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UNIVERSITIES AND INNOVATION

Dr. Ir. Josef Ritzen

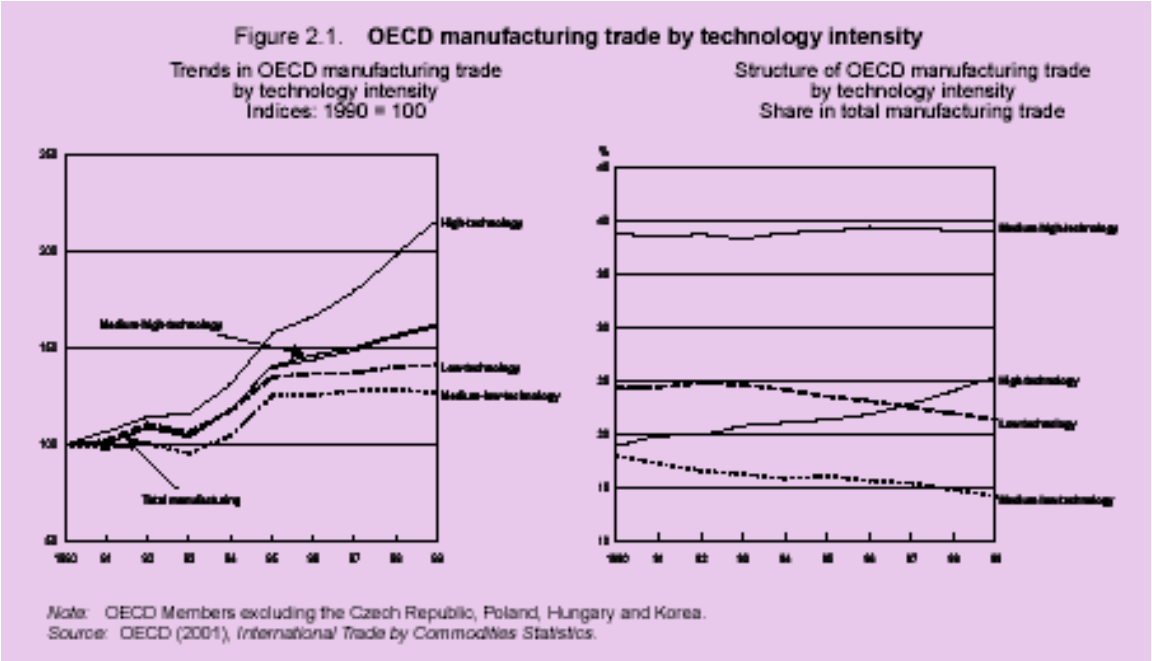
Maastricht University
The Netherlands
Tel.: +31 43 388 3153 • Fax: + 31 43 388 4883
E-mail: j.ritzen@cvb.unimaas.nl
Internet: http://www.unimaas.nl

Contents

1. Introduction

For many decades innovation plays an important role in the business sector. In recent years, the connection between universities and innovation triggered more interest. Applying a search engine[1] on the web for the exact phrase "*universities and innovation*" yielded some 1,5 million hits. The keywords "*university and product innovation"* , however, yielded only 24 hits, showing that the subject indeed still is a matter of academic contemplation, more than a day to day practice.

The economic impact of innovation is apparent. Studying new patterns of growth, the OECD points at the many signs at micro and industrial level of the increasing importance of new technologies, and associated structural and organisational change[2]. In the decade 1990-1999 the trade in high tech products increased more than 100%, compared to 40 to 55% for low tech and medium tech products. The rapid decline of the share of low tech products in trade illustrates the changing structure of our economies.



Already in the 1995 Green Paper[3], the European Commission started a union wide discussion on the importance of innovation to competitiveness. That discussion culminated in the ambition "*to become the most innovative economy in 2010"*, adopted at the Council Meeting in March 2000 here in Lisbon.

The Commission's Communication "*Innovation in a knowledge driven economy"* adopted in September 2000[4], translated the Lisbon summit's goals into priorities and practical steps for Member States in the area of innovation policy. The main action lines according to this document are:

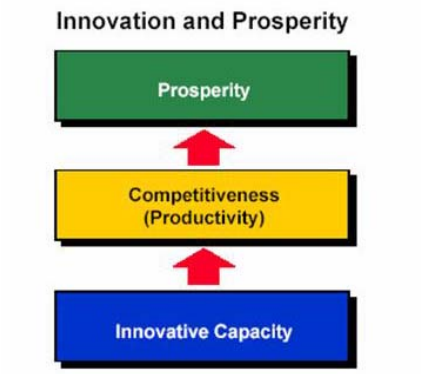
1. Coherence of innovation policies
2. A regulatory framework conducive to innovation
3. Encourage the creation and growth of innovative enterprises
4. Improve key interfaces in the innovation system
5. A society open to innovation

[1] Google, April 7th, 2003
[2] OECD, Science and Industry Outlook, 2001
[3] COM (1995) 688
[4] COM (2000) 567 final

As usual, measures are to be taken by the EU on communal level and by the national governments. The item "Universities and Innovation" is touched marginally in this policy document. Recently the Commission presented a Green Paper on the role of universities in the knowledge driven economy.
In my contribution today, I will elaborate on the present trends in innovation and the consequences they have on the educational mission of universities and on the relation of universities with the business world. As many of you are involved in Science Parks, you know from experience that science can be difficult, but connecting science and technology with business, is really a challenge.

