

The dynamics of industrial emergence : **Insights from ink jet printing technology**

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ABSTRACT

What dynamics underpin industrial emergence? This question provides the motivation for this paper.

Some suggest that submarkets are regularly more profitably developed by owner-managed SMEs than big firms leading employees to start their own venture. Others argue that the impetus for spinning off is given by organizational constraints or difficulties faced by incumbents and their unwillingness to develop new organizational capabilities. Others suggest that employee learning theories also explain why technological companies are giving birth to spin offs.

The role of initial conditions is preliminarily précised.

In this paper, we concentrate on the commercial ink jet printing industry in the vicinity of Valence, France, to explore the true emergence and early development of a local knowledge-based (high tech) cluster .

There is a significant element in the emergence of the industrial ink jet sector in France: The group of IJP firms formed organically after spinning off from the same parent or its descendants. The common origin of all these new ventures enabled to survey the emergence of an industrial cluster through the evolution of a group of spinoffs from the same anchor.

Keywords: Cluster dynamics; Spinoffs; Genealogical / Ecological processes; Ink jet.

INTRODUCTION

On the basis of the French ink jet cluster analysis, we explore the dynamics underpinning industrial emergence through the genealogical process of firms spinning off from the same parent. The examination of “arising novel and coherent structures, patterns and properties driving the process of self-organization in complex systems” (Goldstein, 1999, p. 49) is only recently galvanizing the search for more data. This blooming interest is particularly highlighted in the analysis of activities supported by companies making up local high tech clusters. Such works reveal that improved understanding of the processes underpinning the development of local clusters and constituent firms (Braunerhjelm and Feldman, 2006; Menzel and Fornhal, 2007) can help gain a better picture of industrial emergence as a whole. We define a cluster as a geographical concentration of firms that have horizontal (ecological) and/or vertical (genealogical) relations (Garnsey, 2009).

Numbers of features have been identified in the theory to explain emergence, such as: Supply and demand interaction, industrial cycles, reduction of uncertainty. But most of those findings are relating to maturing or mature industries (Afuah and Tucci, 2003), not emergent ones.

It is then useful to explore further the role and conditions of entrepreneurial agency in the creation process of new industrial sectors emerging from technological disruptions.

As such, the French industrial ink jet cluster was identified as an appropriate field of investigation.

Three additional reasons were supporting this choice:

First, because through this cluster we can analyze the entire evolution of industrial ink jet printing from the mid-1970s up to now. The cluster is indeed covering the 40 years of ink jet history. With the story of the main actor in this cluster, Imaje S.A., covering itself 30 years of this period (1982 – 2012). The data are thus a complete census and not a mere statistical sample.

Second, as the French ink jet cluster gave birth to numerous companies from the same parent, this was revealing an homogeneous and well-defined sample for a survey on the dynamics underpinning spinoffs performance

Third, several articles have already be written on the Cambridge commercial ink jet cluster (Gransey, 2009; Ford, 2011) giving a basis for comparison.

We investigate the theme of dynamics underpinning industrial emergence through the study of a new technology, the French ink jet cluster, and also referring to the other European industrial ink jet cluster in England (Cambridge). It begins with a literature review and the research process conducted, before giving an evolutionary account of the industrial French cluster. This brief history is also showing the bonds between the two European clusters. Finally we analyze the dynamics of emergence through a discussion based on considering the initial conditions of the system, and then from three different theories explaining spin offs: Entrepreneurial Agency, Organizational Capabilities and Learning Theories.

LITERATURE REVIEW

This work builds up on numerous studies of high-tech and high-growth startups. In addition to these studies, relying upon interviews and archival sources, the theory of disruption first developed by Christensen (1993) also gives very interesting and useful insights on the performance of innovative startups. The work of Christensen chronicles the whole history of the disk drive industry up to 1989. He then explained (2006) the difference between considering an innovative technology versus a disruptive business model. A consideration bringing a new light to the very understanding of the performance concept. Another set of studies, that were particularly informative, were focusing on high-tech spinoffs.

Databases on high-tech spinoffs were thoroughly investigated by Brittain and Freeman (1986), Franco and Filson (2000) and Klepper and Sleeper (2000). Klepper reviewed the content and conclusions of these studies in a synthetic paper (2001). The data are covering spinoffs from the Silicon Valley semiconductor producers in 1955-1981, US commercial rigid disk drive producers in 1977-1997, and US commercial laser producers in 1961- 1994. Information on the anchor firms and their spinoffs was collected through business directories, trade sources and genealogical trees.

