, the survey found that promotion of skills and training (i.e., skills for innovation) in firms is not a key priority in many countries[38]

"Skills for innovation, as expressed by the particular promotion of skills and training in firms do not represent a high priority for most countries considered. Only the UK and Finland put exceptional emphasis on this policy, representing less than 7% of the sample. Five more countries, notably Iceland, Italy, Spain, Sweden and Switzerland consider skills for innovation a sufficiently important area…" (p4)

The report goes on to suggest that, on the basis of survey findings, 76% of respondents indicate that skills for innovation is perceived as either an 'average' or relatively unimportant priority (indeed, 38% report that skill promotion is of little relevance in the context of national innovation policy[39] - see Table 3.2.1 below). Moreover, the report's authors suggest that even where training is indicated to be a priority, this may reflect rhetoric or aspiration rather than reality and implementation may be very limited. Thus it appears that less that a quarter of the surveyed countries identify skills development as an important component within innovation policy, and that it is only in Finland and the UK that skills development is perceived to be highly important.

Table 3.2.1 Importance of skill promotion and training as a component of innovation policy

Level of importance	Number of countries	Share (%)
Low	4	14
Medium-Low	7	24
Average	11	38
Medium-High	5	17
High	2	7
Total	29	100

Source: Cunningham (2004)

3.2.2 What Policies and initiatives for skills and innovation are particular countries pursuing?

The Trend Chart survey identifies nine categories of specific policy measures that are associated with the enhancement of business and innovation skills (see Table 3.2.2). Respondents from the 29 countries were asked to indicate what categories of measures had been pursued within their territories.

[38] Cunningham op. cit.
[39] This is more frequently the case with new and smaller EU member states

Table 3.2.2 Specific policy measures

Programme Category	No. of Prog-rams	Share (%)
Getting industry involved in curriculum development at (technical) schools	16	13
Providing subsidies for employee training (including tax benefits)	22	18
Providing subsidies to develop vocational training projects at firm and sector level	16	13
Recruitment of highly skilled employees for innovation projects in firms	9	7
Recruitment of researchers, technicians, PhDs and Post docs in firms	16	13
Schemes to allow R&D personnel to gain higher degrees while working in firms	11	9
R&D programmes that include a percentage of the budget for vocational training	4	3
Schemes to allow firms to develop human resource skills strategies	12	10
Schemes to support innovation management, i.e. to improve the skills of managers of firms in the area of innovation	17	14

Source: Cunningham (2004)

Of the 29 countries surveyed, 27 indicated that they have some form of specific policy measure for innovation skills enhancement in place[40]. In total, respondents reported a total of 123 initiatives or programmes concerned with skills enhancement. It is clear that subsidies for employee training are available in a majority of surveyed countries. Indeed, provision of subsidies appears to be the most popular means of supporting skills uplift. Programmes for (a) Involvement of industry in curriculum development, (b) subsidies for training at firm and sector level, (c) recruitment of highly skilled/qualified employees, and (d) innovation management training are also found in a majority of countries. Programmes aimed at innovation-targeted recruitment, higher degree schemes for R&D workers, HR skills strategy development, and partial hypothecation of R&D budgets (for training) appear to attract significantly less interest. Table 3.2.3 presents a brief overview of activities with respect to each specific policy measure.

[40] It is not clear if the two countries that did not report on skills programmes have any such programmes in place – it may be that some provision exists but that respondents lacked requisite knowledge

