8. 'Reassembling the social' in entrepreneurial innovation and academic entrepreneurship studies: the 'amphibious scientist' phenomenon

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8.1 INTRODUCTION

The aim of this chapter is to 'translate' the research strategy of the Actor-Network Theory (ANT) in Management and Organization Studies (MOS), with reference to research on Academic Entrepreneurship.

The concept of 'amphibious scientist', recalled in the title, was introduced in a research program on the emergence of markets and organizations from a sociological perspective. Padgett and Powell (2012) have investigated the development of biotechnologies, the operation of laboratories dedicated to life sciences and the role of venture capitalists (VCs) in front of the possibilities offered by the new technologies of genetic manipulation developed in the academic field. In particular, Powell and colleagues (Powell and Owen-Smith 2012; Powell and Sandholtz 2012a; Powell et al. 2012) analyzed the first generation of dedicated biotech firms (DBFs): these companies were founded by an amphibious scientist 'who carried scientific practices into the world of commerce', creating, as a result, 'a science-based firm, which was the product of overlapping networks of science, finance, and commerce' (Padgett and Powell 2012, p. 73).

Reassembling the Social: An Introduction of Actor-Network-Theory is the title of Latour's (2005) book: the ANT takes into account the social, political and technical dimension of sciences and technology not as indistinct spheres, but as mutually constitutive processes, taking place in 'socio-technical networks' (Jensen 2010). The emergence of the amphibious scientist phenomenon allows for the investigation of the entrepreneurial innovation as a process in which actors and contexts are co-created, while entrepreneurial processes are an 'ongoing process involving embedded actors who contextualize innovation through performative efforts' (Garud et al. 2014). In terms of academic entrepreneurship, therefore, the amphibious scientist is an 'actor-network', a collective actor where 'human and non-human materials' (social components, organized practices and artifacts) are 'assembled' and stabilized as a result of their field of relations (scientific, business and financial relations) (Padgett and Powell 2012).

The work is developed as follows: The theoretical context problematizes the literature on entrepreneurial innovation and academic entrepreneurship. The empirical context and the method section describe the combination between the first DBF and the creation of the Applied Genomics Institute (IGA) and the IGA-Technology Services (IGA-Tech). The emergence of the amphibious scientist phenomenon as an 'actor-network' characterizes the results and discussion in terms of the stages of the translation process and the narrative dimensions of entrepreneurial innovation.

8.2 THEORETICAL CONTEXT

The research deals with 'translating' the ANT (Callon 1986, 1998; Law 1986, 1991, 2009; Latour 1987, 2005), as part of the research on academic entrepreneurship. With a view to a critical investigation (Alvesson et al. 2009), proposing a new vocabulary and emphasizing the emergence of specific phenomena in other conceptual apparatus, we pay attention to: (i) the materiality of entrepreneurial processes; (ii) the role played by the practice knowledge in these processes; (iii) by connecting entrepreneurial innovation in life sciences to academic entrepreneurship.

From an ANT perspective, actors and structures acquire form and features through their relationships with other entities through the process of emergence (Latour 1987). In the case of the academic entrepreneur as an 'actor-network' (Callon 1986; Law 1986; Latour 1987), the phenomenon can be traced back to a process in which 'human and non-human materials' (social components, organized practices and artifacts) are 'assembled' and stabilized as an effect of the field of relations in which the academic entrepreneur is embedded. In different research traditions of MOS (Czarniawska 2005), actors develop interactions that 'stabilize' in structures, which in turn act as constraints to the following interactions. But if the focus shifts on 'networks of action', you may think that these networks produce both identity ('actors') and institutions ('structures'), questioning: (i) both the traditional hierarchy between the 'levels of analysis' (micro vs. macro); (ii) and in ontological terms and units of analysis, the customary 'individual', 'group', 'organization', and 'society' labels. The problem of the relationship between structure and agent resolves, or rather 'dissolves', in the priority given 'to actions that, when repeated, produce and reproduce themselves, the individual identities and institutions of a given field' (Czarniawska 1997).

Entrepreneurial innovation. The literature on entrepreneurial innovation, between the role of actors and the contexts, identify a complementary path within the research program that includes this work (see Chapter 1, Lauto, Pittino and Visintin).

In their research note, Shane and Venkataraman (2000) synthesized three main questions related to the phenomenon of entrepreneurship: why, when, and how (1) 'opportunities for the creation of goods and services come into existence'; (2) 'some people and not others discover and exploit these opportunities'; (3) 'different modes of action are used to exploit entrepreneurial opportunities' (p. 218). In the following passages, the authors questioned arguments on entrepreneurship and on those research streams that traditionally investigated this phenomenon. First, 'entrepreneurial behavior is transitory' and entrepreneurial behavior differentiates in time and space. Second, existing individuals and organizations can take advantage of opportunities or exploit those opportunities by creating new organizations. Furthermore, the proposed framework takes into account the 'sociological and economic work in which researchers have examined the population-level factors that influence firm creation' in a complementary way (p. 219).

Therefore, based on the suggestions by Shane and Venkataraman (2000) and the subsequent developments of the literature (Sarasvathy 2001a; Sarasvathy and Venkataraman 2011; Shane 2012), building and formulating 'innovative' research questions on the evolution of entrepreneurship seems to involve the dialectic comparison between familiar theoretical positions and other needs and approaches (*problematization*) rather than investigating the literature in terms of '*gap-spotting*' (Alvesson and Sandberg 2013).

In this respect, the work by Garud and colleagues (2014) opens 'new' theoretical and empirical spaces, by: (i) identifying the dynamics between the assumptions that characterize agentic-centric and context-centric perspectives of entrepreneurial innovation (micro–macro approaches); (ii) identifying and organizing the development of alternative assumptions derived from observations of 'real context' and the 'historical context' in the multilevel approaches; (iii) evaluating these assumptions in relation to a new point of view, comparing them with the role of entrepreneurial innovation in terms of an ongoing process involving embedded players who contextualize innovation through performative efforts.

Table 8.1 summarizes the logic that led to 'problematize' the literature on entrepreneurial innovation, based on the conceptualization and different theoretical assumptions related to the role of 'context'.

Table 8.1 Perspectives on entrepreneurial innovation

Approach	Micro-macro approaches		Multilevel approaches		Constitutive approaches	
Analytic focus	**Antecedents:** Factors that explain entrepreneurial innovation		**Events**: Episodes when entrepreneurial innovation is 'found' or 'made'		**Journeys**: Dynamics whereby entrepreneurial innovation emerges	
Perspective	Agentic-centric	Context-centric	Discovery	Creation	Co-creation	Narrative
Emphasis	Emphasis on entrepreneurial agency	Emphasis on entrepreneurial contexts	Emphasis on opportunity discovery	Emphasis on opportunity creation	Emphasis on dynamic equilibrium and ongoing change	Emphasis on meaning making through interplay of entrepreneurs and environments
Locus and nature of agency	Agency established by actor attributes	Agency prescribed by institutional structures	Agency cultivated by being alert or by spanning structural holes	Agency derived from capacity to bricolage and effectuate	Agency located in ecology of interactions	Agency 'translated' through social and material networks
Role of context	Contexts are not explicitly considered	Contexts explain entrepreneurial innovation	Contexts moderate availability of opportunities	Contexts moderate viability of creations	Contexts are both the medium and outcome of action	Contexts are constituted through performative efforts
Notable research streams	Personality; Cognition; Teams	Nations; Regions; Industries	Alerteness; Brokerage	Bricolage; Effectuation	Structuration; Complexity; Disequilibrium	Actor-Network Theory; Path creation

Source: Garud et al. (2014).