The information from all these studies is supplemented by 2 sets of studies covering the 2 industrial inkjet clusters in Europe:

- The English cluster surveyed by Ford et al. (2011) and Garnsey (2009).
- The French industrial inkjet cluster in the Rhone-Alps region that we studied as described below.

RESEARCH PROCESS

In the case of the Cambridgeshire Cluster, we have considered all the companies selected by Ford (see bibliography and below) in its various surveys.

In the case of the French cluster, no previous data was available. We had then to build the entire panel by ourselves.

Thus, between June 2011 and October 2012, more than 20 spinoffs from the same parent were identified and then contacted using available previous knowledge of the micro-fluidics sector and snowball sampling.

Early stage: Most of the companies were identified. At first, using our general available knowledge of this industrial field, we have selected a series of people involved in the micro-fluidics cluster for a long time. These people have helped to make a list (Appendix 1) of companies having spun off from the same anchor : Imaje S.A. corp. This was covering the period 1982 – 2012. It happened that this list is probably exhaustive. More than 20 companies having spun off from the same parent (Imaje S.A.) in France have been thus identified. All

the companies listed were considered as active in micro-fluidics. And we did consider only companies existing in 2012.

Then, the research process developed along 5 different steps:

Step 1 a selection of 12 spinoffs occurred According to the purpose of the present research, among the initial 20 plus spinoffs, only 12 companies were selected for the final sample.

Step 2 : interviews. The scale of priority previously defined led to various types of interviews.

Step 3: The results were gathered, organized and analyzed.. And findings led to write a new version of history of industrial inkjet development.

This new version was submitted to comments from experts.

Step 4 : 3 experts (see. Table 1) were involved in the research process to validate internally the findings .These experts have a broad as well as in-depth knowledge of the micro-fluidics technology .Each of them has more than 20 years of experience in ink jet .

And they know a complete version of industrial ink jet technology's history.

Experts	# years of experience in micro-fluidics	Position	Main exposure Science vs Markets
1	➤ 20 years	General manager of inkjet companies in various contexts.	Markets
2	➤ 30 years	Scientific Head for micro-fluidics in a multinational cy.	Science and Markets
3	➤ 30 years	Dean at university level (specialty: micro-fluidics).	Science

Table 1

These experts, all well aware of the evolution of the French cluster in Valence, were chosen among 7 potential experts initially identified. They were more intimately matching the needs of this research because they were in part complementary and in part redundant.

They were complementary in the way that their main exposure to science or markets was diverse. They were redundant because 100 % of their long professional experience was coming from micro-fluidics . The wish to have comments and feed-back from several experts was attached to the importance of using multiple source of evidence from multiple experts .A research process enabling cross-comparison on patterns, visions and facts.

A methods also leading to the triangulation of some pieces of information peculiarly sensitive and conclusive.

Step 5 A new version of history. The comments of the experts are confronted and combined on the basis of a Delphi approach.General conclusions are drawn. All along the research process, and in addition, the French industrial inkjet cluster is described through a case-study.

A BRIEF HISTORY OF INDUSTRIAL INKJET IN FRANCE

The global IJP industry, encompassing office and home printers on one side, commercial applications on another side, emerged in the 1970s. On the basis of a Standford's patent, the very first firm to develop the CIJ technology was the printing firm A.B. Dick corp. in Chicago (Il.). A.B.Dick was well known latterly, in the coding industry, under the name of Videojet. Almost in parallel, a Mr. Paton declared in Cambridge (England) another patent, very near from the initial one. Thus started the English cluster.

A couple of years later, in the late 1970s, in France, Thomson group was working with 2 teams of engineers from its subsidiary HBS on 2 projects to develop a Fax system. One team was based in Paris and the other one in Valence. These projects were the basis of an offering for the French public postal service. Given that the French postal service had, at that time, a monopoly for this kind of communications.