Table 3.2.3 Description of Skills for Innovation Initiatives and Activities

Policy & Scheme Category	Commentary on activities[41]
Getting industry involved in curriculum development at (technical) schools	Involvement ranges from formal cooperation agreements at the highest government-industry levels (e.g., France) to *ad hoc* arrangements (UK and Austria). Geography is an important factor – some schemes operate at national level, some at regional (Italy), and others at the level of individual organisations
Providing subsidies for employee training (including tax benefits)	22 countries report provision of subsidies. Support can be direct or indirect and much is organised centrally (some use of ERD Funding is recorded). It is common to see aid granted to SMEs only. Some schemes operate on the basis of a mandatory levy on business that is repaid in the form of a training grant (Hungary)
Providing subsidies to develop vocational training projects at firm and sector level	Vocational training is frequently organised and coordinated by a public or semi-public intermediary. Some national ministries offer grants for 'employment and knowledge enhancement' programmes under a broad umbrella of training. Programmes are in place in Netherlands, Portugal, Sweden and UK
Recruitment of highly skilled employees for innovation projects in firms	Some recruitment is project specific. Schemes operate at either national or regional level. 'Mobility schemes' are designed to allow companies to employ highly skilled R&D personnel
Recruitment of researchers, technicians, PhDs and Post docs in firms	Schemes in this category aim specifically to increase research activities in firms (and are not targeted at general skills development). Programmes support the employment of researchers in start-ups and transfer of research results (via transfer of researchers). Some countries indicate that one aim of recruitment schemes is unemployment reduction
Schemes to allow R&D personnel to gain higher degrees while working in firms	Such measures are targeted at reducing 'blocking' of research careers. Institutional arrangements that hamper the development of research careers (when academics work in industry or their 'applied' research leads to patents rather than publications) are identified as a major obstacle to the mobility of researchers and knowledge transfer. (See 'Knowledge Transfer' and 'Faraday' Partnership schemes in the UK)
R&D programmes that include a percentage of the budget for vocational training	In a small number of countries, a percentage of research programme budgets is reserved for vocational training (Belgium, Italy, Latvia and Turkey)
Schemes to allow firms to develop human resource skills strategies	HR development is rarely perceived as a strategic target for companies. Schemes in this category aim to support a change in corporate culture that will ensure that the development of HR is taken seriously. Programmes involve training entrepreneurs in techniques for long-term HR strategy-building, and support for contracting-in HR consultants
Schemes to support innovation management, i.e. to improve the skills of managers of firms in the area of innovation	Schemes support the cost of management training (sometimes inside an individual company, sometimes involving a specific training provider). Many programmes are one category in a broader innovation training programme

[41] Commentary presented here is a précis of materials drawn from the Trend Chart report

The Trend Chart report concluded that skill enhancement is central to educational, labour market and competitiveness policy, and that it is taken seriously by most countries included in the survey. All countries have adopted some support measures for skill enhancement but only a minority have a strong focus on training to improve innovation capacity and capability. There appears to be a general perception that general support for upskilling or skills enhancement will lead (in some way) to more or better innovation. Public intervention is widespread but there is no standardised approach to skills enhancement and no real vision with respect to the most appropriate forms of skills mixing. Moreover, little attention has been paid to the issue of ensuring that schemes are (or can become increasingly) cost effective.

The report also concludes that 'quality of training' is an issue that requires more detailed consideration:

"The quality of training largely depends on standards. In 14 out of the 29 countries there are organisations involved in the development of training standards. There is again a broad mix involved in the creation of standards: many are the national ministries or agencies directly supervised by the ministries, in other cases there are specialised institutes or even chambers involved in training. The most extensive coverage of standards in different educational categories appears to be in Finland."

Monitoring of training outputs and outcomes is evaluated in many territories, but systematic and commonly agreed application of tools and metrics for the evaluation of return on investment is lacking both within and across European nations. Indeed, evaluation of skills enhancement programmes and innovation measures appears to be generally 'thin'. European Trend Chart on Innovation attempts to capture information relating to evaluation of programmes but recording of ex ante, ongoing and ex post assessments are intermittent and patchy at best (whether this is a reflection on recording practise or, more worryingly, on the extent of efforts to evaluate is not known).

3.3 How have "Skills for Innovation" Policies and Initiatives Performed?

Following on from the above, the sheer volume of programmes and initiatives across Europe implies that it is not possible here to offer any realistic overview of the success or otherwise of the schemes that are in place (in addition, many are ongoing and evaluations have not yet been undertaken). However, it is possible to offer insights into the performance of some specific programmes in a limited range of countries. Here we have selected programmes that involve the provision of subsidies for employee training (a route adopted by more than 80% of nations in the survey above) and assess the evaluation evidence for the UK, Poland and Spain

UK: Modern Apprenticeship Training Programme (MA)[42] - the programme was launched in 1995 and targeted at addressing intermediate level skills deficiencies in the workplace. The programme focuses on (on-and off-the-job) training for 16-19 year old workers relating to vocational skills and occupational knowledge but includes a 'key skills' component. An evaluation undertaken in 2003 (with responses from 1500 employers) concluded that (a) satisfaction is generally high with 37% and 52% of respondents indicating that they are 'very satisfied' or 'satisfied' respectively, (b) employers appreciate the opportunity for staff to gain a formal qualification (as this aids retention), (c) the key skills component that covers communications is perceived to be particularly relevant (numeracy and IT skills are relevant too but a little less so), and (d) the MA scheme commonly represents 'new' training or better training than that in place hitherto. In sum, the MA programme was well-received by participating employers, a large majority of which indicated an intention to continue with the programme. In general, the quality of training on offer is perceived to be high.

