E105 - 2013A - FS01-01

EI05. Introduction to innovation studies.

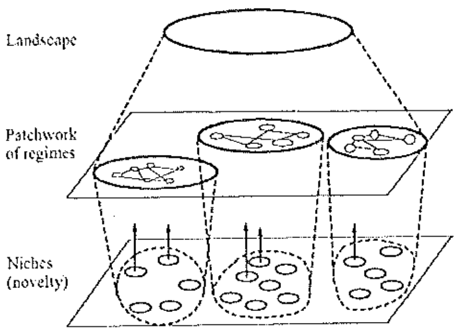
Please answer to the following questions on different sheet of paper.
The four questions have the same share of the final grade.

Question 1.

1.A. Comment on the following sentence:
"The most important insight that has dominated the field of innovation studies in recent decades is the fact that innovation is a collective activity. It takes place within the context of a wider system. This wider system is coined the *innovation system.*" (Hekkert et al. 2011)

1.B. What are the main components of a Technological Innovation System?

1.C. What is the meaning of this picture?



Question 2.

Users and innovation

> "**Innovation among Hospital Surgeons**
> Lüthje (2003) explored innovations developed by surgeons[1] working at university clinics in Germany. Ten such clinics were chosen randomly, and 262 surgeons responded to Lüthje's questionnaire—a response rate of 32.6 percent. Of the university surgeons responding, 22 percent reported developing or improving some item(s) of medical equipment for use in their own practices.
> Using a logic model to determine the influence of user characteristics on innovation activity, Lüthje found that innovating surgeons tended to be lead users ($p < 0.01$). He also found that solutions to problems encountered in their own surgical practices were the primary benefit that the innovating surgeons expected to obtain from the solutions they developed ($p < 0.01$). In addition, he found that the level of technical knowledge the surgeon held was significantly correlated with innovation ($p < 0.05$). (...)
> With respect to the commercial value of the innovations the lead user surgeons had developed, Lüthje reported that 48 percent of the innovations developed by his lead user respondents were or soon would be marketed by manufacturers of medical equipment. (Von Hippel, 2005, p.30).

Answer to the questions according to the case and beyond this special case.

a) **Why may a user innovate?**

b) **What are the main characteristics of these users-innovators?**

c) **What is the main benefit the market can gain with such users?**

d) **Give an other example of a user-based innovation**

[1] Surgeon: chirurgien.

Question 3.

*NAME:*____

*SURNAME:*_____________________________________

Please answer clearly and briefly to the following questions:

1.1. Recall and define each type of innovation considered by J.A. Schumpeter.

2. Explain the epidemic diffusion pattern (i.e. the S-curves) that can be observed for most of innovations.

3. Discuss briefly the role of learning in a `System of Innovation'.

4. What characterizes a technology according Dosi's `Technological Paradigm' approach ?

5. Discuss the role of the socio-economic factors in defining a `technological trajectory'.

Question 4.

Technological « spillovers » from military R&D.

David C. Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth*, Cambridge (Mass.), Cambridge University Press, 1989, p. 137-147.

Technological "spillovers" from military R&D

Have military expenditures strengthened the R&D capabilities of private firms? At issue in any assessment of the commercial benefits of military R&D are questions that go beyond the direct transfer to commercial applications of specific pieces of hardware – as in jet engines, semiconductors, and new materials. What are the second-order spillover effects of military R&D on other industries? Much of the "output" of military R&D is incorporated in improved products and processes that have been diffused widely throughout the economy. Military and space programs, for example, have developed new materials with improved performance characteristics (such as light weight, high strength, durability, and electrical conductivity). Similarly, military programs have aided the development of electronic components (especially semiconductors) that are used in a broad array of sectors. Measuring the full civilian benefits of military R&D requires that one trace thousands of small improvements in a great many economic sectors.

Other issues that demand attention in any systematic assessment of the commercial effects of military R&D include: What commercial benefits flow from military spending on "upstream" basic research or applied research of a more generic nature, and to what extent do U.S. firms capture these benefits? Do military R&D expenditures in specific industries or technologies allow for the exploitation of scale economies as research facilities reach some minimum efficient size? For contractors performing military R&D who also design and sell civilian products, does "learning" on military contracts benefit their civilian-oriented activities?[8]

Even more difficult than tracing out the interindustry flow of military-funded technological improvements is establishing the content of the "learning process" in the sectors that receive the majority of military R&D. Product designers and technical specialists working on defense projects in fact may "learn" an indifference to cost in the pursuit of performance improvements. Military (and space) programs have notoriously subordinated cost considerations to the improvement of performance – often incurring very high costs for very small improvements, few of which are relevant to civilian markets. Military R&D programs may also encourage "learning" of expensive and ultimately inefficient habits, for example, a predisposition to substitute large-scale experimentation and computation for rigorous thought. Such learning "spillovers" may reduce the effectiveness of R&D personnel in competitive commercial markets where close attention to cost considerations can be a matter of commercial success or failure.