The combination of 'constitutive approaches' to micro–macro approaches and multilevel approaches, takes place through the different nature of the basic assumptions: on the one hand, the agency component is located in an 'ecology of interactions'; on the other hand, actors are 'translated through social and material networks'. The latter perspective, in particular, comes from the real observation of phenomena related to the ANT perspective: entrepreneurship, collective actions and the processes of emergence of them (Callon 1986); where to pay attention to 'processes of interactive modification between multiple kinds of actors' (Latour 1987); and where to understand that market creation implies tracing 'how the webs of heterogeneous material and social practices produce them [in a performative sense]' (Law 2009).

In this chapter we talk about narrative dimensions and processes of signification (Polkinghorne 1988; Czarniawska 1997) produced by actors who are committed to getting out '*ad hoc*' organizational forms for research in life sciences (Hughes 2011; Myers 2015) both in their original configurations and in 'hybrid' organizational forms.

Academic Entrepreneurship. In MOS, ANT and its research strategies are traditionally framed within the practice-based theories (Schatzki 2002; Gherardi 2012; Nicolini 2012). In this chapter, the amphibious scientist phenomenon is introduced with empirical and analytical purposes. With regard to the first aspect, it is possible to observe scientists and technologists struggling with organizational and management practices that shape new models for technological transfer. From the analytical perspective, innovation in academic entrepreneurship in terms of new organizational forms 'emerges across multiple, intertwined social networks' (Powell and Sandholtz 2012a, 2012b). In other words, new practices and organizational models are the result of processes of combinations between attributes and practices coming from the different social dimensions in which the amphibious scientist acts at the same time.

In descriptive terms, the amphibious scientist phenomenon refers to the figure of a scientist who, simultaneously, has a leading position in the laboratories and university departments where he/she works, as well as in the relevant DBFs; we interpret this as the emergence of a new organizational form. In analytical terms, the amphibious scientist as an actor-network allows for the reconstruction of the way in which the meanings that the collective actors give to a commercial entity to exploit a science-based innovation are formed. Initially, a DBF assumes unstable configurations through the overlapping of scientific, financial and commercial contexts in which the scientist is strategically located and 'in which relational practices flow', stabilizing the form (Powell and Sandholtz 2012a). This perspective uses a biological metaphor: *à la* Schumpeter, in terms of the relation between invention and innovation; and, in some ways, *à la* Nelson and Winter when addressing the 'recombination' of conceptual and physical materials as vital components of 'novelty' and change processes in 'socio-technical' systems. In the case of academic entrepreneurship, Powell and Sandholtz (2012b) examine how entrepreneurs cobble together different practices and templates, conceptualizing the distinction between: (a) 'reconfiguration, a mechanism through which familiar attributes and elements are put together in new but recognizable ways'; and (b) 'transposition, a mechanism through which attributes and elements are introduced into foreign domains, spawning new-to-the-world forms of organizing'.

In terms of practice-approach (Nicolini 2012), what is important from the perspective of the context of analysis is not 'what is done in terms of execution as how it is done, what sense it has and what relations it establishes' (Gherardi 2012, p. 196). The bases of this proposal are to consider the work of scientists and technologists not just as an interaction, but in terms of 'knowledge in action' (*ibidem*, p. 197).

8.3 EMPIRICAL CONTEXT

The amphibious scientist phenomenon emerged by investigating two specific empirical situations: the entrepreneurial events that 'shaped' the first corporates dedicated to biotechnologies (1968–81); and the foundation of a research center and a spin-off for the management of the laboratory and scientific services related to it (2005–09).

The concept of the amphibious scientist allows us to go over the history of biotechnology in terms of academic entrepreneurship.

When connecting the two contexts of research, this chapter will address the issue of academic entrepreneurship assuming that the 'translation' of new ideas (scientific knowledge) into innovations and the impact of such innovations was the consequence, rather than the cause, of a collective movement based on the meaning given to the relation between 'academic science' and the 'commercial world'. The organizational practices that Berman (2012) traces back to 'biotech entrepreneurship', 'university patenting' and 'university-industry research centers' (p. 10) are the emergence of new organizational forms (such as DBFs). In terms of entrepreneurial innovation, the DBFs emerge within the phenomenon of amphibious scientist, a 'social object' able to create networks of relationships.

Creating the 'Market University': Life Science and Biotech between 1968–81. This chapter pays particular attention to the 'background' of the history by considering the 'pioneers' of the academic entrepreneurship in biotechnologies (Table 8.2).

Table 8.2 *Distinctive features of early biotech firms*

	(A) SCIENCE	(B) FINANCE	(C) COMMERCE	What Happened?
Cetus (1972)	● Assembled an all-star science advisory board ● Chose a campus-like setting near a major research university ● Offered ‘free space’ for scientists ● Scientific founder stayed at the university and consulted with the company	● Used research partnerships with a diverse array of large corporations ● Achieved a record-breaking IPO in 1981	● Explored a wide range of commercial applications for biotech	First-mover advantage doesn’t hold due to lack of focus; acquired in 1991 by Chiron
Genentech (1976)	● Insisted that staff scientists publish and contribute to public science ● Scientific founder stayed at the university and consulted with the company ● Launched as a ‘virtual’ start-up: all initial research was conducted by contract with UCSF and City of Hope Hospital	● Received meager funding until scientific ‘proof of concept’ ● Invented ‘milestone payment’ form of incremental financing ● Achieved the first biotech IPO (1980): ‘gene dreams’ for Wall Street ● Used research partnership to share cost and risk	● Pursued a ‘swing for the fences’ strategy focused on blockbuster medicines	Science married to finance creates novel model that produces an enviable record of innovation. Despite considerable resistance, became a fully owned subsidiary of Roche in 2009

Table 8.2 (continued)

	(A) SCIENCE	(B) FINANCE	(C) COMMERCE	What Happened?
Centocor (1979)	● Pursued aggressive in-licensing of research from public science ● Initially located in a business incubator on the University of Pennsylvania campus ● Enjoyed a close relationship with research institute (Wistar)	– / –	● Served as a bridge between academic labs and Big Pharma manufacturing/ marketing ● Recruited a senior exec from Corning's medical products business to run the company ● Focused on diagnostic products	'Academic scavengers' almost lose their company due to grand inspirations to become a fully integrated pharmaceutical company. Acquired by Johnson & Johnson in 1999
Amgen (1980)	● Assembled an all-star science advisory board (SAB)	● Went public in a last ditch effort to save the company, despite no products or patented breakthroughs	● Served as a bridge between academic labs and Big Pharma manufacturing/ marketing ● Recruited a senior exec from Corning's medical products business to run the company ● Focused on diagnostic products	Savvy VCs set out to 'do biotech right' by recruiting stellar SAB and putting talented pharma escapee in charge; a biopharma titan is born

Source: Adapted from Powell and Sandholtz (2012a).