Two technologies were competing inside Thomson to finalize technically the projects : Dot Matrix (Thermal printing) and Ink Jet. The ink jet solution was the one chosen by the HBS team in Valence .To perform the development, HBS subcontracted almost the whole ink jet project to the technology consultancy Cambridge Consultants Ltd (CCL) in the UK. For the later had developed a competence in ink jet thanks to a previous project called ICI.It is to be noticed that the CCL team gathered several future promoters of the ink jet technology: Mike Kealing (subsequently funder of Linx Ltd), Ellen Pullen, members of the Xaar funding team, ...Not to mention Graeme Minto who founded Domino Printing Sciences in 1978: An independent start up which was the first one to concentrate on industrial ink jet technology in Europe. Graeme Minto was, at the beginning of the Fax project for Thomson group, project manager by CCL.

The final choice of Thomson-HBS was to go for the thermal solution. .The ink jet project is thus stopped within HBS. But this decision will lead to the birth of one of the major players in the industrial ink jet worldwide : Imaje S.A.; and as a consequence, the development of a cluster around the ink jet technology in the Rhone-Alps region (See Figure 2).

Indeed, still by HBS, the project leader of the ink jet solution, Jean-Claude Millet, is planning to spin off from Thomson accompanied by Luc Regnault who had worked on the thermal printer. Well aware of the potential of ink jet for the coding and marking applications, they are launching in 1981 a project of a new venture. Imaje S.A. is thus officially registered in 1982.It is to be noticed, that Imaje first started as a distributor of Domino! And when Imaje first exhibited, it was to demonstrate Domino printers. So we can see that, from the very beginning, the history of the 2 ink jet clusters in Europe –the one in Cambridge, and the one in Valence – are intertwined. First with the survey ordered to CCL by Thomson-HBS. Then with the distribution of Domino printers by Imaje. This set of information is new to history. And no genealogical (Garnsey, 2000) , nor ecological (Ford, 2010) link was previously made between the 2 European clusters. Very fast, though, Imaje ceased to act as a distributor of Domino products. What enabled the development of Imaje as an autonomous brand and manufacturer. But that can also explain a kind of sustaining animosity from the people at CCL and Domino as far as Imaje is concerned. Early cooperation transformed into competition between the 2 emerging clusters.

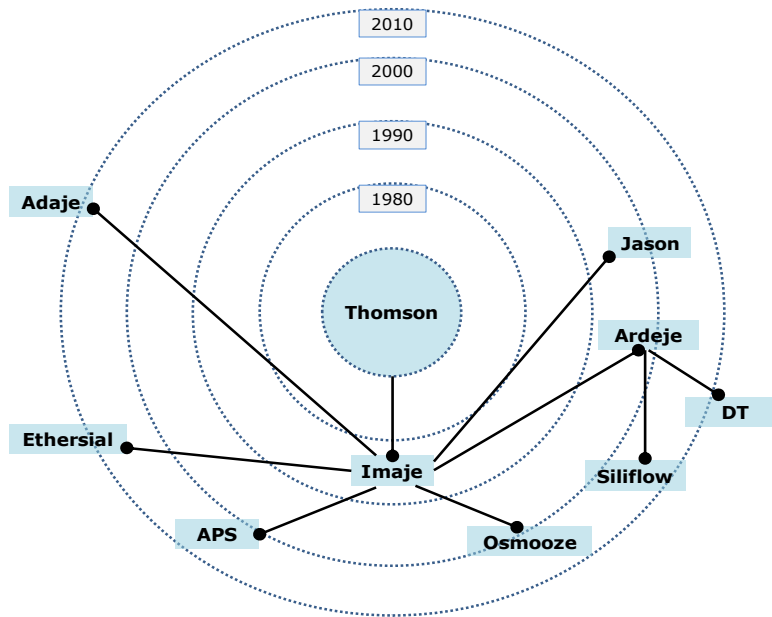


Figure 2: Lineage of Ink Jet Companies near Valence.

DISCUSSION

Whereas the empirical and theoretical literature about spinoffs is abundant on the reasons underlying their founding and the key role of employee learning in their formation, very little is known about how spinoffs evolve after their launching: Do they replicate the activity of their parent ? Do they accept or seek support from the anchor company? Do they expand and how? Do they build active technological collaborations and common projects? All these questions have direct or indirect consequences on the growth rate and success of spinouts.

