Microelectronics clustering efforts in Grenoble

European Cluster Mapping Project “Identification, analysis, and monitoring of business clusters in Europe”

Case study for the Commission of the European Communities Enterprise and Industry Directorate-General*

This cluster case study and 14 other cluster case studies conducted under the same project are available at www.clusterobservatory.eu together with a synthetic analysis of the potential of 25 European clustering efforts for promoting innovation and competitiveness.

31 March 2008

*The opinions expressed are those of the authors, the consultancy Competitiveness (www.competitiveness.com), and do not represent the Commission’s official position.
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1. Objectives of the case studies

Under the 6th framework programme, the European Commission / DG Enterprise and Industry, has launched a range of projects related to clusters and innovation. One of them, under the Europe INNOVA programme, develops a comprehensive set of data and analysis around clusters, innovation, and related policies. In December 2006, the importance of these studies was reinforced by the Competitiveness Council’s conclusions, which describe clustering as an area of priority where actions should take place in support of innovation.

Addressing the European innovation gap

There have been many other efforts to address the European innovation gap, and it is difficult to summarize the actions needed and proposed in one paragraph, but the report “Creating an innovative Europe” commissioned to former Prime Minister of Finland, Esko Aho, by the Hampton Court Summit, gives a clear message of the actions required and how clustering efforts could help close that gap.

The report states in its summary: “Achieving an Innovative Europe requires a combination of a market for innovative goods and services, focussed resources, new financial structures and mobility of people, money and organisations. Together these constitute a paradigm shift going well beyond the narrow domain of R&D and innovation policy.”

Understanding if clustering efforts are helping to close the gap

The Aho report gives as well a perspective of how clustering efforts can help that paradigm shift:

“Clusters and, more generally, regional agglomerations are often at the core of innovative development. It is widely recognised that new firms thrive in the proximity with other companies, investors, educational institutions and research centres afforded by clusters particularly in the presence of world-class academic institutions. Mobility can be maxi-

mised when there is a local labour market that allows regular flows of people from one situation to another, with accompanying diffusion of knowledge. As well as the greater opportunity range it is clear that barriers such as the need to move house or schooling for families are removed. However, it also emphasizes that minimising such barriers more generally will create a more functional society. It is important to ensure that clusters are defined in terms of the new market and knowledge relationships needed for emerging sectors to thrive. It is even counter-productive to reinforce traditional sectoral clusters as these may inhibit the necessary mobility. Firms in traditional sectors are far more likely to find innovative growth by forming new linkages and applying new technology to their existing products and services. This can be facilitated by opening the clusters to cooperation with and learning from other clusters in the same or other sectors. 

Why the microelectronics clustering efforts in Grenoble can be a useful example

The case studies of this European Cluster Mapping project place a special consideration to see if the clustering efforts analysed have helped move the companies towards new market and knowledge relationships or just to reinforce or defend acquired positions in traditional sectors.

The microelectronics cluster in Grenoble is noteworthy for its market-driven focus, coordinated effort at all administrative levels, and agility in responding to increasing challenges in such a dynamic industry. The cluster benefits from its location in the Rhone Alps region of France, which has a leadership position among EU regions thanks to significant research capacity, industry, and major infrastructure investments, among other factors. But perhaps as important as all of these, the cluster is driven by a longstanding culture of scientific entrepreneurship in which research leads naturally to the market.

Grenoble is a very unique case of success that might be influenced by the sports and mountain spirit of its residents. The vision for the future, clustering efforts and institutional alignment seem to be quite unique and have not been reproduced in other clusters.

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2. Have the clustering efforts been a driver for innovation in the microelectronics cluster in Grenoble?

**Contribution to the development of lead markets**

While the cluster demonstrates successful collaboration in the design and development of microelectronics, its product focus has been primarily “pulled” by demand for improved mobile phone functionality, but the decisions on these functions were external to the cluster.