Poland: Development of Personnel of Modern Economy – the programme aims at raising the competitiveness and developing the adaptability of enterprises via investment in human resources (this aim is founded on the notion that the strength of the Polish economy will continue to depend on the adaptive capacity of enterprises' human resources in the face of changing economic conditions). The scheme involves provision of training and counselling for management and enterprise employees and the promotion of 'systems solutions for adaptability' in the knowledge economy. Evaluation at present is *ex ante* only but the report suggests: "Projects…may bring about considerable effects already in the course of implementation, also in the form of dissemination of the best practices. From the point of view of economic development, investments in staff are necessary to increase their competitiveness through modernisation of human resources management and stronger focus on innovations in companies…In the long-term, the growing pressure of enterprises to improve conditions for introducing more flexible work organisation may be observed...This requires legislative changes, but also partnership in achieving social consensus in these issues. The monitoring indicators are cautious, but with rational logic. They show an extreme quantitative scale of growth in influencing such undertakings. They also include a delicate measure showing the durability of beneficiaries' (enterprises') functioning improvement – at a high level."[43]

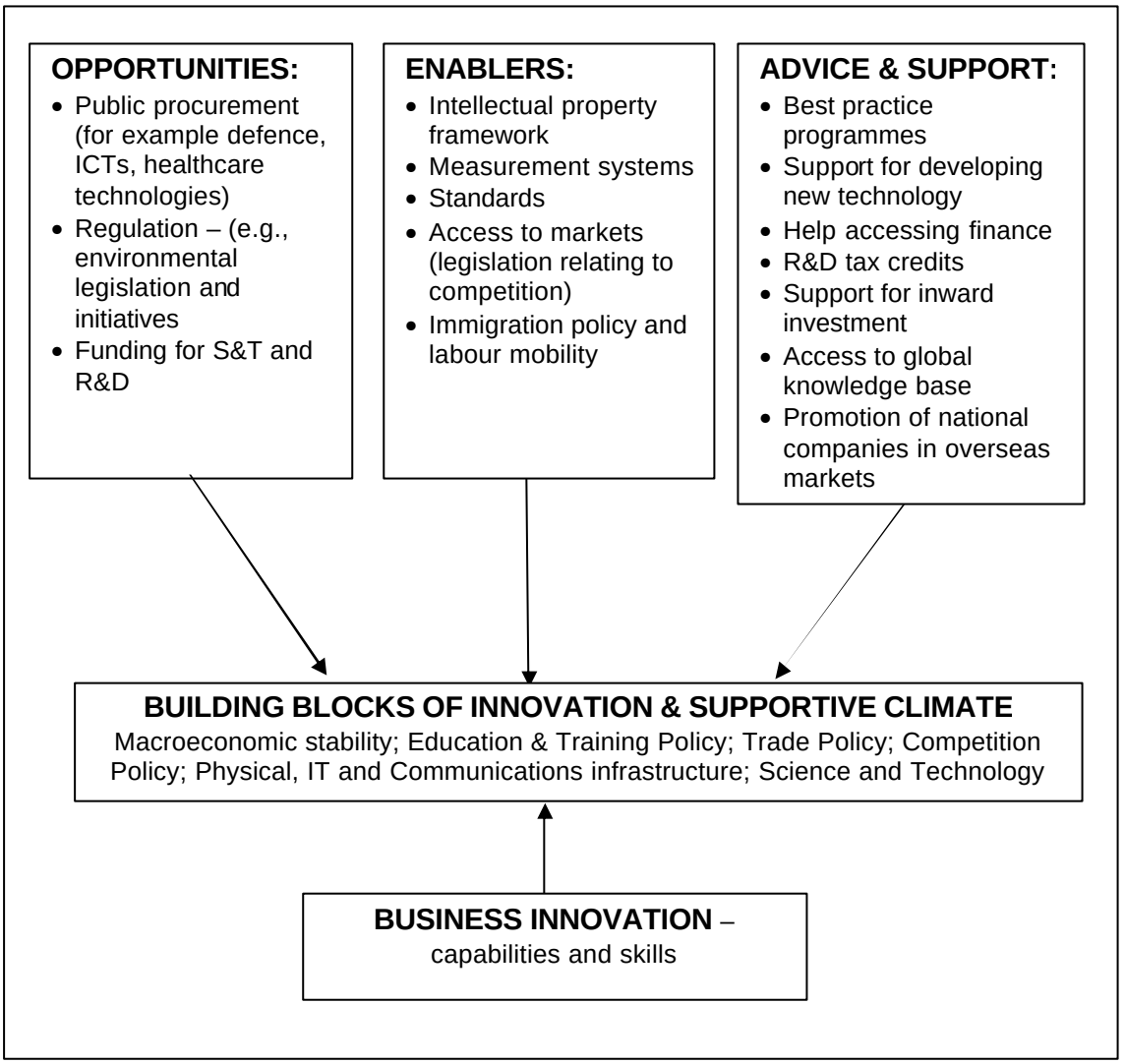
Spain: Forintel Telecommunication training programme - this measure aims to improve the professional development and technological training of enterprise workers and promote new measures for guaranteeing lifelong learning. At its core the scheme targets the upgrading of innovation related skills via diffusion and application of new technologies in enterprises and public sector and non-profit organisations. There has been an official (mid-term) evaluation by ESF: at the time of writing, results are not fully available in the public domain but initial findings are reported to be generally positive.