In the fervor of findings in the *life sciences*, scientists have not expected that 'others' formed a sociology that redefined 'society' (Latour 1987). In that particular historical period, before the 'technical usability' of recombinant DNA (rDNA) became a 'black-box' and the 'social legitimacy' of biotech terms was reduced to a matter of 'technological transfer', scientists redefined 'the concept of society and what constitutes it' (Latour 2005; Law 2009). Moreover, the seminal works by Herbert Boyer and Stanley Cohen had huge consequences in terms of economic development linked to cloning techniques and the subsequent emphasis on the commercial exploitation of the first biotechnology products (synthesized antibiotics, hormones, and enzymes). Between 1977 and 1978, 'three policy decisions were made that contributed to the unleashing of a wave of entrepreneurship in the biosciences' (Berman 2012, p. 98): the decision of not acting, from a legislative perspective, to regulate the use of rDNA; the 'Revenue Act', which cut 'capital gain taxes', favoring investments; and the change in the regulation on the investments of pension funds, allowing the entry in the 'venture capital funds' (ERISA and 'Prudent Man' rulings). Powell and Sandholtz (2012a, 2012b) and Berman (2012) agreed that 'policy decisions and innovation arguments were not the most important factors in explaining the take-off of the market logic [in the university system]' (p. 102). At the beginning of 1978, in fact, only three start-ups (Cetus, Genentech and Genex) marketed products related to rDNA technology. On the other hand, the growing number of scholars that were involved in biotech start-ups in the following years does not seem justifiable with only these interventions of industrial policy. Similarly, the famous '*Diamond vs. Chakrabarty*' ruling in June 1980, through which the US Supreme Court recognized the right to patent living microorganisms produced by the development of molecular biology, cannot be considered as the starting point of a movement with a more structured origin. Companies, research institutions and investors have long bet on the importance of patents in this field to encourage technologic innovation, genetic engineering, and the competitiveness of the entire high-tech system of the United States.

A laboratory in a research center. The timeline of Figure 8.1 shows the whirling development of Next-Generation Sequencies technologies (NGS) in a decade, overlapping the temporal sequence of some research projects that, at an international level, have characterized the scene of molecular biology studies. In the decade after the publication of the first sequence draft of human genome (2001) and the end of the Human Genome Project (2003), studies on genomics developed strongly.[1] Currently, scholars seem to agree on the future developments linked to: (i) five fundamentals (genome structure; genome biology; disease biology; advances related to science; and an effective health care system); and (ii) three important

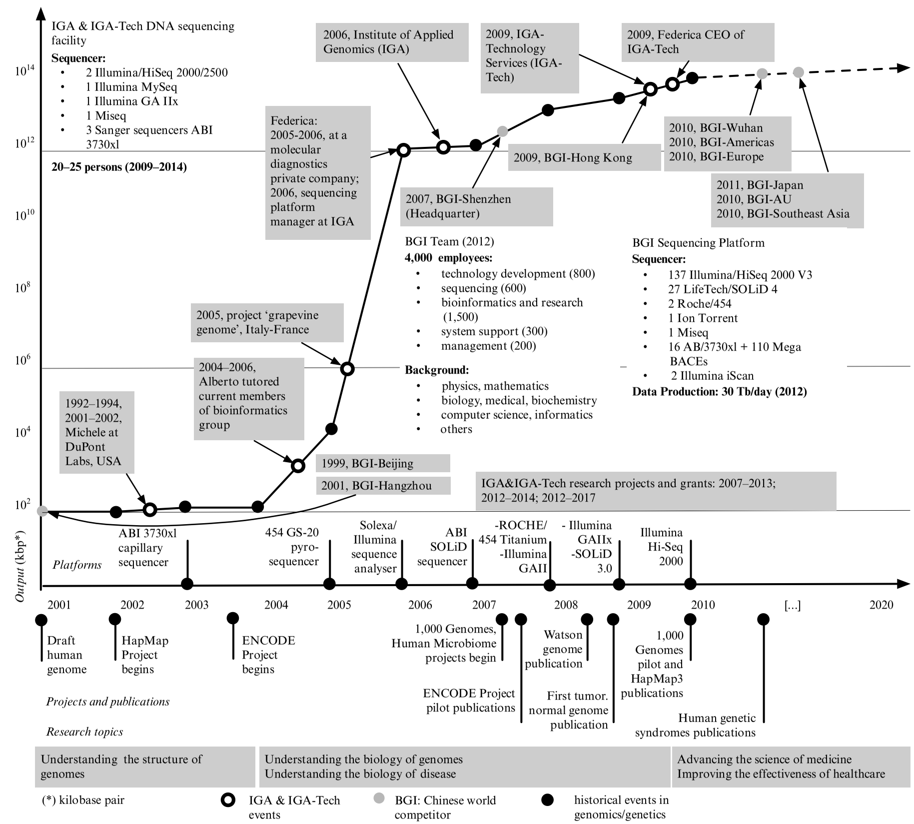

Figure 8.1 A timeline of events

cross-cutting areas to the entire spectrum of findings in life sciences and their application in biotechnologies (bioinformatics and computational biology; training and refresher courses; the relationship between genomics and society).

The IGA was founded in 2006 by four scholars interested in the development of research applied to the genome of plants, in an important phase of this historical path: both from the perspective of technological development that would have characterized the sequencing techniques; and with regard to the development of research programs that linked the genome biology to medical therapy (Hughes 2011; Myers 2015).

Raffaele, Michele, Alberto and Gabriele (see Table 8.3) came from three different departments of the same university: Agriculture, Biology and Mathematics and Computer Science. Raffaele played a crucial role in linking research to agriculture, biotechnologies and patenting on agricultural plants. Thanks to his high status, Raffaele played an important role as the link during the establishment of the Institute and for the work teams within the IGA, guided by Gabriele (the youngest scholar in the team), Michele and Alberto. The last two are the senior scientists, and IGA research activity is based on their work; they belong to the same generation and, for their respective areas of research, have a scientific profile recognized worldwide. In particular, Michele had several experiences in Italy and the US: until 2002, Michele worked in the Agriculture Products Department of the DuPont Labs as post-doctoral and Senior Scientist, and headed the research group dedicated to the maize genome and the construction of its physical map. In the same years, Alberto headed a research group of bioinformatic scientists, which is still working on the plant genomics projects, in the University, the IGA and the IGA-Tech.