This study intends, in the following sections, to explore dynamics underpinning emergence and growth in ink jet industrial clusters. The core of our findings relates to the in-depth survey conducted over the last 5 years on the industrial ink jet cluster in France. But the scope of the study is also considering previous work elaborated on the other European inkjet cluster in the Cambridgeshire. Number of determinants of dynamics underpinning true emergence are also featured through various theories proposing models of spinoffs: collaborations, employee learning, entrepreneurial agency, frustration of founders, initial system conditions, uncertainty reduction and technology valuation. This account is considering two theoretical perspectives exclusively: initial system conditions and entrepreneurial agency. For the purpose of the narrative is to illustrate the early evolution and choices of the firms in the cluster studied: What was the opportunity identified at origin (if any)? Did this original target evolved and how?

That is why we first establish a picture of the ecosystem through the description of the initial conditions in the cluster.

Then, three dynamics relating to entrepreneurial agency theories are explored.

INITIAL SYSTEM CONDITIONS

Evolutionary theory accounts how variety is generated in socio-economic systems (Nelson and Winter, 1975). We know that the apparition of new activities, technologies and companies are the result of an underlying process of *creative destruction* (Schumpeter, 1928). We also know that one can analyze these evolutions as a recombination of resources. Resources understood not in the sole sense given by Penrose (1959) as “*labour and staff*”, but also as a body of “social resources” opening the window for the understanding of the specific role of networks in industrial dynamics.

Thus, considering models describing these “dynamic capabilities”, it appears that industrial clusters are offering relevant fields of research to analyze emergence. For, even if a ‘cluster’ is not associated with a unique definition (Teräs, 2008), clusters are generally considered as small, special kind of networks or nets (the relation between networks and clusters is discussed by Hakansson and Waluszewski, 2007). Furthermore, clusters can be pictured as geographically proximate groups of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities (Porter, 1998). This is specifically the case of the group of companies from the same parent shaping the industrial ink jet cluster in France. Location: In the vicinity from the same anchor.

During the last 30 years, from 1982 to 2012, this cluster emerged then grew, nurturing a very rich and complex ecosystem. An ecosystem consisting of a dozen of different companies, making billions of turnover each year, employing thousands of people and deploying several branches of the generic ink jet technology. All this, within half an hour driving distance from the center of the same relatively small city (less than 100 000 inhabitants for Valence and its neighborhood).

The most significant in the context of the French ink jet cluster is that all the companies belonging to this group were spun out from one sole parent: Imaje S.A. Contradictorily to what happened in the other European ink jet cluster in Cambridge, most of the spin outs from Imaje did not have the support of their parent company. Except in the case of Adaje, all the other spinoffs were “offensive”, not “planned” (Dick, 1997) and not related to any help or support from their parent. Parental involvement refers to heritage theories and suggests by analogy that both the parent company and the new venture are interested in the successful development of the spinout.

The lack of involvement from the parent in the case of the French ink jet cluster could be related to the nature of the anchor company: Imaje was in a sense a pure industrial player focusing on its own technological choices and focusing its investments and resources spending on the most promising applications in terms of ROI. Whereas, the project-based nature of the CCL consultancy business in the case of the British cluster, led to foresee a continuous process of new technologies incubation and spin out of new ventures.

The location in the Rhone-Alps region has also been important in the emergence and growth of the cluster, as the startups had access to competencies and appropriate infrastructure. Along with the two other industrial ink jet centers, namely Chicago and the Cambridgeshire, Rhone-Alps is a high-tech region with established and extensive networks of actors and resources at disposal of innovative projects. In this framework, the vicinity of university facilities dedicated to engineering and specifically micro-fluidics was an obvious plus for the

strengthening of the ink jet companies. Besides, the access to a reservoir of skilled employees, generated by the cluster itself, constituted a prominent advantage of the location.

Relationship with parent: Jason, Adaje, Osmooze, Ethersial, Ardeje and others are companies spun out from the same parent: Imaje S.A. The emergence and creation of the industrial ink jet cluster in France shows a high number of entrepreneurial initiatives. Beyond the names of structured companies that are mentioned in this narrative, number of other ventures were seeded but remained individual spin off initiatives. These creations were nevertheless very useful to the overall development of the ink jet ecosystem locally, by nurturing the network of available advanced skills for any company within the cluster. One among the many cases illustrating the previous proposition is the one of JL Laval that launched an individual company (Codesys) specialized in software for automatic identification (ink jet). J.L. Laval was formerly head of a department inside Imaje , and providing tailor-made solutions for ink jet customers. His new structure was also regularly subcontracting for the parent company and former employer. This tends to comfort the theory (Klepper, 2000) marrying the concepts of reproduction and inheritance with the evolutionary modeling of organizations pioneered by Nelson and Winter (1982).

