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科目：管理論文評論

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There is an additional dynamic, which we will provisionally call 'technological agglomeration' *i.e.* the geographic co-location of different scientific and technological fields. Technological opportunities as well as requirements on further technological development (e.g. a next generation of chips) stimulate linkages and coordination amongst different fields, and this may create cumulative advantages for clusters in which a wide range of scientific areas is explored. Thus, there is a technological driver in the agglomeration of actors and activities in a geographical region, and more generally, in clusters building on proximity.

Technological agglomeration is a general phenomenon, but it is particularly visible in newly emerging nanotechnology-linked developments. We will use our ongoing studies of regions with a high concentration of nanotechnology-linked activities to show the importance of technological agglomeration for the overall dynamics of development. Our analysis of these techno-institutional dynamics and related changes in networks of firms, research centres, and regional actors and policy makers, takes technology infrastructures and in particular, technology platforms as the main entrance point. Technology platforms are increasingly recognized as important in enabling innovation, as a key part of business models of (high-tech) start-ups, and as having dynamics and requirements of their own.

In this note, we present a first analysis of the role of technological agglomeration in the evolution of nano-clusters in the Netherlands and in Grenoble.

The research note contributes first to the empirical understanding of how technological characteristics are leading to geographic agglomeration of scientific activities. It specifically highlights the role of technological platforms in the agglomeration process. Second, it presents

two different processes of agglomeration, a centralised one in France and a distributed one in the Netherlands. Third, our note illustrates the multilevel character of such technological agglomeration.

## The Technological agglomeration and technology platforms

The past ten years have seen an explosion of interest for the area of science and technology labelled "nanotechnology". Nanotechnologies are defined as technologies which include components that have at least one dimension between 1-100 nm, and display unique characteristics due to being at this scale. Unlike previous high-technology waves, nanotechnology covers a diverse field of sciences and engineering, crosses boundaries between them and aims to utilize the very fundamental characteristics of matter by manipulation and control at the nanoscale.

As they cross many disciplines, also many industries and technology chains, nanotechnologies reshape the existing organisational arrangements amongst actors. Technological agglomeration *i.e.* the co-location of scientific and technological supports the development of nanotechnologies within the area. They also involve large investments in infrastructures. Bigger and better clean rooms, atomic force microscopes for observation and manipulation at the nanoscale, e-beam lithography and nano-imprint lithography to make the channels, pores, and circuits needed for the research. Organisationally, it requires the sharing of facilities, equipment and skilled technicians for these very different technology/research fields. Since such facilities are expensive and take some time to construct, they need high investment (both financially and in training of manpower) over a period of time.

Developments in most fields of nanotechnologies are tied to technical facilities, that is the instrumentation itself and the skills that are needed to operate them. In addition, a lot of nanotechnology research involves development, construction and implementation of new instruments. In other words, nanotechnology must be a field that allows us to study the phenomenon of technological agglomeration.

Actually, the infrastructural requirements add up to a basic set of technologies and skills, which allow, when in place, a variety of further work and product development. In other words, there is a technological platform *i.e.* a set of instruments which enables scientific and technological production: it allows exploration and exploitation of a variety of options, for strategic research, technology development, and sometimes also product development. Such a basic set of technical infrastructure is somewhat independent of the team which originally built and assembled it. It is recognized by others as important, and assembled to be able to profit from the variety of purposes it can be put to. It is not focused, however, on appropriating part of the value added in producing goods or services, but to enable innovation and valorisation (and appropriate the resulting technological options, for example in publications, patents, and as core competence of a start-up firm).

A technology platform is not just a collection of equipment. It enables and constrains further actions. Furthermore, the recognition of the possibility of such platforms incites actions to realize them. As product platform (Gawer and Cusumano, 2002) focuses on the standardisation of interfaces which makes it compatible with the other modules, technological platforms appear as enablers of R&D, of families of technological options, and of successive product development. A sector can then be viewed not in terms of a dominant design and related industry structures, but as a patchwork of technology platforms and related coordination, up to aggregation. Peerbaye

(2004) shows how genomics platforms emerged in R&D institutions and some R&D companies (e.g. micro-arrays), but took on a further feature in France when public financing was made available provided there was some geographical concentration and provisions for access ('dispositif instrumental partagé').