[42] Tracy Anderson with Hilary Metcalf, 'Modern Apprenticeship Employers: evaluation study' National Institute of Economic and Social Research available at: http://www.dfes.gov.uk/research/data/uploadfiles/ACF4B6.doc
[43] Trend Chart on Innovation available at: http://trendchart.cordis.lu/tc_datasheet.cfm?id=8694

3.4 What are the implications for the wider policy environment?

There are policies and initiatives that are designed to shape the business skills (and skills for innovation) landscape directly. But there are also contiguous areas of policy-making, impacting upon the environment in which businesses (and public sector organisations) operate, which thus influence perceptions and activities relating to skills needs and development. It is not possible to detail here all of the different areas of policy that can conceivably connect with skills/innovation issues (let alone to map the linkages between them). But we can provide a basic sketch of some major policy areas with substantial implications for the innovation activities and capacities of firms. These are presented in Figure 3.1 and discussed briefly below. Particular attention is paid to immigration policy, a highly contentious issue at present. (Other policy areas, at national and supra-national levels, such as Trade, Competition, Infrastructure and Communications, Education, Regulation etc. will also, of course, shape the economic and social environment for innovation.)

Figure 3.1 The Policy Environment for Skills and Innovation



3.4.1 What, briefly, are the implications for Procurement?

Public procurement does not directly impact on development of skills for innovation, the nature of demand (and the way in which demands are framed) is often a trigger for innovation activity. Some portion of State spending will always be connected with development of novel products, systems, solutions or services etc. and this will inevitably require some skills upgrading or enhancement (and perhaps recruitment or strengthening of links between suppliers/providers and Higher Educational Institutions).

3.4.2 What, briefly, are the implications for Regulation?

Similarly, regulatory initiatives and legislation, whilst not connected directly with skills enhancement, are likely to spur innovations of various forms. They will thus impact on the skills and capabilities profile of business and public sector organisations. (Environmental legislation, and the search for technological solutions for problems of resource depletion and pollution, form an interesting case in point here).

3.4.3 What, briefly, are the implications for Science policy?

Naturally, policy (and related funding) directed at scientific and technological advance will impact directly on skills-building. This will especially be the case where R&D funding, for instance, is directed into HEIs and public or semi-public research organisations. Research may translate more or less directly into undergraduate or (especially) postgraduate training, while those engaged in the research may well develop skills that they will later take into industry.

3.4.4 What, briefly, are the implications for 'Enabling' Policies?

"Enabling policies" refers here to those policies designed to foster innovation in our economies. One major area of policy is that relating to the organisation of *Intellectual Property* (IP) regimes, which has clear implications for innovation, but whose relation to skills is also of interest. The availability of IP protection mechanisms offers tangible incentives for innovators and thus a signal to firms that innovation activity can offer rewards and enhanced competitiveness. IP is a major challenge for many firms, especially smaller firms: access to skills relevant to negotiating, securing and implementing IP rights is clearly important. (Note however that inappropriate IP systems can act so as to deter innovation: skills in formulating policies, and representing industry needs to policymakers, are also important!)

With respect to *standards*, another enabling factor, there are evident issues to do with acquiring and certification of skills relevant to particular classes of technology. Individuals are encouraged to pursue training in standards to enhance their career prospects. The establishment and monitoring of standards can constitute an entry barrier (excluding players with insufficient capability or capacity to ensure compliance) into some markets. There is thus an incentive for firms to be in a position that enables them to 'enter the game'. An important means of achieving this is to ensure that human capital is sufficiently developed to permit participation (and access on a competitive footing).

Policy relating to the opening of both *product and labour markets* is a further (albeit indirect) trigger for innovation and innovation skilling. As competition intensifies and new skills are required in order to understand, access, develop and exploit new markets, so attention is directed towards the development of greater levels of (and appropriate) human capital.