The IGA-Tech was established in 2009 to independently manage the research lab. The cases identified by Powell and Sandholtz (2012a) (in Table 8.2) and the analysis of the IGA and the IGA-Tech (considered as a single research site) are interesting research contexts for different reasons. First, the different stories allow for the observation of the 'action networks' that constitute the unit of analysis. Furthermore, the two research contexts were allowed to observe the evolution of organizational practices in their respective generative periods, which is a very rare aspect in MOS. Finally, by connecting the two events it was possible to overlap the origin of the first DBFs and the evolution of the symbiotic relationship between the IGA and IGA-Tech: (i) by retrospectively identifying the relational features that stabilized the configuration of the amphibious scientist as an actor-network (configuring the DBFs); and (ii) describing and analyzing the phenomenon of the amphibious scientist 'in action', in the case of a

Table 8.3 Informants, data and archives collected in the research sites

Code	Sources and description
Inter_#01	**a) Interviewees:**
Inter_#02	Chief Executive Officer, IGA-Tech (Federica, 3 interviews)
Inter_#03	Founder of IGA (1 interviews)
Inter_#04a-c	External Stakeholders (2 interviews)
	Bioinformatics Research Group (5 interviews, 3 interviewees)
	a. Cristian; b. Simone; c. Alessandro
	b) The Board & Founding Members (IGA & IGA-Tech):
	● **Michele** (1987, degree in Agriculture), Professor of Genetics, *Founder, Scientific Steering Committee and Scientific Director-IGA*
	● **Alberto** (1984, degree in Mathematics, MSc in Computer Sciences), Professor of Informatics, *Founder and Director of Bioinformatics Research Group-IGA*
	● **Raffaele** (1977, degree in Agriculture), Professor of 'Fruit Science' and 'Genetics resources in agriculture', *Founder, Chairman (Board of Directors) and Chief Executive-IGA*
	● **Gabriele** (1999, degree in Agriculture), plant molecular geneticist, *Group Leader Molecular breeding-IGA*
	● **Federica** (1994, degree in Biology), *Chief Executive IGA-Tech and Scientific Steering Committee-IGA*
IGA_#year	**c) Archival Records:**
IGA-Tech_#year	Financial Statements IGA, 7 years, 2007–2013 Financial Statements IGA-Tech, 3 years, 2010–2012
IGA-Tech_00	01) Technology:
	● sequencing (Illumina; ABI3730xl);
	● datacenter (computing and storage: www.inasset.it)
	02) Services:
	● NextGen Sequencing (NGS) and Sanger Sequencing;
	● NGS Data Analysis and Sequencing Data Storage
	03) Bioinformatics and NGS Training
EPIGEN	**d) Research Projects/International & National grants/ Publications:**
DNAMICA	Italian Ministry of Education, University and Research and the National Research Council: 'how epigenetic mechanisms regulate biological processes, determine phenotypic variation and contribute to the onset and progression of diseases', web: http://www.epigen.it
PON Citrus	POR-FESR 2007–2013 – Platform for Molecular and Personalized Medicine, web: http://www.dnamica.it
BIOWINE	
WATBIO	
DISCO	
IGA-TS CLONI	
IGA-pub_Journal	

Table 8.3 (continued)

Code		Sources and description
		PON Ricerca e Competitività 2007–2013 – Functional genomics, genetic improvement and innovation to enhance the value of the citrus supply-chain PO FESR Sicilia 2007–2013 – Multidisciplinary approach for quality improvement in wine production EU FP7 – developing drought-tolerant biomass crops for Europe EU FP7 – From DISCOvery to products: A next generation pipeline for the sustainable generation of high-value plant products Regional project LR47/78 – Innovative diagnostic platform for grape clone identification n. 52 scientific publications (analysis of research programs, network of scientific partnerships, evolution of research topics)
News_local	**e)**	**Local and National Newspapers:**
News		n. 22 articles (2006–2013): Messaggero Veneto (local newspaper) n. 54 articles: National & International newspapers

contemporary and necessarily 'hybrid' DBF, that is, before the organizational practices would let it take a 'stabilized' form.

8.4 METHODS

8.4.1 Data Collection

This research is an ethnographic case study (Garfinkel 1967; Van Maanen 1988; Agar 1996), following an interpretative approach (Marcus and Fischer 1999) between historical institutionalism and historicism in entrepreneurship theory (Bucheli and Wadhwani 2014).

Table 8.3 summarizes the material used in the research, the categories of interviewed informers and the different types of collected material. To investigate the origin and the functioning of IGA and IGA-Tech, we have reconstructed the history of the first project (the grapevine genome), and collected the documents on the major research projects, business plans, financial documents, articles from national and international press review, scientific publications linked to the team of founders and the network of research partnerships that were to follow. The interviews took place between spring and summer 2014. A further stage followed, until spring 2015, when the work team focused on the history of the entrepreneurial team and the research groups within the IGA and IGA-Tech, paying particular attention to the core skills of the biocomputer scientists.

To develop the analysis on the origins of academic entrepreneurship in life sciences, we started with the research project by Powell and Sandholtz (2012a, 2012b), recovering rich archive material and stored interviews from the 'Oral History Project-Regional Oral History Office, The Bancroft Library', of the University of California, Berkeley. Moreover, other secondary sources were collected (Hughes 2011; Stevens 2013; Myers 2015) as well as the stories from the *Life Sciences Foundation* (published in the six-monthly magazine).

8.4.2 Analytic Process: ANT as a Research Strategy

Based on the suggestions by Padgett and Powell (2012), the two mechanisms (reconfiguration and transposition) that characterize the founding models of the DBFs, bolster a two-level innovative process compared to the time factors: 'historical time' (long term) and 'biographical time' (short term).

In the long term, relationships produce actors; the approach of historical institutionalism suggests that attention be paid to (Bucheli and Wadhwani 2014, p. 101): (i) how 'diffused practices change as they move through time and space'; (ii) the fact that 'there is a sedimentation effect in which the adoption of earlier practices influences the expression of later practices'; and finally (iii) what is 'the role of history in processes of diffusion'. By contrast, the 'biographical time' dimension is a historical reasoning more inclined to investigate how 'context' and 'change' are essential for the collective construction of entrepreneurial processes (Bucheli and Wadhwani 2014). Emphasizing the 'meaning making' through the interplay of entrepreneurs and environments (Garud et al. 2014), the narrative approach to entrepreneurial innovation takes into account the temporality that 'includes not only an individual's personal experience of time, but also one's awareness of a "social" past that shapes one's relationship to social groups . . . and to collective identities' (*ibidem*, p. 208).