In nano R&D and product development, the range runs from the basic set necessary for manipulating at the nanoscale (STM, AFM, surface analysis instrumentation, nano-fabrication including clean room facilities) to further technological (and social) infrastructure necessary for nano-production. This will be different for different types of products: coatings vs. biochips vs. nano-electronics. Such products are not (and most often cannot) be exclusively nano: for example, micro-systems enabled by nano-inputs (components, modifications). When the new industries have become articulated and stabilized, the technology platforms turn into platforms enabling product families in the traditional sense (Tatikonda 1999). What is still distinctive is that these product families are defined by the technology rather than the sector. Start-up companies basing themselves on a technology platform can identify and follow-up opportunities in different sectors.

Technological platforms, when sought after, are intentional opportunity structures. They are also part of evolving (or emerging) techno-industrial networks and help structure them. This note argues that technological agglomeration is the effect of technological platforms being set up, used and expanded. Because of the coordination (*de facto* through the nature of the platform, as well as intentional, e.g. when organizing access) that is involved, there is a proximity effect and some clustering will occur. There are two main routes of technological agglomeration (and one may find other routes in between, a mix of the two main routes).

- building interrelated and interdependent networks, where technological opportunities and platforms get assembled by being available at the same time ("off the shelf"), and allow various exploitations. This can then be recognized for what is happening, optimised, and packaged to be used elsewhere & elsewhen. Already in the region Twente, but definitely the Netherlands (the second case study), one finds a number of nanotechnology value chains (*filières*), some still only emerging. In new fields such a bottom-up fabrication, and to a certain extent bio-nanotechnology, previous arrangements are absent, or are more diffuse. A technological *filière* is not there yet, in contrast to the situation in micro/nano-electronics. Still, one sees technology platforms being constructed and exploited.

- building co-localised facilities and scientific and technological competencies (geographic concentration), where the technology platforms are expansions of existing facilities. They have to be articulated and designed as such, which requires a concerted effort from the beginning. The second route often builds on what has been happening in the first route, in particular when a certain threshold of articulation and stabilization has been passed. The French public policy which supported the creation of technological platforms within the Genopole programme is an example of such articulation allowing further steps to be made (Peerbaye 2004). The Minatec project in Grenoble (our first case study) was conceived as a major new step, but derived its legitimacy from what was happening already in the region.

In both cases, technology platforms need to be located near a research centre or university. The high investment of monetary and human capital into such technology platforms, and the possibility of many various diffuse technology chains to cross at a technological platform, imply that it is attractive to locate the various technology platforms at the same location, near skilled workforce (and a workforce that evolves with the evolution of the technology platform). Small

and large companies could then locate themselves nearby and profit from this agglomeration. Platform agglomeration is also an enabling tool to run complementary experiments and to explore different scientific fields. In addition to scientific and technological convergence in nanotechnologies (Roco and Bainbridge, 2002), generic platforms appear to be the locus of hybridization amongst technologies (Avenel *et al.*, 2006), where teams from different traditions and disciplines can meet around technological facilities. Platforms are a hub for the different disciplines to meet (Carlile, 2004), a sharing facility which play the role of a boundary object (Carlile, 2002; Star and Griesemer, 1989).

There will be path dependencies, in the sense that earlier investments and competencies shape what can be done later. Sometimes, such path dependencies are actively constructed by institutional entrepreneurs who mobilize a variety of resources to create a new and major lab (Jean Therme and Minatec in Grenoble) or a distributed set of lab facilities (David Reinhoudt in Twente, and his colleagues in Groningen and Delft, in the Netherlands), which will then have a life of their own. Initiatives from such institutional entrepreneurs will be the other entrance point for our case studies, because these project futures and actively combine resources from different levels. In a particular locality or region, combinations of disciplines and infrastructures can be assembled and exploited that is adapted to existing competencies and networks. For example, Grenoble focuses on nano-electronics and the Twente region in the Netherlands on materials and sensors.

1. According to this article, how will you define a cluster? (35%)
2. How does a technology platform facilitate innovation? (35%)
3. Please discuss how can a firm within a technological cluster benefit most from the agglomeration economies? (30%)

(No more than 300 words for answering each question)