3.4.5 What, briefly, are the implications for 'Advice and Support'?

Policies aimed at supporting innovation, and skilling for innovation, are discussed at length above and elsewhere in this report. However, it is worth reiterating the role of 'awareness-raising' and diffusion of good practice in relation to innovation and skills development. Whilst no commercial or public organisation operates in a vacuum, the focus for many, especially SMEs, is the 'bottom line' (and even survival in some increasingly competitive sectors). Given this reality, there is clear scope for policies targeted at (a) raising awareness relating to the potential and value of upgrading skills for innovation, and (b) those that offer attractive incentives for investment in skills development.

3.4.6 What are the implications of Skills for Innovation for Immigration Policy?

The growth of the new global economy over the past two decades has magnified the importance of human capital and educated workforces to economic growth. In this context, worldwide competition for highly skilled workers is strong. Anything which makes the labour market more active ought to increase the ability to match supply with demand, so increase in the labour pool ought to have a positive effect in any case. The effects of migration on innovation performance are complex to untangle because immigrants, for example, would have more flexibility in some ways while perhaps lacking some specific skills in others, so that only sector-specific studies will show if the overall effect is positive or negative. This is currently an under-researched area. An influx of persons with basic engineering or scientific skills could have a positive effect on the turnaround time for developing and testing basic technological innovations, or new products, but the effect of this may be minor in reality because of legal requirements for extensive testing of any such products and processes.

Historically Europe has been a net exporter of labour but since the mid-seventies this trend has reversed as Europe turned into a net importer of labour from outside the European Community. These enhanced immigration flows are, of course, coinciding with structural changes and important demographic shifts including ageing populations in the receiving countries and are. However, it might be worth noting that migration across regions within a country and between European countries within Europe has been in decline in recent decades and has impacted negatively on economic adjustment, growth and job creation compared to, for example, the American experience, although this may yet change[44]. There is evidence of this now in east to west labour flows across the European member states.

[44] (Bauer et al 2004, Obstfeld & Peri 1998)

3.4.7 How are the implications of Skills for Innovation being taken into account in Immigration Policy?

The USA continues to attract higher rates of skilled migrants than the EU. Some 85 per cent of unskilled labour goes to the EU and only five per cent to the United States whereas 55 per cent of skilled labour goes to the US and only five per cent to the EU[45]. At the pan-European level there is impetus to create EU-wide policies (requiring Member State agreements) to increase the inflow of all ability workers from outside the Member States to meet perceived skills gaps and future skill needs which have resulted from changing demographics and organisational change. An EU proposed "blue card" is designed to allow skilled workers to live, work, and move between European Union member states. Migrants would apply for a two-year residency that could be extended. After five consecutive years, an immigrant could apply to live in the EU permanently.

At the National Level, there are a range of approaches being developed, but none of which are specifically aimed at *getting* skills for innovation from migrant labour: the Czech Republic in order to increase its supply of skilled workers is introducing in 2008, a "green card" for foreign workers from outside the EU. The system will allow qualified applicants to receive the card in as little as 30 days and grant them permission to work for one employer for two years. Three groups of foreign workers will qualify for the card: workers with university degrees, specialists with vocational high school qualifications (primarily in technical sectors), and top management personnel. 209,000 migrant workers were employed in the Czech Republic at the end of the first six months of 2007. 69,000 of them came from outside the EU. This green card program has little in common with the US Green Card Programme and does not grant permanent residence. It is similar to Ireland's Green Card system which allows non-EU/EEA workers to take up employment for a limited amount of time.

Finland is experiencing labour shortages due to the large number of people leaving the work force every year (an estimated 25,000), has started a programme to attract skilled Chinese workers to fill shortages.

Currently Germany requires a job offer with a minimum salary of 85,000 Euros a year for migrants who are hoping to get a work permit. On top of that, the employer has to prove that a suitable German candidate could not be found. However, Germany with the largest economy in Europe has the greatest shortage of IT staff. The German Information Technology Association estimates that twenty-five percent of IT vacancies remain unfilled. Germany and the UK together account for half of Europe's IT industry, and IT staff are among the largest beneficiaries of the 75,000 work permits (formerly called green cards) issued each year by each of these countries.

The United Kingdom offers a number of schemes which allow third country nationals to live and work in the country without a specific job offer. For

[45] Reported speech of EU justice commissioner, Franco Frattini, 13/09/07 Lisbon

example, the UK Highly Skilled Migrant Programme (HSMP) is an UK immigration category for entry to the UK for successful people with sought-after skills. It is in many ways similar to the skilled migration programs for entry to Australia and Canada.