Today, the cluster has “ideas labs” to gather university researchers and company representatives to reverse this pattern. One example is the nanobio initiative that aims to leverage the biotech and healthcare expertise of Grenoble and Lyon and Tenerrdis concerning energy. Results remain to be seen.

**Help in focusing R&D&I resources**

The cluster has proven very effective in focusing R&D resources towards commercial applications, and aligning stakeholders to reach sufficient scale.

The current manager of the CEA in Grenoble, Jean Therme, is a visionary who has motivated stakeholders of very different types, rallying and aligning all levels of government from municipal to EU, as well as different institutional and private stakeholders, to create the Minatec centre. He follows in the footsteps of one of the cluster’s pioneers, Louis Neel, who created industrial spin-offs from the labs he founded.

**Improvement of human, financial and knowledge mobility**

The cluster’s track record in mobility of knowledge is quite strong. Grenoble has such a concentration of know-how and industry that it has become a magnet to the best researchers and professionals all over the world, and you can find its scientists and engineers everywhere as well. Every year, some 6,000 students and 400 academics and researchers from abroad study or work in Grenoble-Isère.
Microelectronics clustering efforts in Grenoble

Have the clustering efforts been a driver for innovation in the microelectronics cluster in Grenoble?

Even with such a critical mass, Grenoble did not initially attract the early stage investors in as high a concentration as would be expected. But financially speaking, there has been a tremendous improvement following the institutional efforts. Grenoble has finally attracted the attention of French and international venture capitalists, leading to a better climate for start-up financing.
3. Successes and failures of the microelectronics clustering efforts in Grenoble

In defining the perimeter for the clustering effort

Geographically, Grenoble is an isolated "pot" surrounded by mountains. Pretty much everything in the area, including health and energy research and firms, end up linking to the microelectronics cluster and producing new opportunities. The main players making this possible are INPG, CEA and the industrial players. The "Université Joseph Fourier" (UJF) and the CNRS also play an important role.

This has led to fruitful cross-fertilisation that does not let the cluster become obsolete. It benefits the existing companies, and allows the creation of new ones in convergent or innovative fields. When the interaction does not come naturally, there is a public effort to extend the reach of microelectronics, like the efforts to incorporate microelectronics into "traditional" sectors like technical textiles or paper, and further help the companies launch innovative products.

In setting the strategies to build a sustainable competitive advantage

Advised by industry and through continuous benchmarking efforts, CEA is actively setting strategies that gather up the increasing capabilities, fostering new ones and converging them with future trends.

In managing the clustering efforts jointly

Grenoble is an example of coordinated efforts. Institutionally, from the chamber of commerce to the municipality, department and region together with universities and research centres join efforts to have the same "pitch", design effective support services and lobby together to obtain policies and funds from France and Europe.

In applying the learning to the whole economy

Grenoble is a very unique case of success that might be influenced by the sports and mountain spirit of its residents. The vision for the future, clustering efforts and institutional alignment seem to be quite unique and have not been reproduced in other clusters.
4. Learning from the Grenoble microelectronics clustering efforts

Implications for the local and regional support institutions

Since the early 1990s, the semiconductor industry in France has benefited from substantial investment and partnership programmes between industrial firms and publicly funded laboratories. This has fostered a network of expertise in France, centred on major players and laboratories such as ST Microelectronics, LETI, etc. Several international players have entered the picture, attracted by the availability of highly skilled labour and significant markets in telecoms, automotive and health sectors.

The R&D focus of these support strategies is highly significant, as exemplified by Minatec, a centre of public and private research on micro and nano technologies, and the Minalogic partnership, which has a portfolio of 50 collaborative research projects in a wide range of application fields.

In fact, Grenoble is an example of coordinated efforts. Institutionally, from the chamber of commerce to the municipality, department and region together with universities and re-search centres join efforts to have the same "pitch", design effective support services and lobby together to obtain policies and funds from France and Europe.