The theoretical context of the research comes from the empirical observation of the context described in the previous section: both the characteristics and features assemble the original DBFs in terms of entrepreneurial innovation; and their 'dynamic' dimension, linked to the fact that the academic entrepreneur translates into practice the social components of the field strengths that contain and produce him/her as an actor-network.

In particular, in the ethnomethodology field (Garfinkel 1967) the empirical ability of the ANT is shaped ('describe networks by following the actor into translations', Latour 2005), as in the case of the studies of scientific laboratories (Latour and Woolgar 1979; Latour 1987). The language that we have introduced so far revolves around the concept of *translation*, which is pivotal in the ANT, and according to Callon (1986), it provides: 'the existence of a unified field of meaning, attention and interest, that is, the expression of a common desire to achieve the same result. Translating involves creating confluences and homologies by relating things that initially were distant' (p. 211). On the one hand, with a perspective of the *materiality of the social world*, actors are effects of the relationship field where they are included, which defines their features in a social ordering process. On the other hand, the ethnomethodology and the ANT complement each other without considering the existing structures but conceiving the modes of ordering as a *performance* that needs to be continuously developed (Garfinkel 1967).

Through the lexicon of the ANT, in the interpretive part of this work, we will (i) reconstruct the work of the first scientists called upon to define the technology transfer in the life sciences through the artifacts of biotechnology (the four phases of the translation process: problematization, interessement, enrollment and mobilization); and (ii) see how the amphibious scientist phenomenon allows one to define 'the social, institutional, conceptual and material' through the way these dimensions are related narratively (Gherardi 2012), so that 'to study their configurations . . . it is enough to follow their associations' (Latour 2005).

8.5 FINDINGS

If the technological, institutional and regulatory developments do not seem to provide enough factors for understanding the emergence of the DBFs, the focus shifts to: how elements coming from scientific, commercial and financial contexts can flow in the form of networks of action from those domains, so as to create new organizational boundaries; and how these social dynamics can be fueled by new practices able to stabilize the meaning given to them in terms of collective action.

Overlapping the two stories in terms of institutional history and biographical time, we will see the characteristics of the first generation DBFs come out (in the first part) and how these characteristics are mixed when the amphibious scientist is 'in action' in search of a new 'stabilization' in hybrid organizational models (the symbiotic relationship between the IGA and IGA-Tech).

'Attack of the cloners': DBF emergence (1968–81). Arthur Kornberg was one of the most important and influential biochemists in the twentieth century. He was an ALZA consultant and cofounder of DNAX (one of

the companies founded by Zaffaroni). He described critically the atmosphere of the 'race to patents' in life sciences. As suggested by Kornberg, when people try to cope with new organizational situations, such as in the case of the atmosphere of optimism about biotechnologies, they 'survey their social worlds for cues about appropriate action, drawing on their existing knowledge and routines' (Powell and Sandholtz 2012b). The 'assembly' process gives the analogy between organizational dynamics and the biochemistry of the theoretical proposal by Padgett and Powell (2012), on the concept of the coevolution of 'multiple social networks' through the first order constructs described in Table 8.4.

The features of the two DBF versions ('science-centered' and 'commerce-centered') seem to stir the assumptions of the linear processes of scientific discovery and the exploitation of technological opportunities, which lie at the root of much of the literature on entrepreneurship. In fact, there is the presence of a good deal of 'chance, necessity, and naïveté – rarely mentioned in explanations of entrepreneurial outcomes – [but] essential in the invention of new organizational models' (Powell and Sandholtz 2012b, p. 94). The original meanings of a DBF are present in the entrepreneurial experience regarded as the reference model. The case of ALZA, founded by Alejandro Zaffaroni, allows one to appreciate what thinking in terms of 'relational materialism' implies, considering the heterogeneity 'within and between overlapping networks' (Law 2009). For the DBFs, the social domains where the founders' team is strategically located and from which the relational practices flow into the new organizational entity, are the sources of meaning for 'cognitive materials' and 'artifacts' that converge in the emerging entrepreneurial experiences.

ALZA: A First Prototype of DBF. The figure of Zaffaroni was instrumental in defining the identity of actors and building meaning through the ties that would unite them: it was about describing a system of alliances (associations, in the ANT language) where the scientific values could become the way through which the new entrepreneurial realities were 'credible', 'acceptable' and 'legitimate'.

Zaffaroni was probably the first 'serial entrepreneur' in the history of science-based start-ups (Kornberg 1998): during his vast experience, Zaffaroni launched at least half a dozen biotech enterprises. ALZA is considered a real prototype: it was founded before the emergence of publications on 'gene splicing' (1973) and 'monoclonal antibodies' (1975). Moreover, it was based on the previous experience of Zaffaroni at Syntex, a small pharmaceutical company in Mexico that would become the first company to move to the United States.

Zaffaroni was born in Uruguay, he studied at the University of

Table 8.4 Two variants of a new form

A Science-Centered Variant	A Commerce-Centered Variant
Science takes the lead, with VC and management support	Management takes the lead, supported by VC funding and academic science
Renowned scientist-founders straddle domains, often occupying key executive and academic roles early roles simultaneously	Scientifically-trained business leaders play crucial early roles
Science Advisory Board (SAB) is used for peer review	Science Advisory Board (SAB) is used as a signal of approval
Firms exhibit a strong commitment to publishing research findings	Publishing is not encouraged
Investors take an 'empirical' approach: minimal funding of laboratory research (proof of principle), with further investment contingent on scientific results	Investors weigh commercial considerations such as size of market, current competitors, projected cash flow, speed to profitability, etc.
Academic headwaters: William Rutter's interdisciplinary lab at UCSF	– / –
Commercial headwaters: ALZA Corp.	Commercial headwaters: entrepreneurial divisions of health care or pharma companies (i.e., Baxter, Abbott, Corning)
Exemplars: Genetech, Biogen, Chiron, Immunex	Exemplars: Hybritech, Centocor, Amgen, Genxyme
Failed attempt: Cetus (lacked strong scientific leader)	Failed attempt: Genex (lacked strong commercial leader)
Mechanism of genesis: **transposition**	Mechanism of genesis: **recombination**
(1) Established routines prove lacking. . . (2) so founders draw on existing knowledge. . . (3) and scan their social worlds for cues. . . (4) forging unique elements of a science based organizational form.	

Source: Adapted from Powell and Sandholtz (2012b).

Rochester, and he completed his Ph.D. on an original work on steroid hormones. Driven by leading academic institutions, he began his adventure at Syntex, Mexico City, contributing to the technical and commercial success of the small chemical enterprise for the following ten years. Syntex became an advanced research laboratory that was definitively turned into a pharmaceutical enterprise. In 1962, Syntex moved to Palo Alto, in the heart of Silicon Valley.

In 1968, Zaffaroni left Syntex to develop his own enterprise, ALZA. He explained his attraction for entrepreneurship as follows: 'Truly exciting innovations rarely come from large, established companies. It's the new, small groups that risk life and death for innovation. I always liked taking risks and proving myself' (*LSF Magazine*, Spring 2014, p. 23).