2. About Innovation in general

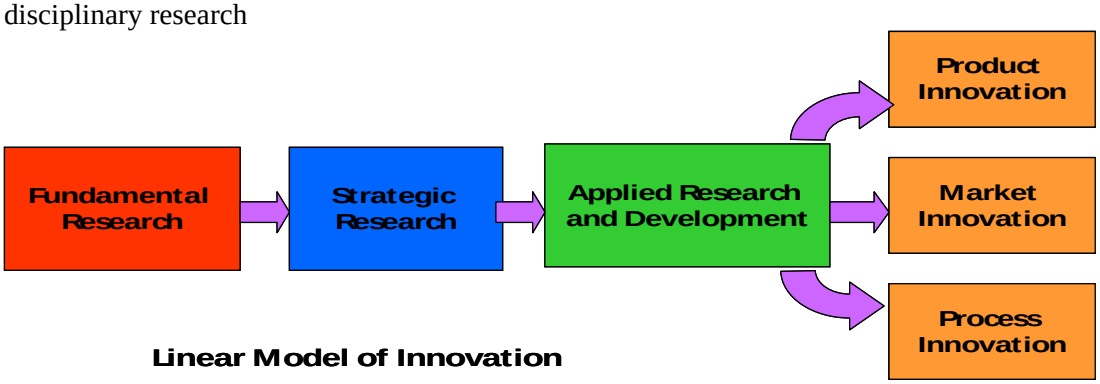
The precise definition of innovation by the EU is[5]: "the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organization, and the working conditions and skills of the workforce".



In advanced economies, innovation is needed to support high levels of prosperity

2.1. Changing patterns in innovation

The high standard of living in developed economies can only be maintained by a continuous high level of added value[6]. To a certain extent, innovation is identical to increasing added value of economic actors. Innovation comes in three basic forms: market innovation (new target groups for existing products or production competencies), product innovation (new products with a better fitness for use) and process innovation (better ways to produce goods and services). From these market innovation and process innovation, mainly cause a shift (functional, regional or financial) in value creation. Only product innovation has the potential to increase total value creation as it mobilizes production factors in a new way to meet unfulfilled demand. These three forms of innovation come traditionally out of a stepwise development of knowledge through inventions and development work. In each phase of development specialized organizations have their role. This linear model of innovation has been appropriate and very successful in the past century. It created the disciplinary research



Linear Model of Innovation

institutes as we know them, especially in science and technology. Fundamental research was the domain of universities and research institutes, while applied research and development was very much within industry. The main problem of the institutional division of focus is of course the

[5] COM (1995) 688
[6] passim. The figure is by Michael Porter, The Microeconomic Foundations of Economic Development, World Economic Forum, 2001

management of the interfaces where feed forward and feedback (!) takes place. Governmental research policies, professionals networks and written communication (journals, standards) are the characteristic ways to cope with the interfacing problem. Towards the end of the past century, the model became to complex to manage and the rise of ICT, new disciplines like life sciences and nanotechnology and of course the widespread availability of the internet, gave birth to a new model for innovation, the interactive approach. The interactive networks between the universities, the intermediates and industry open the door to this dynamic form of innovation. Doing so, innovation is not a cascade of institutes passing blocks of knowledge to each other from research to market application, but innovation becomes a process of transfer of knowledge from and to the research body in all stages of product development, production and market introduction. This, of course, has consequences for the organisation of knowledge transfer and on the way linkages between researchers and business people are institutionally managed. We will return to this issue in the last part of the contribution.

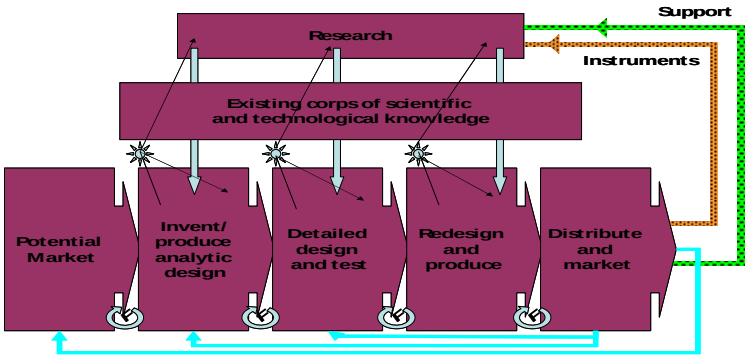


Fig. 1 Interactive model of innovation (Kline and Rosenberg, 1986)

2.2. Side effects of innovation

The phenomenon of innovating economies has many interesting effects. We mention three of them. The first is the gradual and sometimes shock wise disappearing of traditional employment from developed countries to low wage countries. Differences in knowledge intensity and in the level of wages create a push-pull effect that will speed up this process, the positive outcome being a new leash on life and welfare to developing countries. A new vision on the global distribution of labor will be on the agenda for the politicians in the years to come.
The second is the opportunity for sustainable development created by the need for new added value in knowledge intensive sectors of industry and society. Durability, sustainability and environmental issues are to a high degree unfulfilled demand that can become the target of product innovation.
The third is that innovation, this new driving force for economic development, is very much a matter of brainware, of individual skills. The basic resource for innovation is human resources. Focus on innovation implies focus on human development. Previous economic revolutions, for instance the agricultural revolutions in the middle ages, the industrial revolution and the IT revolution, had an emphasis on natural and material resources. The present development values human skills highly and has the potential to put the human factor in the centre.