3.5 Skills for Innovation: is there a Role for the European Commission?

The European Commission has already introduced an enormous array of comprehensive approaches, policies and measures aimed at modernisation and re-innovating of the EU economies. These have been outlined in the Lisbon Strategy for Growth and Jobs[46], which also includes the objective of increasing research and development spending to 3% of total GDP. The agreed new Financial Framework, including cohesion policy, the 7th Research and Development Framework Programme and the Competitiveness and Innovation Framework Programme, also offer significant financial envelopes targeted at innovation. In addition, Member States have been encouraged to take action in favour of innovation in the framework of the National Reform Programmes, based on the Integrated Guidelines of the renewed Lisbon Strategy for Growth and Jobs. The European Trend Chart on Innovation[47] gives a picture of European innovation performance and of the national innovation systems of the EU Member States and of their strengths and weaknesses enabling progress to be closely monitored.

The need for modernising education systems and their content to ensure sufficient availability of key skills to support innovation has been prioritised at the Commission level. Lack of appropriate skills, in particular in the field of science, engineering and ICT have been identified as a major challenge. According to Eurostat data on Human Resources in Science and Engineering, the EU has recently achieved an increase in the absolute number of maths, science and technology graduates, but the overall share of science and engineering graduates continues to decline, aggravating an unfavourable age structure in these disciplines in some countries and risking undermining the future capacity of Europe to innovate. This is a problem not just for the majority of new Member States, but also for older Member States such as Austria, Germany, Italy, the Netherlands and Portugal (despite some improvement in the absolute numbers of science and engineering graduates over the past years)[48]. The move towards recognition of key competences (see annex 4) necessary for living and working in a modern innovation-oriented society is an example of attempts to change the content of education. These include entrepreneurial skills (see annex 5) in the wider sense, as well as literacy,

[46] "Common Actions for Growth and Employment: The Community Lisbon Programme" - COM (2005) 330, 20.7.2005.
[47] Innovation Policy in the EU – see http://trendchart.cordis.lu/
[48] Commission Staff Working Document SEC(2006) 639, p. 19,

scientific and mathematical competence, languages, learning-to-learn skills and social and cultural competences. They also include digital literacy, which is a sine qua non for a wider uptake of ICT and its innovation potential.

Many forms of knowledge transfer need to be improved in our societies to support innovation - contract research, collaborative and co-operative research, licensing, publications and exchanges of skilled researchers between the public and private sectors, and so on. These all require skills to perform and manage. The European Institute of Technology (EIT) is intended to be a pioneer here, being envisaged as an integrated partnership of science, business and education, and to be a key driver and a new model for innovation in strategic interdisciplinary areas. It will pool together the best European students and researchers to work side by side with leading edge business in the development and exploitation of knowledge and research, and to enhance research and innovation management skills.

A particular area which will need continued Commission encouragement relates to the expanding service sector, which accounts for more than two thirds of GDP and employment. Understanding of the skills and competences needed and good practices involved remains under developed.

3.6 What Outstanding Questions need to be answered?

We have noted that the definition of skills and competences is not uniform across the European Community. Statistics on skills usually employ qualifications data are proxy indicators, and these too are not completely uniform across Europe, despite the efforts of statisticians. This presents a range of problems associated with agreements on what constitutes the component parts of occupations and job tasks: this becomes particularly problematic as new occupations arise (as a result of innovatory processes). Not least among these problems is that of enhancing labour mobility.

In order to clarify the question of the role that the European Commission should play fostering skills for innovation, more research across the Community is required to answer the following questions:

- What are the major variations in skill and competence across different types of innovation and innovation process? What are the implications of this, for example in terms of business strategies, training systems, and innovation and training policies?
- How can we identify, characterise and classify the skills required for *incremental* (mainly technological) innovation in products?
- How can we identify, characterise and classify the skills required for *'organisational'* innovation and innovation in processes?

- How can we identify, characterise and classify the skills required for innovation in *services* (including services that complement and support technological and product innovation)?
- How can we identify the skills required to stimulate and support *radical and disruptive* innovation (mainly technological)? What is required by way of Generic versus Specific Skills, Familiar versus New Skill Sets, and New Occupations and the associated requirements for training, certification, professionalisation, etc.?
- How can we forecast *future* skill needs for innovation? What are the most useful methods for identification and tracking of new skills as they are manifest in the course of technological, organisational, and other trends?
- What is required by way of determining policy developments in which innovation and skills are targeted? What is the scope for determining and disseminating good practice?