Implications for the national and EU institutions

Basically, the Grenoble microelectronics cluster is strong and coordinated enough to have had lobbied to obtain things rather than being a result of European specific sectoral or territorial policies.
5. Appendix I: The clustering efforts of the microelectronics industry in Grenoble

A - The microelectronics sector

The *electronics sector* had a turnover of 1,163 billion Euros in 2006 and it has been the fastest growth industrial sector over the last 10 years.

![Production per application sector](image)

![Production per region](image)

Figure 1 World electronics industries: € 1,198 billion, 2007 (Source: Decision Consult)

While for many years defence drove innovation in electronics, in the last years, the main trigger for innovation has been consumer applications and specially, mobile phones, with increasing functionality in an ever decreasing appliance size and demanding lower energy consumption.

The forecast is that the average annual growth from 2006 to 2011 will be a 6%, a bit lower than in the past decades. However, it will be more robust as multiple drivers stimulate the growth (Flat TV, laptop computers, medical equipment, portable media players, automotive) rather than a single killer application like mobile phones. Still though consumer electronics.

In this framework, the *microelectronics sector* is the branch of electronic technology devoted to the design and development of extremely small electronic devices that consume very little electric power. It is in the heart of many other industries, from consumer...
electronics to automotive or defence and aerospace. Semiconductor technology is the basis of today's microelectronics industry with the resulting impact on computer and communication technology.

The main products of microelectronics are Semiconductors, Integrated Circuits (IC) and Microsystems. Regarding semiconductors, with a total turnover of € 238,9 billion in 2006 the estimated breakdown is as follows:

![Semiconductor revenue by product, 2005 (Source: IC Knowledge)](image)

Although the production of microelectronics has progressively shifted to lower cost countries, the design still remains in Europe, especially for automotive, industry and telecommunications.

![Europe’s share in world markets and design, 2006](image)

During the past years, microelectronics has been converging with other technologies such as biotechnology, mechanics, etc. to expand applications further in such fields as health, environment or energy. Additionally, the developments in nanotechnologies, with a com-
completely different logic to that of microelectronics\(^3\) make it more difficult to predict both the technology roadmap and the further “killer applications”. This is why most of the players are start-ups.

<table>
<thead>
<tr>
<th>Microsystems</th>
<th>Millions of euro, 2000</th>
<th>Millions of euro, 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug delivery systems</td>
<td>10.8</td>
<td>257.2</td>
</tr>
<tr>
<td>MEMS optics</td>
<td>703.8</td>
<td>1 366.4</td>
</tr>
<tr>
<td>Laps-on-chips</td>
<td>541.4</td>
<td>1 929.1</td>
</tr>
<tr>
<td>Magneto-optical heads</td>
<td>433.1</td>
<td>522.5</td>
</tr>
<tr>
<td>RF MEMS</td>
<td>81.2</td>
<td>116.6</td>
</tr>
<tr>
<td>Micro motors</td>
<td>32.5</td>
<td>401.9</td>
</tr>
<tr>
<td>Inclinometers</td>
<td>70.4</td>
<td>60.3</td>
</tr>
<tr>
<td>Injection moulding device</td>
<td>27.1</td>
<td>33.0</td>
</tr>
<tr>
<td>Anti-collision systems</td>
<td>16.2</td>
<td>19.3</td>
</tr>
<tr>
<td>Electronic nose</td>
<td>4.3</td>
<td>4.8</td>
</tr>
<tr>
<td>Micro relay</td>
<td>20.6</td>
<td>20.9</td>
</tr>
</tbody>
</table>

Figure 4 Product launch value in microelectronics’ emergent markets, 2000 and 2005

Today, the microelectronics industry with a top-down approach is reaching its limits, as the so called Moore’s Law\(^4\) reaches both technological and economical barriers: on one hand, CMOS technology has driven down the size of the smallest feature in an integrated circuit (IC) from 10 to 0.25 microns, and on the other hand, the cost of semiconductor production facilities has been estimated to be around € 5 billion in 2010. See Figure 5.