Every story of this entrepreneurial venture has at least one common element. Zaffaroni loved to gather the best people: young scientists, engineers and managers who should not only be talented, but also accompany their potential with passion and enthusiasm; and 'the company's business and finance professionals also had to understand the founder's commitment to excellence' (*LSF Magazine*, Winter 2013, p. 29). ALZA's organizational culture reflected the soul of its leader and his clear vision on what Zaffaroni considered to be 'business maturation': 'We would grow, I hoped, not by expansion, the way most American corporations did, but in a much stronger and more creative, even biological way, the way cells themselves grow: we would grow by division'.

ALZA was a huge technical success: in 1974, the Food and Drug Administration (FDA) approved the first product and, in the following 25 years, the innovative drug delivery technologies by ALZA were used in 30 commercial products, sold in more than 70 countries and based on different medical platforms. ALZA inventors produced over a thousand patents and, in those same years, the financial evolution of the company was characterized by clever choices that guaranteed its independence for a long time (in 2001, ALZA was taken over by Johnson & Johnson for US$10.5 billion).

Transposition: A Science-Based Variant. The first DBF variant has a particular configuration of the general features (see Table 8.4): (a) noted scientists on the founding team; (b) founder who alternated between academia and the start-up; and (c) the absence of a senior executive from Big Pharma. Different episodes and situations in the stories of Genentech and Cetus are representative of this configuration.

Robert Swanson (co-founder, CEO and Chairman of Genentech until 1996) described the 'research based' characteristics of the organization, led by scientist-founder, Herbert Boyer, as follows:

> Boyer's philosophy, which I agreed with, was that you gain more from interaction with your academic peers than you give up by telling the competition where you are. So with interaction you can move quicker; you gain more people willing to collaborate with you. We knew then we weren't going to have all the best ideas, and we said, where do the academic scientists go when they have an idea that they think needs to be commercialized? We want them to think of us first.

Swanson had graduated from the MIT (BS in chemistry, MS in management) and in 1974 he decided to leave his present company to work with Eugene Kleiner and Thomas Perkins, VCs in San Francisco (Swanson 2001; D'Andrade 2001; Perkins 2002). Swanson had the task of monitoring the investment of Kleiner and Perkins in Cetus (Cape 2006): a few years later, the VCs left the company, while their young partner decided to stay there since he was fascinated by the story of Donald A. Glaser (the Cetus co-founder) and his journey into the world of bio sciences (Boyer 2001; Glaser 2006).

In the first years of rDNA spreading, Cetus was not the only company to have long-term reservations about the opportunities that this technology could provide. Only in 1978, did 'Cetus lab become operational and the first explanatory rDNA experiments were launched' (Cape 2006). By contrast, Genentech was founded around the quite complementary trends that characterized both founders: on the one hand, Boyer went on publishing his scientific works with dynamism; on the other, Swanson developed a coherent business idea with the VCs. A few years later, Kornberg himself recognized the uniqueness of Genentech: 'Unlike other biotech ventures, with a seasoned scientist or a distinguished board of scientific advisors for guidance, Genentech relied on its 'Young Turks', unheralded but talented, industrious, and highly motivated to succeed'. Between 1980 and 2001, 'Genentech published more highly cited bioscience papers than any other institution except MIT' (Powell and Sandholtz 2012a, p. 420).

For many ventures like that, scientists-founders did not have the problem of legitimizing their actions and the arrangement of a Scientific Advisory Board composed of 'all-star' scholars was unnecessary for them: what should be preserved and what could already be ensured by founders without relying on a 'high-powered external committee' (Cape 2006), was the ability to maintain connections with the high level scientific world, both in terms of relationship and academic field.

Conversely, from a strategic point of view, financial and commercial dimensions were strongly affected by the 'good science': 'networked enterprises', around the research projects in life sciences, became 'tacit blueprint' of sorts (Powell and Sandholtz 2012a). The story of the VC Perkins is representative and refers to the period of the IPO by Genentech in 1980 – the first 'public company' in the biotech: 'Once it becomes a public stock, the preferred shares convert to common and everyone is on the same platform. So how are we going to continue to attract these people? Continue to hold these people? It was a big problem' (Perkins 2002).

Reconfiguration: Different Commerce-Based Variants. DBF variants based on the connection between financial and commercial dimensions, have these general features (see Table 8.4): (a) active publishing was not constitutive in their formative years; (b) science and scientists stayed in the firm but were less connected to the broader scientific domain; and (c) interaction between finance and commerce flows indicated an investment strategy based on 'commercialization' into profitable and existing markets. Processes of reconfiguration of organizational practices related to these features can be traced back to experiences such as Amgen, Centocor, or Hybritech.

As suggested by Powell and Sandholtz (2012a), a peculiarity of these firms is the separation of the academic from the commercial as the 'academic' dimension *is translated into* the 'commercial' dimension. In the case of Centocor, the vision was quite clear, 'to be the bridge from the academic research laboratory to the established health care supplier', based on an innovative strategy of licensing from academic and non-profit laboratories (Rathmann 2004; Byers 2006). However, some episodes revealed the criticality of some practices. For example, Hilary Koprowski, manager of the Wistar Institute, strongly believed in the commercialization of monoclonal antibody technology, but just before the IPO in 1982, this situation led him to clash with several colleagues and to resign from Centocor managership to avoid jeopardizing the action, which was necessary to refund his research. On closer inspection, the disagreements with Wistar began during the first licensing experience of Centocor, the exclusive holder of the license of a patent from the Institute: on that occasion, many colleagues in the Board blamed Koprowski for being in the difficult situation of a conflict of interests (Byers 2006; Cape 2006). After these episodes, in order to ride the explosion of commercialization of biotechnologies in the early eighties and to pursue the goal of becoming a fully integrated pharmaceutical company, Centocor broadened its activities to diagnostic and therapeutic tools (Powell and Sandholtz 2012a):

This managerial/commercial dimension emerges also through the stories of Gordon Binden, CEO and CFO at Amgen, who considered this structural component significant: 'Much of Amgen's success in raising capital can be attributed to the fact that every one of our senior managers had worked for large corporations' (Powell and Sandholtz 2012a, p. 411). George Rathmann (CEO, and president of Amgen, 1980–88), in his turn, underlined how Amgen was characterized as being 'science based but not science led' (Rathmann 2004). Rathmann (Ph.D. in chemistry at Princeton) spent the first 20 years of his career in important private ventures. Later on, he joined the Abbott Labs as R&D vice president. In that period, also, Rathmann began to fit into the plots of the financial circles of the industry: a famous VC like Moshe Alafi (investor in both Amgen and Biogen, as well as one of the Cetus founders), 'tried to recruit Rathmann to run the US operations of Biogen. In the end, Rathmann opted for freedom and control offered by Amgen' (Powell and Sandholtz 2012b, p. 411).