It is important to distinguish between cost discipline in the *performance* of R&D and similar discipline in the *design* of the finished product – or "gold plating," as it is sometimes called. The purely economic impact of the gold plating of military hardware may be very large. In addition, however, defense procurement policies may provide insufficient incentives for R&D in manufacturing *process* technology. Military suppliers have learned over the years that contracts are won on the basis of actual or promised product performance, not on the basis of cost-reducing innovations in process technology. Thus, the military procurement system may create a strong bias in favor of product innovation and against process innovation.[9]

Assessing the impact of military R&D spending is further complicataed by the fact that the influence of military R&D spending can easily be confounded with that of federal procurement. Most military R&D is obviously directed at the development of products that are designed for eventual purchase by the military itself. Indeed, the allocation of military R&D expenditures may be taken as an excellent guide to military procurement intentions.

This point is critical to any evaluation of the effects of American military R&D in the past forty years. The benefits that are sometimes perceived to flow from military R&D are in fact the product of military R&D plus frequently massive military procurement. The willingness of private industry to commit substantial resources to innovation in a particular sector has been dominated by an awareness of the potentially large markets for military products of superior design and performance capability. Without the pull of defense procurement in such sectors as jet aircraft, integrated circuitry, and computers – especially in the critical early years of development of these technologies – the impact of military R&D spending alone would have been far smaller.

The example of semiconductors illustrates an instance in which the role of military procurement may well have outweighed the direct influence of military R&D expenditures. Following the wartime demonstration of the importance of electronics for communications and many other military applications, the military services were intensely aware in the 1940s of the potential military applications of semiconductors and followed developments in this technology closely. "Followed," however, is the operative word. The major scientific and technological breakthroughs in semiconductors were achieved in the private sector with private funds, and not, in the most important instances, with military R&D support. Yet much of this privately funded work on semiconductors was motivated by an awareness that military electronic equipment was plagued by equipment failures that stemmed in part from the systems' complex circuitry and reliance on vacuum tubes. The continual lure and the eventual reality of vast procurement contracts drove much of the R&D effort in this sector.

The invention of the transistor at Bell Labs was achieved without government financial support but with an awareness of the large potential market within the telephone industry for a solid-state substitute for vacuum tubes. Although Bell was well aware of the great military interest in its discoveries of 1947–48, its more immediate concern was to prevent that interest from imposing restrictions on civilian diffusion of the new technology. According to one authority, "There was substantial concern in early 1948 that disclosure of the transistor to the military prior to public announcement might lead to restriction of its use or to its classification for national defense purposes. Thus, Bell did not disclose the invention to the military until one week prior to public announcement" (Levin, 1982, p. 58).

During the 1950s the military supported a number of R&D projects in microelectronics as part of broader research programs in radar, missile guidance systems, and fire control systems. Some but by no means all of these programs focused on semiconductors; most attempted to improve the ruggedness, miniaturization, and reliability of radio tube technologies. As it happened, these projects, such as Tinkertoy and Micromodule, were not successful, and none of the major technological breakthroughs of that period were directly supported by the military. This failure reflected the dominant role within the military research programs of established producers of electronics, such as General Electric or RCA, who were weak in semiconductor technologies. Nevertheless, some of the most important breakthroughs, such as the silicon transistor and the integrated circuit, were undertaken with the needs of the military foremost in the minds of the successful inventors.[10]

The large procurement needs of the military and NASA and the increasing concern with the importance of miniaturization were vital in the early years of new product development in electronics. The Signal Corps was the largest military purchaser of semiconductors in the early and mid-1950s. A major expansion in demand occurred in 1958 with the Air Force's decision to employ semiconductors in the guidance system of the Minuteman missile. In 1962 NASA made public its intention to introduce integrated circuits into the guidance computer of the Apollo spacecraft. Soon after, the Air Force announced that the guidance system of the improved Minuteman intercontinental ballistic missile would make extensive use of integrated circuits.

From the mid-1950s to the late 1960s, the federal government (overwhelmingly the military and NASA) accounted for a large, although declining, share of the output of semiconductor devices (see Table 6.10). In the first year of integrated circuit production, the federal government purchased the entire $4 million of output (Table 6.11). It remained the largest buyer for the first five years, although the government share declined rapidly. By the end of the 1960s the rapidly growing computer industry displaced the military as the largest end-user market for integrated circuits.

Several conclusions can be drawn from a review of the military role in the development of the semiconductor industry in America during the 1950s and 1960s: (1) The major early innovations were achieved largely without military R&D support;[11] (2) military R&D projects that pursued alternatives to miniaturization through semiconductors were largely unsuccessful; and (3) the procurement needs of the military resulted in considerable firm-financed R&D spending. Profits and overhead from military procurement contracts supported company-funded R&D and thereby may have generated more civilian spillover than R&D that was directly funded by the military. In addition, direct financial support from the Pentagon was available for the construction of production facilities by winners of contracts under the provisions of the Defense Production Act.

Defense procurement may have lowered marketing-based barriers to entry. Lower entry barriers allowed small firms, such as General Radio, Texas Instruments, and Transitron, to direct their development efforts to meeting the performance and design requirements of a single large customer in the 1950s. The relatively modest barriers to entry were associated with the entry and rapid growth of numerous young, relatively small firms in the industry. This pattern contrasts sharply with the development of the biotechnology industry, where young firms have relied heavily on linkages with larger firms in order to obtain capital and marketing expertise (see Pisano et al., 1988).

1. How do you understand the words « technological spillovers »? Give some example.
2. What are the military influences in the industrial R&D? Could you describe different ways of influence by military R&D?
3. What are the other issues of the government involvement in national R&D systems since WWII?
4. Who is the better between firms and State to sustain and develop R&D? Present a short discussion and give some arguments and selected examples.