The evidence gathered in all the studies screened by Klepper suggests the importance of spinoffs exploiting skills their founders acquired in their prior employment (Klepper, 2000, p. 640). It also underlines that founders of spinoffs have been frustrated with their prior employer's unwillingness to pursue ideas they perceived to be promising. As spinoffs developed innovations their parents do not want to pursue, parents are supposed not to initially perceive spinoffs as a competitive threat. This proposal is illustrated in the case of European ink jet clusters by what happened in Cambridge: The anchor company CCI never considered its spinoffs like competitors. But it is mostly due , in this case, to the nature of the parent: CCL, as a consulting group had indeed developed from the late 1960s to the mid 2000s a positive experience and a culture of spinning out new ventures (see Figure 3). Furthermore, this was, executed on a collaborative basis, the parent company supporting most of the projects from the beginning (Domino, Elmjet, Xaar A sign of this support being the official partnerships established at IP level.

Entrepreneurial initiatives were thus promoted in the British cluster. It was not the case as far as the French cluster is concerned .Indeed, Imaje, behaving as a traditional industrial firm, feared to generate competitors on variants of its products.

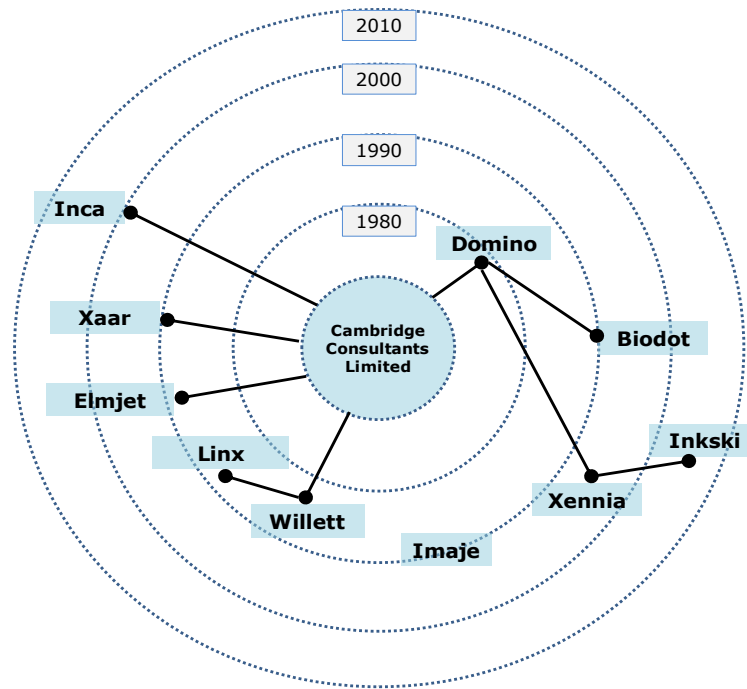


Figure 3: Lineage of ink jet firms in the Cambridgeshire.

ENTREPRENEURIAL AGENCY

In the following section three dynamics relating to entrepreneurial agency theories are explored: The first explains how spinoffs benefit from lower structure costs (Bankman and Gilson, 1999). The second approach reviewed is considering parental organizational limitations favoring spinoffs (Tushman and Anderson, 1986). In the last perspective, we analyze the bond between spinoffs and employee learning in the framework of the ink jet cluster.

AGENCY COSTS

In some circumstances, a discovery can be more profitably developed by a firm started by an employee than by the future parent company. When an employee makes a valuable discovery, he can develop it in the framework of his or her contract with the employer. Or the discovery can give an impetus for spinning off. Several works are theorizing on these topics, such as Wiggins (1995) or Bankman and Gilson (1999). Wiggins suggests that certain kinds of innovations are more likely to be developed by spinoffs, namely innovations taking a long time to become mature enough to be marketed. He refers to innovations opening new submarkets within the industry and path-breaking ones. Because, in this case, and given the long, uncertain and capital-intensive investment of the employer, the employee can expect less personal benefit from his work. In the ink jet cluster, none of the spinoffs surveyed is corresponding to this case.