2.3. Challenges of universities

The transition from post industrial society towards the knowledge intensive society is a way with many obstacles and potential friction. Traditional patterns of employment careers and the existing institutional frame works for research and development and technology transfer, have to be rearranged. The traditional linear model from knowledge creation to marketable products is changing to an interactive model of continuing exchange of insights and experiences between the research community and the business sector. Again, the European Commission is starting a

discussion on *"The role of the universities in the Europe of knowledge"* with the recent Green Paper[7] on this matter, which is intended to result in decision making on the summit in Berlin in September. The need for skilled workers and innovative actors challenges governments to restructure education, in particular higher education. This calls for a new approach to the content of education and for a new approach to the intertwining of higher education and the productive sector. The challenges are, according to the EU Green Paper:

- increased demand for higher education:
- internationalization of education and research
- to develop effective and close co-operation between universities and industry
- the proliferation of places where knowledge is produced
- the reorganisation of knowledge
- the emergence of new expectations

3. Education for innovation

The innovation we are looking for is complex and of high level. To produce and market a new pharmaceutical drug for instance, it requires a long and deep effort in research, development, testing, trials, marketing, production and distribution. Even the facilitating services involved, like funding, risk management, product liability, intellectual property and product presentation, require well managed highly qualified skills. The same holds for a range of other innovative products like new means of transportation, conservation of energy, applications of virtual reality, nanotechnology, waste treatment facilities, consumer goods and so forth.

3.1. Teamwork

Innovation involves many disciplines, a lot of team work and process management. Development of a new product is no longer within the domain of one enterprise. A company almost never innovates in isolation[8]. In many cases various companies are involved (cf. Senseo, the coffee machine jointly developed by Philips and Sara Lee). Innovation by **consortium** has been the preferred way to go for many years in the EU Framework Programs and the emphasis becomes even more in the 6th FP. The reason is not only the promotion of technology transfer to a larger group of participants in a consortium, but most of all to bring together sufficient innovative capacity and interdisciplinary contributions. In recent years, much attention is paid to innovation by **clusters**, regions of excellence in well defined sectors of the economy. Michael Porter's book *The Competitive Advantages of Nations* (1990) and his detailed descriptions of several industrial clusters in de USA, show how innovation and competitive advantages arise in economic networks of strongly interdependent businesses, knowledge producing agents and demanding customers, linked to one and another in a value adding production chain. The difference between clusters and consortiums is that clusters have a regional component: they are bound to a particular region and as a consequence, they have a link with local population and local government.

[7] COM (2003) 56 final, Brussels, 05.02.2003

[8] Cluster specialisation patterns and innovation styles, Research Unit Ministry of Economic Affairs,, The Netherlands, The Hague,1998 (Beleidsstudies Technologie Economie)

3.2. Multidisciplinarity

So, the practice of innovation nowadays, shows us the need for competencies not traditionally in the core of university programs of study like: creativity, boundary spanning, teamwork, interdisciplinary work, and project orientation, acquisition of new knowledge (lifelong learning), knowledge management and valorisation of science. In a survey[9], carried out by one of the researchers in my university, a clear distinction could be made between "front runners" and "pack members" among innovating firms. The figure shows that 85% of the front runners often or always make use of multidisciplinary teams, as opposed to only 45% of the pack members.
Entrepreneurship in the knowledge intensive society too is becoming team based and requires highly skilled and multidisciplinary capable people. The time for heroic[10] entrepreneurs – the single person who starts a company and expands it to a global business - is over. The knowledge society needs therefore HE graduates with entrepreneurial skills and processes by which these skilled people are organised in teams to start new companies.