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Annexes

Annex 1: Composite Skills for Innovation Index

STI1 - HRSTC (Human Resources in Science and Technology Core)	The innovative performance of enterprises depends in part on the production of highly trained science and technology (S&T) human resources and on the firm's capacity to integrate such human resources into innovative activities
STI2 - BERD (Business Expenditures on R&D) as a percent of GDP	An important by-product of in-house R&D activity is the development of the skills and competence engineers and technicians need to absorb new external sources of scientific and technical knowledge for innovation: An important by-product of in-house R&D activity is the development of the skills and competence engineers and technicians need to absorb new external sources of scientific and technical knowledge for innovation
STI3 - HRST job-to-job mobility as a percentage of employed HRST	Firms can acquire science and technology skills through the mobility of mid-career scientists, engineers and technicians: Such mobility may be of especial importance in fast moving technological sectors where tight competitive conditions call for a quick reconfiguration of the firm's competence base
STI4 - Computer training for the use of computers in work:	Computer training is arguably a prerequisite for the use of advanced forms of ICT in the innovation process, such as computer simulation and computer-aided design
DUI1 - Individual responsibility for quality assessment	This form of employee involvement plays a central role in the development of the sorts of skills and knowledge that contribute to the feedbacks and knowledge flows that Kline and Rosenberg (1985) identify as fundamental to innovative performance.
DUI2 - Employee involvement in problem-solving	There are close links between problem-solving activity and the development of new knowledge: Problem-solving in team settings can contribute to making explicit what employees know implicitly
DUI3 - Discretion in determining work methods	Discretion contributes to innovation because it increases the scope for exploring new knowledge: Case study evidence points to a positive relation between innovative performance and such factors as the delegation of responsibility or the use of autonomous team organisation
DUI4 - Learning new things in work	This indicator captures informal learning dynamics in the broadest sense and is positively associated with the other three DUI-indicators

Annex 2: Innovation Management Skills

Key Areas of Knowledge, Experience and Skill for Innovation Managers	
General Technology Knowledge	• General knowledge about diverse technologies – the overriding view is that innovation managers should probably be technically oriented (with a background in technical development)
Sector-specific Technologies	• Knowledge of sector specific technologies (especially those that are central to the development of novel goods and services)
Knowledge or Organisations and Structures	• In-depth knowledge with respect to company organisation and structure – this is an important skill for the innovation manager as her or his activity involves brokering and coordinating between technical and R&D departments
Change Management	• 'Management of change' is perceived as an area of core competence: innovation managers are frequently called upon to oversee the inception and implementation of projects that will have far reaching consequences for employees and for the organisation of workflow
Technology Development	• Technology watch and competitive intelligence – here managers are expected to be aware of emerging technologies, the positioning and strategies of competitors, and market trends
Knowledge Management	• An understanding of KM processes and needs is a key capability for the innovation manager: KM is the process via which organizations generate value from their intellectual and knowledge-based assets
ICT Knowledge	• An ability to deploy and use ICTs

	creatively and in a way that adds value
Human Capital	• The innovation manager's role frequently involves fostering creativity within the organisation via importation, development and management of human capital
Coordination (for Development)	• Development of new products is largely a function of the innovation manager's cooperation with technical, research and development departments – an ability to coordinate activities and to negotiate with internal and external partners is a key capability for the innovation manager
Marketing and Commercial Management	• Related to the above, aligning and balancing sometimes competing interests of the marketing and commercial functions within an organisation is an important role

Annexe 3: National Organisations with Responsibility for on-the-job Training

Belgium	DIVA (Training and Alignment Information Service) created in March 2003.
Cyprus	The Human Resource Development Authority of Cyprus (HRDA) is a semi-government organisation, established in 1999
Czech Republic	National Educational Fund
Estonia	Labour Market Department in Ministry of Social Affairs partly is dealing with this topic as well the Business Development Division in Enterprise Estonia
France	The Coordination Committee of Regional Programmes of Apprenticeship and Continuous Vocational Training (CCPR) was created in 1983
Germany	Federal Institute for Vocational Training
Hungary	Országos Feln_ttképzési Tanács (Vocational Training Council)
Italy	Direzione Generale per l'orientamento e la formazione professionale dei lavoratori Ministry of Welfare
Latvia	Department of Vocational and Continuing Education at the Ministry of ducation and Science
Malta	The Employment and Training Corporation (ETC) acts as the national employment agency as well as a provider of accessible training programmes, particularly for new entrants into the labour market, the unemployed, the unskilled and other disadvantaged groups in the labour market
Norway	VOX, National Centre for Learning in the Workplace developing regional networks between industry and education providers
Poland	The Ministry of National Education and Sport is responsible for nearly the whole system of education
Portugal	Instituto do Emprego e Formação Profissional
Romania	Ministries and other central administration
Slovenia	There is not a single national organisation responsible for dveloping and coordination of on the job training, but several different institutions share the task of promoting lifelong learning
Spain	Tripartite Foundation for the Formation in Employment (Fundación Tripartita para la Formación en el empleo)
UK	Learning and Skills Council
Finland	Finnish National Board of Education is the agency responsible for the development of education in Finland