But if we consider Anton and Yao (1995) entrepreneurial agency theory, the vision is different. They confirm that spinning off is related to particular kinds of innovations. But they

define these innovations as not requiring distinctive complementary assets. In the ink jet cluster, two spinoffs are using the same technology and same general assets as the parent: Adaje and APS. Adaje did not really innovate. They are exploiting a field of application for the technology that the parent did not want to pursue. They are mainly covering the postal markets and the addressing market using CIJ for this purpose. On their side, at origin, APS was mostly duplicating the parent company's activity.

It is though interesting to notice that in both cases, the parent was not willing to occupy the positioning of the spinoffs because of its cost structure. So, by a different route, we reach the same conclusion than Anton and Yao on the topic: Projects highly related to parent's core activity are more likely to lead to spinoffs.

ORGANIZATIONAL CAPABILITIES

From Cooper (1985, p.79) we know that organizations undergoing crises have higher rates of spinoffs. In parallel, Tushman and Anderson (1986), then Christensen (1993), have featured how incumbent leaders can have difficulties to adapt to technological and market evolutions. Eventually, Christensen (2006), proposed that difficulties for incumbents were mostly linked to business model disruption and not only to technological radical changes. So the dynamics behind spinoffs creation can come from the constraints and evolutions affecting the business model of the parent company. Disruptions in business models would favor the creation of spinoffs.

For Tushman and Anderson explain that "competence-destroying" innovations require competencies not possessed by established firms. Facing difficulties, these companies are focusing on their core business and avoid to invest in projects they consider ambiguous because not adapted to their current business model.

At the same time, employees of incumbent firms are well positioned (Garvin, 1983) to learn about new emergent submarkets associated to dominant business models changes.

Organizational difficulties faced by incumbents then lead to generate new firms started by individual employees. As the later see distinctive opportunities in emerging submarkets. Organizational capability theories suggest that founders of spinoffs will have been frustrated with their prior's employer unwillingness to pursue ideas and/or innovations they perceive to be promising.

In the French ink jet cluster, several companies started because of projects abandoned by the parent company Imaje. Embleme and Impuls were created after the first serious difficulties faced by Imaje in its history, in 1992. For Ethersial, the decision to create a venture occurred when Imaje decided to stop abruptly a 5 years project in 2003.

Imaje itself, the parent of the cluster as a whole, had become a spinoff of the juggernaut Thomson group when Thomson decided to stop the ink jet postal project in 1981

LEARNING THEORY

Franco and Wilson (2000) have featured that the better a firm's knowledge, then the lower the wage R&D employees will accept to work for the firm because of the greater prospects of starting their own firm. Employee learning theories envision spinoffs either as overall

competitors of their parents or competitors for one of their parents' activities. Consequently, entrepreneurs duplicating the strategy or part of the strategy of the parent do not want the parent to be involved at all in their venture. They will take distance from the anchor company in terms of projects, in terms of people and in terms of contacts.

The survey of the French ink jet cluster confirms these conjectures. Four among the five direct spin offs from Imaje S.A. in the ultimate sample analyzed (Figure 2 above) have no relationship with the parent company. The managers of these startups indicate that they did not tried to develop projects with the parent company (and vice-versa). They also precise that they have even no official contact at all with their previous employer. This is really surprising when one considers that these firms are located sometimes very near from their parent. Less than a mile!

People from the various companies in the cluster just have personal contacts with employees, sometimes senior executives, by the parent. That leads to a sort of informal network between people of all kinds : technicians, salespeople...Extended to all the employees of the ink jet cluster, this network creates a reservoir of ideas, frustrations, competences and knowledge. This part of the local ecosystems provides skilled manpower, information and spinoffs opportunities reinforcing the specialization of the industrial network in the vicinity of Valence.

Another side of the learning theory (Klepper and Sleeper, 2000), shows that the richer a firm's know-how associated with a product variant, the lower the requirements for employees to start profitably a spinoff and thus the greater the number of spinoffs from the firm producing a related product variant. This in addition to the idea that in regions with more firms in the same industry, the spinoff rate will be higher because of the higher number of knowledgeable employees available to aggregate in startups (Garvin, 1983, p. 8; Copper, 1985, p. 78).The two reasons before could explain the considerable number of ink jet spinoffs (more than 20) that Imaje S.A. spawn in thirty years (1982 -2012).