Ivor Royston (biomedical research at UC-San Diego, and Hybritech founder) moved in the same direction, but with a more remarkable entrepreneurial spirit: 'Hybritech was a successful IPO in 1981 . . . Hybritech's founding executives and scientists went on to found dozens of biotech ventures and establish San Diego as one of the three dominant hubs of biotech activity in the US' (Powell and Sandholtz 2012a, p. 426).

On March 17, 1980, the US Supreme Court ruled in *Diamond vs. Chakrabarty* that living things were eligible for intellectual property protection. The Cohen-Boyer process patent was granted on December 2, 1980. In August 1982, the NIH's rDNA Advisory Committee issued revised and relaxed 'Guidelines for Research Involving rDNA Molecules'. 'All was settled. The revolution was bureaucratically approved, and the world had been irrevocably changed' (*LSF Magazine*, Summer 2013, p. 75).

An Organizational Hybrid: IGA e IGA-Tech as a DBF variant. IGA and IGA-Tech are 'symbiotic' components of a single body: a non-profit organization between scientists interested in genomics and a research institute having the same name; a scientific laboratory equipped with latest generation expensive machinery for genome sequencing (NGS); and three 'facilities' sharing the same 400 square meters of University Technological Park, founded a year before. Financial uncertainty for scientific research, people working for years on the issue of plant genomes, joint decisions on how to compete and collaborate in the genetic improvement of plants and the latest scientific debates (e.g., on genome editing), are some dimensions that bind this 'body' and the university departments it comes from.

In 2007, some important scientific publications by the IGA showed the international community a first detailed analysis of the grapevine genome. The project on the grapevine genome, set up for the establishment of IGA and IGA-Tech, reveals the role that, for both bodies, scientific production had to play. As a building block of the new organizational form, for the founders, the quality of publications represents an automatic and renowned 'validation mechanism', compared to the new way (in terms of organizational model) and new tools (managerial and commercial) that they had decided to work with in the two realities. Moreover, the issues of epigenetics and DNA methylation are linked with particular attention to the scientific practice 'organized' within the new 'facilities'. On the one hand, the 'weak rhetoric' of the scientific literature (in the language of ANT) makes use of IT tools that make NGS adoption possible. On the other hand, to produce 'ready-to-use knowledge' from the information coming from NGS machines, the new 'organizational model' has the need to mobilize many more resources ('human and non-human') with respect to different division models of the scientific work. The production of physical maps in modern genomics projects urges the creation of different research organization models compared to the past, when dozens of research institutes, departments and laboratories had: 'to ensure high quality data and extensive utility with robust data standards; computational intensity in terms of data analysis, data integration, visualization, computational tools and infrastructure; and continuous training' (Stevens 2013; Myers 2015). Alberto, Gabriele and Michele, driven by Raffaele's suggestions, formed the three working groups within the IGA, necessary to meet the needs that arose from the 2005 project, having a shared perspective of the most advanced developments at international level, and being aware of how these pathways could be original or seemingly unusual.

The stories of Federica, current CEO of IGA-Tech (Ph.D. in Plant Biotechnologies, 2001, under Michele's guidance; a long experience in molecular diagnostics companies and private laboratories), reveal different ideas on what is implied by always anticipating the most promising research topics in order to make research projects potentially able to shape the scientific scenario.

If this logic characterizes the current focus of IGA and IGA-Tech to select research groups in which to operate, it is a 'de facto' feature common to different levels: '[Even at the time of the Ph.D.] being next to [Michele], for all my colleagues and me, was about being always updated on all scientific and technological news from the USA, five or ten years before Europe or Italy' (Inter_#01). The layout of a laboratory, which is fully open space, the characteristics of the architecture and the atmosphere in an incubator in the Boston region dedicated exclusively to life sciences, are not different from those of the laboratory managed by IGA-Tech. Compared to the early 1960s, what really changes in a 'contemporary' lab is the 'multidisciplinary team made of biologists, bioinformaticians, computer scientists and software developers' (Inter_#02): in parallel with what happened in medicine, the relations between engineering disciplines, biology, and medicine were laboriously labeled with terms such as 'biomedical computing', 'computer medicine' or 'medical electronic data processing' (Jensen 2010); and similarly, the 'digitization', 'computerization' or 'dematerialization' of a molecular biology laboratory did not characterize adequately the real ongoing change in the life sciences (Stevens 2013). First, this aspect is linked to the management of a laboratory that acts directly as the support for research projects as a scientific partner rather than as a simple service provider.

In 2006, Federica went back to Udine to join her managerial and scientific skills in the new IGA laboratories, and in 2009, she became CEO of the newly formed IGA-Tech and person in charge of IGA laboratories and all its scientific and research equipment: 'Learning how to perform many tasks, continuously overlapping lab work with management issues, going "from one thing to another" with ease had become something ordinary for me, something that was linked to the way of conceiving the scientific work I had learnt from Michele' (Inter_#01). The design of the experiment became the client's project and an integral part of a relationship that was, at the same time, scientific and commercial.

At the bottom of the open space, the laboratory is equipped with three computer stations and a large room with servers for the acquisition and processing of data coming from sequencing machines that are arranged in the nearby air-conditioned room. Since early 2000 the IGA paid attention to the evolution driven by informatics. The current group of bioinformatics grew steadily under the guidance of Alberto: Cristian, Simone, Alessandro and Alberto C. completed an interdisciplinary program, with competencies in biology, computer science, mathematics, statistics and software engineering (Inter_#04).

Between 2002 and 2003, laboratories, machinery and 'new' professions began telling stories (using the language of ANT) on computers, biological databases, algorithms as part of a story where people should be able to associate considerable resources, talk with local and national authorities, recruit other people and institutions and convince universities, farms, and private and public financiers that equipping laboratories and research institutes properly was an integral part of their 'entrepreneurial opportunities'. The grapevine genome project was an important step toward establishing a direct link between research and industry in agriculture. Between 2007 and 2009, the issue on the choice of the sequencing platform to be installed became crucial. The main 'bottleneck' in genome sequencing technologies is not characterized by data generation but 'in terms of quality in data processing, storage, management and interpretation – with the use of new algorithms and robust computational tools – according to a data integration approach' (Inter_#03). In this statement, Cristian describes the effects of the choice made on the nature of the work they were going to do:

> Today, a sequencer can produce 350 billion base pairs in about two weeks (from 1 to 2.5 TB of data) and the parallel execution of 6 different DNA mappings can lead the IGA-Tech to generate up to 15 TB of raw data to be stored in a few days. (Inter_#04a)

The project EPIGEN highlights the role of the creation of 'local strongholds' around hybrid professional profiles, young scholars and a hybrid organizational model where the academic component (university departments), the research institute and the scientific laboratory are interdependent. The project is multidisciplinary for its purposes and involves 70 Italian research groups that are engaged in different international projects. Here, experimental models and the use of innovative technologies become an integral part of a training program that involves young scholars committed to the same research groups, with a specific focus on the whole pipeline linked to the application of the NGS and bioinformatics.