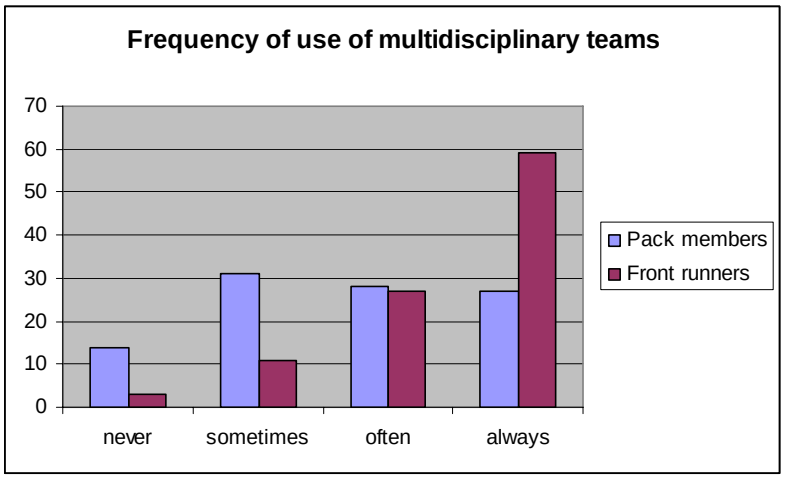
3.3. Innovation paradox

In Europe there is a growing concern about the innovation paradox: an excellent research base exists in the EU, but when it comes to valorization of knowledge the Europeans perform poorly compared to the USA and Japan. As a result the EU is not as competitive as it should be (and wants to be). The two main causes of the lagging behind of the EU and many other countries in the world compared to the USA and Japan are[11]:

- the gap in business expenditure on R&D relative to GDP, and
- the gap in the capacity to transform knowledge into successful innovation and business.

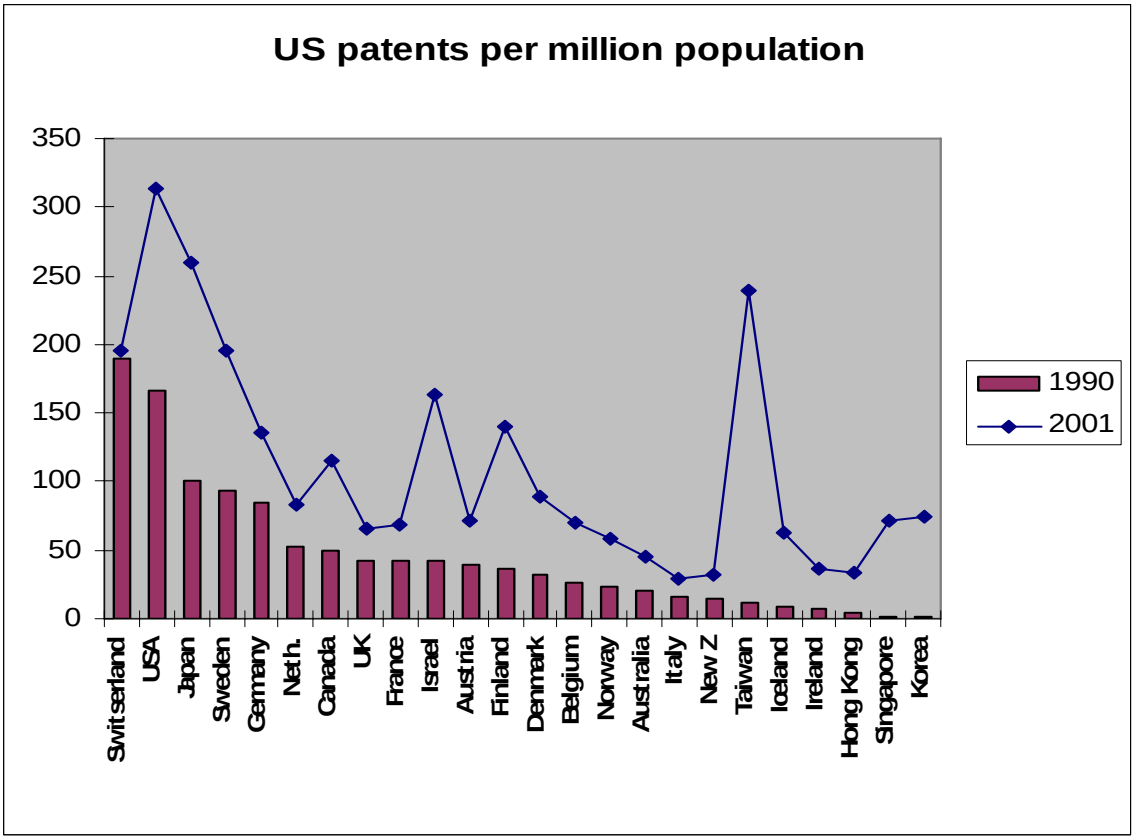
Gap in business expenditure

A good flow of ideas with commercial potential emerging from research is a key contributor to innovation. The EU's gross expenditure on R&D as a percentage of gross domestic product in 1997 was low in comparison with the USA and Japan. What is particularly serious for innovation is that the differences are largely due to a much reduced industrial research effort in the EU: R&D by business in the European Union is only 60 % of the level in the United States[12]. More recent figures show that the gap is not narrowing. In absolute terms, the gap between the US and the European Union in terms of business oriented R&D efforts in 2000 represents today practically the total size of business-oriented R&D efforts within the European Union: around 80 billion euros, a full 1% of European GDP. This explains the sharpening of the Barcelona objective to double private R&D efforts within the European Union from the current level of 1% to 2%



[9] Managing Innovation at the Company Level, J. Cobbenhagen, diss, Maastricht 1999
[10] M. Bruyland, Thesis, Leuven, 2001
[11] Preparatory Paper for the Innovation Lecture 2002 by Prof. dr. L. Soete, MERIT, Maastricht University
[12] COM (2000) 567 final

of GDP[13]. In the last part of my contribution, more attention is paid to this issue.
The gap is also illustrated by the number of patents relative to population. The graph shows the development of this indicator for the group of 20 most innovative economies at the end of the last century[14].