<table>
<thead>
<tr>
<th>End of the line for Moore’s law?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits / Chip</td>
</tr>
<tr>
<td>Minimum feature size</td>
</tr>
<tr>
<td>Power dissipation (Watt)</td>
</tr>
<tr>
<td>Cost of a fabrication facility</td>
</tr>
</tbody>
</table>

Figure 5 The cost of semiconductor production facilities, 1995-2010

Thus, a new multidisciplinary paradigm is required, with major implications for diverse fields such as microelectronics, quantum physics or biology. During the last decade, the driving force in this evolution has unarguably been nanoelectronics.

\(^3\) In microelectronics, the main challenge is to reduce size (top-down), whereas in nanotechnology it is rather “bottom up”.

\(^4\) Moore’s Law estimates that the processing power of ICs double every 18 months.
B - The microelectronics industry cluster in Grenoble

The microelectronic pole in Rhone Alps is basically centred around Grenoble, by the Alps, home of the French Atomic Energy Commission (CEA), a key player in R&D&I in the fields of energy, defence, information technologies, communication and health. Ever since it was created in 1945, it has been addressing major scientific challenges in various fields, including the French nuclear power generation programme, nuclear deterrence, micro- and nanotechnologies, astrophysics, medical imaging, toxicology, biotechnologies, etc. The slump in the French defence budget resulted in an increased focus towards the private sector, enabling the region to benefit from research groups focused on application and a number of facilities.

France is well positioned in the microelectronics market with an output of 3,2 billion EUR and a managed production through cooperation with production facilities of 6,4 billion EUR, following the outsourcing trends.

![Figure 6 The French Microelectronics production](image-url)
Applications are quite well spread, mainly focused in communications during the past years and shifting focus today on industrial use. Design is still half of the output.

![Pie chart showing different applications in 2006](image)

**2006: 3.2 Mrd EUR**

**Figure 7 Share of different applications, 2006**

In fact, although there are other sites with microelectronics production in France, Grenoble is the leader without a doubt in number of companies, employees and patents. According to a study of published patents, three players based in Rhone Alps lead the research in this field in France: CEA, ST Microelectronics and Soitec.

The granularity of the clustering efforts is quite different from the size of a statistical cluster category or geographical NUTS-2 area used in the European Cluster Observatory, but it is interesting to attempt to link the Grenoble microelectronics clustering efforts to their corresponding statistical cluster category and geographical areas where they have taken place. See the following table.

<table>
<thead>
<tr>
<th>NUTS II Region</th>
<th>Cluster Category</th>
<th>Employees</th>
<th>Size</th>
<th>Specialisation</th>
<th>Focus</th>
<th>Stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhône-Alpes</td>
<td>Analytical instruments</td>
<td>7 782</td>
<td>1.46%</td>
<td>1.39</td>
<td>0.40%</td>
<td>1</td>
</tr>
<tr>
<td>Rhône-Alpes</td>
<td>IT</td>
<td>28 066</td>
<td>1.37%</td>
<td>1.3</td>
<td>1.46%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 8 Statistical employment analysis (Source: European Cluster Observatory)**

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5 A word of caution is necessary to avoid extracting any conclusions from this table, other than that the statistical analysis captures the existence of employment in that area and location, and that further study is necessary.
In 2006, in the big Grenoble area, there were some 24,700 jobs related directly to microelectronics and nanotechnology (MNT) (3,000 in research and 21,700 in companies). The closely related sectors like IT, gets the total amount reach 38,000 jobs. This base has allowed the development and attraction of companies in the entire microelectronics value chain, from design to clean rooms:

- Both sectors (MNT) account for some 500 companies including the leader ST Microelectronics, Freescale (Motorola) and NXP (Philips), but also several start-ups like Soitec as a successful flagship, designing and producing silicon on insulators.
- In terms of public research, the most outstanding actor is CEA with 115 laboratories on the main MNT topics, biotechnology, new energy technologies and nanomaterials. Furthermore, CEA Grenoble has laid the foundations for more than 30 start-ups.
- The LETI, a CEA centre focused on electronics and IT, hosts some 1,500 researchers, a third of them from partners and industry. For example, they applied for 153 patents only in 2003. Comparing it with other European labs LETI has the necessary critical mass and effective transformation of research into commercial value.
- There are many other relevant research and education facilities within CNRS, INP Grenoble, Joseph Fourier University, etc. as well as worldwide leading facilities and infrastructures. This is immersed in a very rich research environment of 21,000 researchers in several disciplines.

The Rhone Alps region, hence, has a European leadership position thanks to significant research capacity and industry as well as the important investments in infrastructure like the “Crolles 2 Alliance” with € 3,5 billion invested (in infrastructure and R&D), mainly private, and the access to state of the art facilities.

The most outstanding sector in terms of turnover and employment is components, especially due to the presence of ST Microelectronics. The components’ players are positioned in growth applications with high added value as telecommunications and industry, in spite of the absence of final manufacturers in the region.

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6 64 on silicium technologies, 48 in IS and 41 in optoelectronics
7 ST Microelectronics, NXP and Freescale
C - The challenges of the microelectronics industry

Grenoble is a European leader but small in scale when we compare it with other relevant centres in US and Asia. See Figure 9 below.

Figure 9 Critical mass of HR in the world (Source: ST Microelectronics)

Despite of the strong position of Rhone Alps both in the French and European scale, the actors face severe competition. Necessary investments to remain competitive are huge. See Figure 10.

Figure 10 R&D expenses’ evolution in the sector, Europe 1994-2002 (Source: Gixel)
D - The microelectronics clustering efforts in Grenoble

Since the beginning of the 1990s, the semiconductor industry in France has benefited from significant investments and partnership programmes between industrial companies and public laboratories which have enabled anchoring with international technology clusters.

The major developments are the following:

- In 1992, ST Microelectronics, the LETI-CEA and France Telecom R&D were associated to foster research and implement facilities for miniaturisation in electronics with the objective of obtaining 0.17 microns on 300 mm wafers. Other achievements are low energy consumption components with SOITEC, fluorescent microdot flat screens of LETI, etc.

- In 2002, Freescale (Motorola) joins NXP Semiconductors (Philips) and ST Microelectronics on the most important industrial investment (€ 3.5 billion) ever in France for Crolles II.

- Since 2002, the Innovation pole Minatec, initiative of the LETI-CEA and the Engineering University INPG Grenoble as a centre of public and private research on MNT that encompasses research, training, technology transfer and services to industry. The investment is around € 193 M, half of it from local authorities illustrating their long term commitment.

- Mid 2005, the formalisation of a cluster under the name Minalogic (See Figure 11 on page 15) under the national “pôle de compétitivité” programme. It coordinates and organizes a major innovation centre, pulling together specialist skills in the design, development and production of products and solutions for smart miniaturized services for industry. It is based on the essential combination of MNT and software, particularly for systems-on-chip (SoC). The Minalogic partnership has already a portfolio of 50 collaborative research projects in very different application fields that opens perspectives beyond CMOS.
Local support has been crucial to all these developments by facilitating and effectively providing services, land and finding support in broader institutions. In any case, the brain behind the developments has often been the CEA in alliance with industry which has resulted in very effective economic results and utilisation of the research facilities.

**E - Present situation**

The Grenoble approach has created a coherent network of expertise in France, based around large players and laboratories such as STMicroelectronics, CEA LETI, etc. Several international players have entered the picture, benefiting from the presence of strong skills and significant markets (telecommunications - automotive - health).

Staying multidisciplinary is crucial for the success of the region.
6. Bibliography

www.clusterobservatory.eu

www.grenoble-isere.com

www.invest-in-france.org

www.minalogic.com