CONCLUSION

By investigating the emergence of a new industry from the ink jet technology, this paper establishes that self-organizing processes were grounding this emergence. No pre-defined purpose of creating a new industrial cluster operated, but actors were individually aiming "at matching the technical possibilities and the market" (Freeman and Soete, 1997, p. 200) by starting new ventures. Founders of these startups are most of the time not supported by the parent company neither financially nor technically. They benefit from the previously acquired. knowledge, routines, experience and network . But they generally keep few or no official contacts with the parent company. This brings new insights on the role of collaborations in industrial emergence and the development of clusters.

Beyond the relationship with parent, the evolutionary account of the spinoffs from the French ink jet cluster in the Rhone-Alps region reveals the importance of valuable opportunities enabling an employee of an innovative incumbent to envision a potential profitable submarket. The survey is eventually pointing out factors of dynamics favoring spinoffs extending the growing literature on dynamic capabilities by elaborating the link between entrepreneurial agency and parent company's organizational limits.

BIBLIOGRAPHY

- Afuah, A. and Tucci, C.L. (2003) *A Model of the Internet as Creative Destroyer*, IEEE Transactions on Engineering Management, 50(4), 395-402.
- Arthur, W.B. (1994) *Increasing Returns and Path Dependency in the Economy*. Michigan: Michigan University Press.
- Ansoff, H.I. (1984) *Implanting Strategic Management*, Prentice Hall International.
- Bhidé, A. (1994) *How Entrepreneurs Craft Strategies That Work*, Harvard Business Review, 72(2), 150-161.
- Braunerhjelm, P. and Feldman, M. (2006) *Cluster Genesis. Technology-Based Industrial Development*. Oxford: Oxford University Press.
- Breschi, S. and Malerba, F. (eds) *Clusters, Networks, and Innovation*. Oxford: Oxford University Press. pp. 411-432.
- Chesbrough, H. (2003) *Open innovation: the new imperative for creating and profiting from technology*, Harvard Business School Press, Boston.
- Cilliers, P. (1998) *Complexity and Postmodernism: Understanding Complex Systems*, London: Taylor & Francis.
- Clymer, N. and Asaba, S. (2008) A new approach for understanding dominant design: The case of the ink-jet printer. *Journal of Engineering Technology Management* 25: 137-156.
- Cooper, R.G. (2001) *Winning at new products – accelerating the process from idea to launch*, 3rd Ed., Basic Books, New York.
- Dosi, G. (1997) *Opportunities, incentives and the collective patterns of technological change*, The Economic Journal, 107(444), 1530-1547.
- Ford, S.J., Routley, M.J. and Phaal, R. (2010) *The dynamics of industrial emergence*, PICMET '10 Conference, 18-22 July 2010, Phuket, Thailand.
- Freeman, C. and Soete, L. (1997) *The economics of industrial innovation*, London: Pinter.
- Gawer, A. and Cusumano, M. (2002) *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*, Boston, MA: Harvard Business School Press.
- Garnsey E., Ferriani S. and Lorenzoni G. (2008) Speciation through entrepreneurial spin-off: The Acorn-ARM story, *Research Policy* 37: 210- 224.
- Garnsey, E. and Minshall, T. (2000) Ink Jet Printing and Domino Printing Sciences, Case Profile, Centre for Technology Management, Institute for Manufacturing, University of Cambridge.
- Glaeser, E.L. (2005) Reinventing Boston: 1630–2003 *Journal of Economic Geography* 5: 119-153.
- Hagedoorn, J. (1989) *The Dynamics Analysis of Innovation and Diffusion: A Study in Process Control*, London: Pinter Publishers.
- Hourd, P.C. and Williams, D.J. (2008) *Results from an exploratory study to identify the factors that contribute to success for UK medical device small- and medium-sized enterprises*, Proceedings IMechE, 22(H), 717-735.
- Kaplan, S. Tripsas, M. (2008) *Thinking about technology: Applying a cognitive lens to technical change*, Research Policy, 37, 790-805.
- Klepper, S. (1997) Industry Life Cycles. *Industrial and Corporate Change* 6(1): 145-181.
- Klepper, S. (2007) Disagreements, Spinoffs, and the Evolution of Detroit as the Capital of the U.S. Automobile Industry. *Management Science* 53: 616-631.
- Lawson, C. (1999) Towards a competence theory of the region. *Cambridge Journal of Economics*, 23: 151-166