Gap in innovation performance

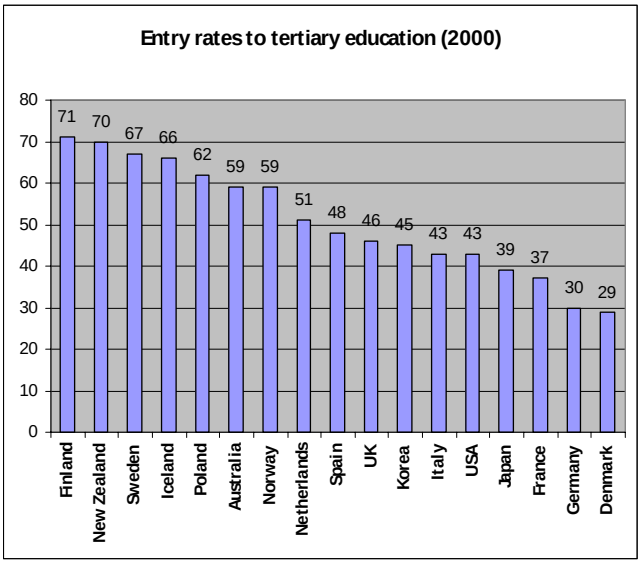
Besides private and public research expenditure, the other factor that can contribute to successful innovation is the efficiency of the process, with determining factors like: the introduction of new products onto the market, the implementation of new production techniques, the right organisational set up, the setting up new, innovative companies, the local innovative and entrepreneurial culture, etc.
The "Innovation Trend Chart" project of the European Commission has developed an innovation indicator on the basis of a series of indicators. This chart is updated yearly in order to monitor progress on the Lisbon objectives. The recent figures show that only Finland and Ireland are moving in the right direction.
With the EU itself and in various countries (UK, France) the agenda is set to change this in the coming years, the focal point being entrepreneurship. Traditionally in OECD countries, the vast majority of new companies are created through non HE educated people. So, the innovation paradox brings us to pay attention to the demographics, the attitudes and culture towards entrepreneurship.

[13] Soete, op. cit. p. 8
[14] USA Patent Office, April 2002

3.4. Socio-economic trends

Participation rate of young people in tertiary education

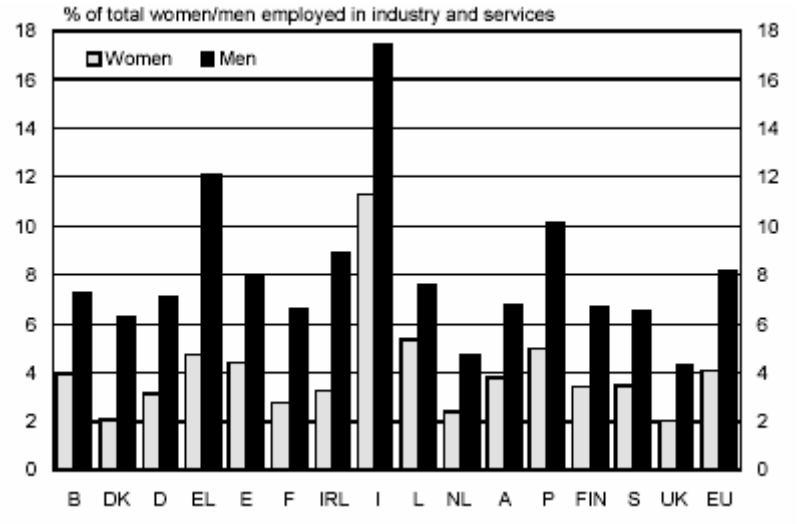
Till now HE graduates show a low propensity towards entrepreneurship. In most HE institutes entrepreneurship is not valued as an academic skill. The urge for an increased awareness and propensity towards entrepreneurship is aggravated by the growing participation rate[15] of young people to higher education, which might lead to a lower rate of creation of new enterprises. From 1960 till now, the participation rate to Higher Education increased from some 10% to 50% on the average in Europe. It is expected that this figure will and has to increase to some 70%, as is already the case in some Scandinavian countries. At present in the EU some 13% of workforce has a tertiary degree, against 26% in the USA[16]. The high entry levels to HE inevitably have as consequence that in Europe too the share of graduates from tertiary education in the workforce will increase rapidly to 20% en later to 30%. The development underlines once again the need of innovative change otherwise a situation of over qualification emerges.



Equal opportunities paradox

The equal opportunities policy of the past 50 years has resulted in more than equal participation of young women in education, especially higher education. In several countries in the EU, the share of female graduates exceeds that of male graduates. So a large proportion of graduates are female, but the number of women who are self employed is very much smaller than that of men, and the number of women entrepreneurs or those with employees, is smaller still[17]. This small number arises partly from the large proportion of women employed in communal services, in health, education and public administration, which are predominantly in the public sector. Only 21% to 24% of entrepreneurs in each age group in the EU are female. In the sector of technology, the situation is even worse.