Annex 4: European Key Competences for Lifelong Learning

Competence	Definition
Communication in the mother language	Communication is the ability to express and interpret thoughts, feelings and facts in both oral and written form (listening, speaking, reading and writing), and to interact linguistically in an appropriate way in the full range of societal and cultural contexts — education and training, work, home and leisure.
Communication in a foreign language	Communication in foreign languages broadly shares the main skill dimensions of communication in the mother tongue: it is based on the ability to understand, express and interpret thoughts, feelings and facts in both oral and written form (listening, speaking, reading and writing) in an appropriate range of societal contexts — work, home, leisure, education and training — according to one's wants or needs. Communication in foreign languages also calls for skills such as mediation and intercultural understanding. The degree of proficiency will vary between the four dimensions, between the different languages and according to the individual's linguistic environment and heritage.
Mathematical literacy & basic competences in science & technology	Mathematical literacy is the ability to use addition, subtraction, multiplication, division and ratios in mental and written computation to solve a range of problems in everyday situations. The emphasis is on process rather than output, on activity rather than knowledge. Scientific literacy refers to the ability and willingness to use the body of knowledge and methodology employed to explain the natural world. Competence in technology is viewed as the understanding and application of that knowledge and methodology in order to modify the natural environment in response to perceived human wants or needs.
Digital Competence	Digital competence involves the confident and critical use of electronic media for work, leisure and communication. These competences are related to logical and critical thinking, to high-level information management skills, and to well-developed communication skills. At the most basic level, ICT skills comprise the use of multi-media technology to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in networks via the Internet.
Learning to Learn	'Learning-to-learn' comprises the disposition and ability to organise and regulate one's own learning, both individually and in groups. It includes the ability to manage one's time effectively, to solve problems, to acquire process, evaluate and assimilate new knowledge, and to apply new knowledge and skills in a variety of contexts — at home, at work, in education and in training. In more general terms, learning-to-learn contributes strongly to managing one's own career path.
Interpersonal & civic competences	Interpersonal competences comprise all forms of behaviour that must be mastered in order for an individual to be able to participate in an efficient and constructive way in social

	life, and to resolve conflict where necessary. Interpersonal skills are necessary for effective interaction on a one-to-one basis or in groups, and are employed in both the public and private domains.
Entrepreneurship	Entrepreneurship has an active and a passive component: it comprises both the propensity to induce changes oneself and the ability to welcome, support and adapt to innovation brought about by external factors. Entrepreneurship involves taking responsibility for one's actions, positive or negative, developing a strategic vision, setting objectives and meeting them, and being motivated to succeed.
Cultural expression	'Cultural expression' comprises an appreciation of the importance of the creative expression of ideas, experiences and emotions in a range of media, including music, corporal expression, literature and plastic arts.

Annex 5: Key Competences in KBS - Entrepreneurship

	FRAMEWORK FOR KEY COMPETENCES IN A KNOWLEDGE-BASED SOCIETY			
Domain	**Definition of the competence**	**The competence consists of the following elements of knowledge, skills and attitudes as appropriate to the context:**		
		Knowledge	**Skills**	**Attitudes**
Entrepreneur-ship	*Entrepreneurship has an **active and a passive component**: the propensity to bring about innovation oneself, but also the ability to welcome and support innovation brought about by external factors. Entrepreneurship includes welcoming change, taking responsibility for one's actions (positive or negative), setting objectives and meeting them and having the motivation to succeed.*	• *Knowledge of available opportunities in order to identify those suited to one's own personal, professional and/or business activities.*	• *Skills for planning, organising, analysing, communicating, doing, de-briefing, evaluating and recording.* • *Skills for project development and implementation. Ability to work co-operatively and flexibly as part of a team.* • *Being able to identify one's personal strengths and weaknesses. Ability to act proactively and respond positively to changes.* • *Ability to assess and take risks as and when warranted.*	• *Disposition to show initiative. Positive attitude to change and innovation.* • *Willingness to identify areas where one can demonstrate the full range of enterprise skills — for example at home, at work and in the community.*