- Kotler (1991) *Marketing management: Analysis, planning, implementation, and control*, Prentice-Hall, Englewood Cliffs, N.J.
- Macdonald, R.J. (1985) *Strategic Alternatives in Emerging Industries*, Journal of Innovation Production Management, 3, 158-169.
- Macdonald, R.J. and Jinlang, W. (1994) *Time, timeliness of innovation, and the emergence of industries*, Technovation, 14(1), 37-53.
- Malerba, F. (2007) *Innovation and the dynamics and evolution of industries: Progress and challenges*, International Journal of Industrial Organization, 25, 675-699.
- March, J.G. (1994) *The evolution of evolution*, Evolutionary Dynamics of Organizations, Baum, J. and Singh, J., eds., Oxford: Oxford University Press, pp. 39-52.
- Meijer, I. S.M. Hekkert, M. P. Koppenjan, J. F.M. (2007) *How perceived uncertainties influence transitions; the case of micro-CHP in the Netherlands*, Technological Forecasting & Social Change, 74(4), 519-537
- Menzel, M.-P. and Fornahl, D. (2007) Cluster Life Cycles - Dimensions and Rationales of Cluster Development. Jena Economic Research Paper No. 2007-076.
- Metcalf, J.S. (1998) *Evolutionary Economics and Creative Destruction*, London: Routledge.
- Nelson, R.R. and Winter, S.G. (1975) *Growth Theory from an Evolutionary Perspective: The Differential Productivity Puzzle*, American Economic Review, 65(2), 338-344.
- Nemet, G.F. (2009) *Demand-pull, technology-push, and government-led incentives for nonincremental technical change*, Research Policy, 38, 700-709.
- Penrose, E.T. (1959) *The theory of the growth of the firm* (3rd edition 1995). Oxford University Press: Oxford.
- Phaal, R., O'Sullivan, E., Routley, M., Ford, S. and Probert, D. (2011) *A framework for mapping industrial emergence*, Technology Forecasting & Social Change, 78, 217-230.
- Porter, M.E. (1985) *Competitive Advantage*, New York: Free Press.
- Rip, A. (1995) *Introduction of New Technology Making Use of Recent Insights from Sociology and Economics of technology*, Technology Analysis and Strategic Management, 17(4), 417-431.
- Robinson, D.K.R. and Propp, T. (2008) *Multi-path mapping for alignment strategies in emerging science and technologies*, Technological Forecasting and Social Change, 75, 517-538.
- Schumpeter, J.A. (1934) *The theory of economic development*. Cambridge, Mass: Harvard University Press.

APPENDIX

Appendix 1

Names of SPINOFFS from IMAJE S.A. in the French ink jet cluster.

Company	Location
APS	Valence (France)
Jason	Valence (France)
Ardeje	Valence (France)
Adaje	Valence (France)
Timis	Valence (France)
Marquage Product	Valence (France)
Codeco	Valence (France)
AOMS	Not based near Valence
Osmooze	Valence (France)
Dracula Tech.	Valence (France)
Ciamtech (Tiflex)	Valence (France)
Teampack (APS)	Valence (France)
Amici	Valence (France)
Impuls	Valence (France)
Ethersial	Valence (France)
Emblème	Valence (France)
Impika	Not based near Valence (Aubagne)
Siliflow	Valence (France)
Codesys	Valence (France)

Appendix 2 :

List of Interviewees

No	Institution / Expert	No. of people	Informant quality
<i>French Ink Jet Cluster</i>			
1	IMAJE S.A.	2	One Founder and The Research Manager
2	APS	2	One Founder and a Subsidiary Manager
3	Ethersial	1	Founder
4	Ardeje	2	Founders
5	Jason	1	Founder
6	Adaje	1	Founder
7	Timis	1	Founder
8	Siliflow	1	Technical Manager
9	DT	1	Founder
10	Osmooze	1	Managing Director

Total number of people interviewed

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