[15] OECD, Education at a Glance 2002, quoted in the UK Green Paper "The Future of Higher Education", Secretary of State for Education and Skills, London, January 2003
[16] COM (2000) 567, Table 2
[17] Franco, A. and Winqvist, K: The entrepreneurial gap between women and men, Eurostat, Theme 3-11/2002



So, the success of equal opportunities in education has no positive effect on innovation by entrepreneurship.

Demographic trend

The dominant trend in demographics in the developed world is aging. Low birth rates, high survival rates and the perpetuate improvement of health services, result in a flat stratification of the population. The distribution over ages is not favourable to innovation and entrepreneurship, as highest propensity to innovate and enterprise is in the age groups of 20-30 and 30-40[18].

3.5. Educational concepts to entrepreneurship

So, in the educational sector there is a challenging agenda for bringing entrepreneurship and creativity for innovation into the programs. Little is known how to teach entrepreneurship, how to develop entrepreneurial skills and how to become an entrepreneur. The start of the International Journal for Entrepreneurship Education[19] last year is welcomed as it creates a scientific forum for research on this issue, thus contributing to the recognition in the academic world for this type of education. Three major features of innovators and entrepreneurs are their knowledge, skills and attitudes. In most formal education situations, the first is treated thoroughly and in an analytical manner; the second receives sketchy attention and is harder to impart within formal educational systems; the third is hardly addressed at all. Yet this later topic of attitudes, the psycho-social forces of the individual and the cultural context, is of prime importance in influencing innovative and entrepreneurial behaviour patterns. If entrepreneurship education and training is to be effective, the contention is that it must be so not only through factual knowledge and the limited skills acquirable in the classroom, but also through the stimulation of new ventures, the success of those ventures and the increasing capacity of the entrepreneur to pursue even greater success[20]. In a Danish Case Study[21], John Heeboll who himself is a practitioner in training young entrepreneurs concludes that the top motivating factors to start a company are:

[18] The Early Environment and Schooling Experiences of High-Technology Entrepreneurs: Insights for Entrepreneurship Education, Marilyn L. Kourilsky (UCLA, USA) and William B. Walstad (Kauffman Center, USA), in IJEE, Vol. 1, nr 1.
[19] IJEE, Senate Hall Academic Publishing, www.senatehall.com/ijee
[20] Garavan, T.N. and O"Cinneide, B: Literature review of problems associated with entrepreneurship education and training programmes, Journal of European Industrial Training, Vol 18, 1995
[21] Heeboll, J: Can Entrepreneurship be taught? A Danisch case study, Journal of European Industrial Training, Vol 22, 1998

- being a child of an independent business owner, which is not much comforting as in most industrialised countries the community of small business owners is decreasing and consequently the number of children predestined to entrepreneurship will decrease in the future, and
- the near-entrepreneurial experience, implying that much can be done to revitalize a dormant entrepreneurial potential by forms of virtual entrepreneurship, which is in line with the theory that entrepreneurs are a product of exposure, competence and luck.

- Student centered
  - aquisition of knowledge <> delivery of well structured theory
  - intrinsic motivation <> planning force of the curriculum
- Small teams
  - teamwork <> individual consumer of education offered
  - managerial skills <> obey imperatives
- Learn to learn
  - meta learning <> reproduce knowledge
  - gradual step to lifelong learning <> final examination
- Realistic problems constitute path of study
  - link with reality <> theoretical framework
  - problem solving skills <> analytic skills
  - multidisciplinary <> disciplinary

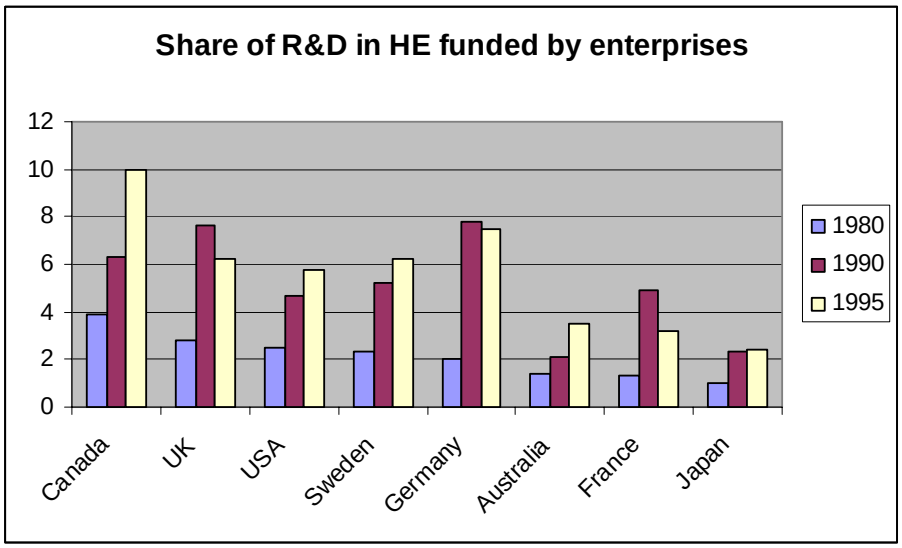
Fig. 2 Characteristics of PBL

Some universities in Europe, like my own, have adopted successfully the educational concept of problem based learning (PBL). In this concept the learning process of the student is at the centre, the acquisition of knowledge has a constructionist approach and the setting is that of collaborative learning. In the design of the program, much is derived from the day to day practice of professionals (e.g. general practitioners, lawyers, managers). A possible way to go in order to meet the need for team working entrepreneurial graduates, might be the educational concept of Real Company Education, in which the setting of an entrepreneurial team is the background for the design of the program.

4. Bridging the gap between HE and industry

Parallel to programmatic reform, the interaction between HE institutes and the market sector has to be transformed, as well quantitatively as qualitatively. Comparison of R&D expenditure in the EU and in the US shows a massive and rapidly growing gap, both in value and as a share of GDP. The gap reached 124 billion current Euro in 2000 and it has doubled at constant prices since 1994. R&D intensity in the EU, measured as the percentage of GDP accounted for by total investment in R&D, stagnated at around 1.9% over the last ten years, while in the US it grew continuously from 2.4 % in 1994 to 2.7 % in 2000. There is an even wider gap between the EU and Japan in terms of R&D intensity, as Japan devotes 3 % of its GDP to R&D. [22].

[22] COM (2002) 499: More research for Europe. Towards 3% of GDP



It is generally understood that the gap in business oriented research and development between the US and Europe, is due to the limited extend of business efforts in R&D. The business sector accounts for 72 % of R&D expenditure in Japan, compared to 56 % in Europe and 67 % in the US. The share of R&D in HE funded by enterprises in a number of OECD countries grew from an average of 2% in 1980 to an average of 5% in 1995. Canada had the highest share with 10% in 1995[23].
So the main priority for European institutes is to increase the level over private funding of R&D, preferably in cooperation from industry with research institutes.

4.1. Cultural gap

The university - industry link is not a natural one and needs to be carefully nurtured and grown. It is a real bridge over a divide between different worlds: the world of the university with its core of teaching / learning and creative research on the one side and the world of industry with its core of entrepreneurship to make a profit by linking production to demand on the other side. In the next table, on some ten dimensions the gap is illustrated.

University	Business
Curiosity driven	Opportunity driven
Knowledge sharing	Knowledge protection
Analytic	Problem solving
Long term	Short term
Risk avoidance	Risk management
Rooted in community	Principally footlose
Continuity	Flexibility
Peer review	Market success
Publish or perish	Profit or perish
Organised chaos	Controlled strategy

Fig. 3 Differences between universities and the business world

[23] Management of university-industry linkages, International Institute for educational Planning, Policy Forum No. 11, Paris, June 2000, p.63

The differences indicate that the relation is far from easy not only because of the differences in goals or structures, but more because of a fundamental difference in mind set. Attempts to convert universities into businesslike organisation are seldom fruitful en will not last for long. The sometimes propagated urge to make researchers develop themselves into entrepreneurs in order to promote the emergence of new enterprises in case of a shortage in creating enterprises, is not the right way to go as:

- everybody understands that it would be unwise to try and convert entrepreneurs into researchers in case of a shortage of researchers; the adverse is also unwise,
- moving entrepreneurial researchers into the business sector deprives universities from dynamic researchers and sometimes of the most productive researchers,
- the knowledge base of a single researcher is in most cases too small to maintain the successful management of a company

The paramount way to overcome the gap is by building bridges between the cliffs en to encourage people from both sides to cross the bridge, be it on their own or in each others companionship.

This is the approach we put into practice in Maastricht, in my own university. This approach has as building blocks:

- creation of teams of entrepreneurs, partly from research and partly form business,
- creation of intermediary steps in order to lower the thresholds for academics to enter markets and for business people to enter the research academy,
- use of business models that capitalise on the competencies of partners

In the Maastricht approach institutional emphasis is on care for intellectual property, creating awareness for entrepreneurial opportunities with students and academics, start-up ventures in order to develop applications form academic research and the promotion of joint ventures between academics and businesses.

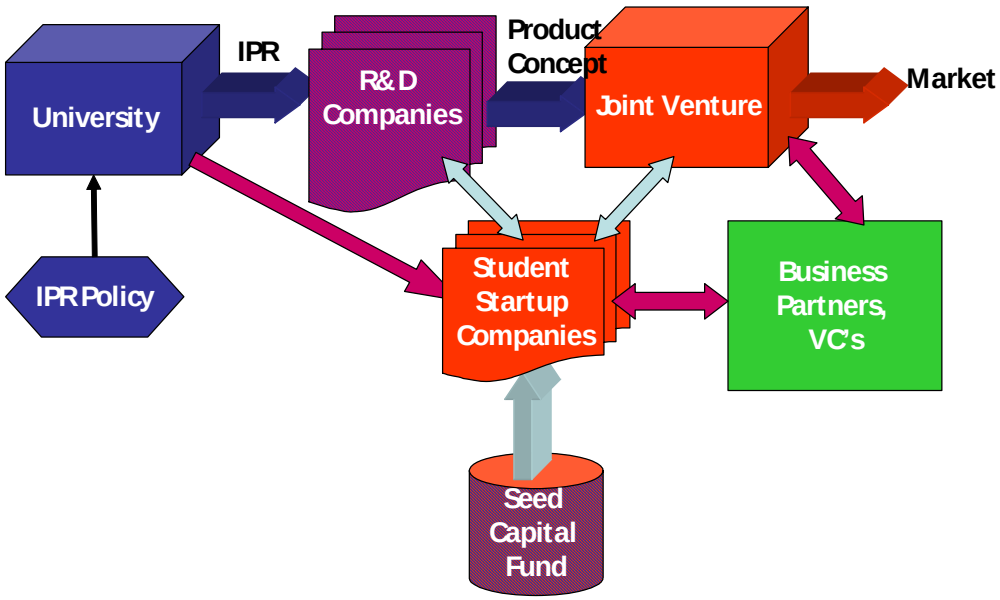


Fig. 4 Maastricht business model

4.2. The narrow bridge

A successful university - industry link first reaps the benefits of the externalities of well trained research staff and of well motivated students, by means of incubators and support in patent applications. There is a tradition in this type of technology transfer, mostly incorporated in small service centres like liaison offices. From the part of the university, this type of knowledge transfer is very much supply driven: those research groups that think they have to offer

something to the market, are the natural and sometimes the only, suppliers of knowledge to be transferred.
This is useful, but should not be exaggerated in its impact to university income. The total value (in terms of turnover from the new start-ups - located in incubators) will generally not even exceed 1 % of the university's budget. Also the long-run impact, through "matured" start-ups who have left the incubator, should not be exaggerated. Costs to the university for developing the benefits of these externalities may well exceed the income derived from these benefits. A well focussed and lasting effort with massive impacts on traditional university structures is necessary to boost this type of income to a level that is no longer marginal in terms of university research funding.

4.3. The broad bridge

The broad bridge entails a university research strategy which is at least attuned to the needs of university - industry co-operation without endangering the basic background of university research. It also entails the presence of industry laboratories on or close to the university campus (compare Nokia at the University of Helsinki or Ericson at the University of Stockholm) and venture capital funds (cf. Yissum, a subsidiary of the Hebron University in Jerusalem[24]). This approach uses various intermediate steps to complete the chain of knowledge that runs from basic research through applied research, testing and development to innovation and entrepreneurship. Intermediates include excellence centres dedicated to transfer of knowledge, student enterprises, spin-off companies, patenting agencies and seed capital organisations, all of which are joint ventures from the university with partners in the market place. This model operates simultaneously on the demand side and on the supply side of knowledge transfer. It approaches very much the interactive model for innovation. University and research centres are nodes in a heterogeneous network of industries, commercial services and funding organisations. All kinds of brainware - patents, licences, academics, students, business people and consultants - move around in the network. If successful and grown to a critical mass that surpasses the regional or national level, such an intelligent network can develop into an innovative cluster as described by Michael Porter. In some countries the promotion of such clusters has become a policy which can include appropriate legislation, targeted research programmes, fiscal measures, incentives and support. This new mode of tripartite interwoven interaction has been called the “triple helix model” of university-industry-government partnership[25].
One of the interesting aspects of the development of intelligent clusters is the link with regional development, as the ore of the knowledge driven society is produced in well-rooted institutes of knowledge creation. Until recently innovation policy, if any, was directed nationally or towards specific sectors of the economy or to a small number of well defined promising technologies. In such an approach little room is left for regional considerations or questions like the spatial distribution of unemployment. The new approach that arises, includes concepts like “learning cities” or “learning regions”, thus providing new perspectives for employment en sustainable growth. At the same time, with the “academisation” of regions, the horizon of regions is broadened and may even become transnational.

Whether narrow or broad: the bridge should be well designed according to specifications, which entail the performance criteria (what is to be achieved and how it is achieved) so that accountability is constructed.

[24] idem, Part IV
[25] Etzkowitz and Lebesdorf, 1997, cited in Management of university-industry-linkages, Policy Forum IIEP, Paris, June 2000

5. Conclusion

Innovation in these days is a challenge to universities, especially in Europe with its high ambition for 2010. From the trends I presented, many of which are global with variations in countries, it becomes clear that the university sector has to adopt alternative approaches to the content of their programmes of study, to the educational concept they use, to the institutional arrangements they practice towards intellectual property and towards linking the university research with industry. Playing a role in the exciting world of interactive innovation and in the creation of transnational innovative clusters on the other hand gives a tremendous reward in terms of regional support, opportunities to boost university income and involvement in economic and social developments in society.

Science Parks have a clear role in the transfer of knowledge from the laboratory to the market, and they perform this role in some places for many years. The present situation is an invitation to science parks to enter into the innovative clustering with the research institutes in the neighbourhood. If in any field the paradigm “Think global, act local” is literally true, it is in the field of innovation and science parks.

I thank you for your attention.