To understand 'the strength of weak ties' in the case of ecology of relationships created by IGA and IGA-Tech and their symbiotic relationship, Figure 8.1 suggests a comparison with one of the most significant and ambiguous biotech clusters in the world: located in Shenzen, the Beijing Genomics Institute is currently able to produce about a quarter of the world's genomic data (*LSF Magazine*, Winter 2015). In 1980, Shenzen was a small village of fishermen on the other side of the great river (the Pearl River Delta) that separated it from areas of Hong Kong and within a few years it was transformed into a cluster (Stevens 2013). A recent report by the Life Science Foundation (*LSF Magazine*, Winter 2015) describes the scientific aptitude of the BGI as a strange combination of skills and practices between the culture of a start-up and the commercial logics of an electronics company: 'BGI is often called a 'biology factory'. Many of its projects are notable for their size and their scaling trajectories – more and more people and machines are being deployed to sequence genomes at accelerating rates with increasing efficiency' (pp. 34–5). In all the stories about the 'BGI world', the representation of the organizational and entrepreneurial model gathers as many skeptics as it does enthusiastic people. Seemingly, the BGI would follow the atmosphere of a start-up in California.

In the last decade, various academic departments of life sciences and many biotech areas have competed alongside the most prestigious academic institutions at an international level. As many professionals and scholars relate, 'history matters in this evolutionary process' (*LSF Magazine*, Winter 2015, p. 3): and these stories reveal that research institute and self-sustaining centers of biotech have been established only when strong science, entrepreneurial cultures, and business-friendly policies meet robust infrastructures, and skilled, knowledge workers.

In this exclusive context, the story of IGA and IGA-Tech seems to rely on a strong and growing reputation that is linked to the ability to turn the 'local strongholds' into 'longer research networks' built around major research topics. In the scientific field, 'long range networks' in terms of research projects, together with 'local strongholds' in professional expertise, become the foundation on which to widen the attention toward new directions: medical diagnostics and clinical practices must be supported by NGS technologies (e.g., in clinical care, clinical utility in oncology or in diagnosis of rare diseases): it is 'perhaps the most competitive market in the global industries connected to the future of biotechnology and life sciences' Federica said, 'but, this industry is naturally developing along the NGS pipeline considering the pre-analytic, analytic, and the post-analytic phases' (Inter_#01). In a recent report on 'Nature Biotechnology' (Curnette et al. 2014) 'interviewed industry leaders generally agree that the platform manufacture market . . . is quite narrow. [And], the price and quality of the current market leaders are substantial hurdles to overcome. In addition, the prospect of unpredictable new regulatory standards further accentuates the risk' (p. 981). In contrast, interviewees agree that there is considerable 'room for expansion' in the post-analytic section of the pipeline. In this context, IGA and IGA-Tech can play a further role in terms of growing relationships and skills, enabling further processes of reconfiguration of new practices and transposition of well-known practices. An example is the project DNAMICA – 'a platform for molecular and personalized medicine, one of the first examples of "industrial research" on these themes in Italy'. As Federica points out in a brief video about the project: 'The science of medicine and the practice of medicine are distinct domains. Our knowledge of the human genome is beginning to transform the former, and there are already examples where genomic information is now part of the standard of care'.

8.6 DISCUSSION AND CONCLUSION: AMPHIBIOUS SCIENTIST AND NARRATIVE PERSPECTIVES IN ACADEMIC ENTREPRENEURSHIP

The goal of this chapter was about introducing the study of the processes of academic entrepreneurship in terms of the *translation* of scientific, financial and commercial practices from the social contexts of the life sciences into new organizational forms for the exploitation of biotech products.

ANT research strategy originates from the study of scientific knowledge and technology as historically situated social practices (Knorr Cetina 1999; Latour 2005). A technology transfer program involving biotechnologies through the processes of academic entrepreneurship stems from beliefs on the social order (the relationship between science and industry) and a set of values (research in life science) that produce an 'institutionalization trajectory' (Czarniawska 1997) and organizational models that stabilize: working practices and professional communities (biologists, bioinformaticians, computer scientists, software developers); interest groups and demonstrations of power (academic world, agricultural and pharmaceutical industry, medical diagnostics multinational companies, VCs and public investors and policymakers).

In terms of problematization (Alvesson and Sandberg 2013) and formulation of research questions within MOS, the ANT provides concepts and languages to investigate new issues or formulate the same issues in a different way. In this regard, the topic of academic entrepreneurship is quite promising for the ANT: as social scientists, we should be interested in entering the scenario of the 'new knowledge' produced by life sciences to assess social relationships that gather around the development of biotech products. The phases of the translation process concern the emergence of the features that assemble the original DBFs; the narrative component of the entrepreneurial innovation allows for coping with the 'dynamic' dimension, the academic entrepreneur 'in action' who 'translates into practice' the social component of field strengths (action networks) that contain him/her and produce the amphibious scientist (actor-network).

How the biotech market becomes a(n) (arti)fact (1968–81). The creation of 'new markets' and the emergence of 'new organizational forms', in this chapter, are a field strength that contains and produces the amphibious scientist, a collective actor resulted from a translation process characterized, in the ANT language, from the succession and repetition of maneuvers and typical stages. Callon (1986) traces them back to: problematization, interessement, enrollment and mobilization.

When Zaffaroni founded the ALZA, scientific articles, protocols, software, artifacts, Nobel Prizes, contracts, patents, funding (*intermediaries*, in the ANT language), began redefining the existing relationships between the players in life sciences. *Problematization* is not only the formulation of a research field, but in redefining the nature of the technology transfer problem in that scientific field, it activates a series of actors defining their identity and ties. The amphibious scientist begins to become a 'net-like translator' who triggers a subsequent phase of *interest* in which to implement 'exclusion' maneuvers (etymologically 'inter-est' means 'interposing'): problematizations and alternative alliances tend to be excluded, testing and accepting the associations that have been able to act in order to impose the identity they have defined in the problematization. Joining the network involves a negotiation that produces stable alliances: in the phase of *enrollment*, actors accept and carry out the roles given to them, so that the issue of academic entrepreneurship becomes secondary. The IPO by Genentech, in 1980, had definitely changed the general attitude: if the 'values of science' revolve around the expansion of human knowledge, and the 'market' could in some way help to facilitate this process, then the 'financial rewards' were entirely appropriate. DBFs' organizational practices are stabilized to the extent that the figure of the amphibious scientist becomes a 'spokesperson' of *mobilization*: the transfer of technology through new forms of organization become credible and indisputable, forming alliances and acting as a single force.

Amphibious entrepreneurs and narrative dimensions. The process of translation is related to what the narrative approach to entrepreneurial innovation defines as: 'an appreciation of the efforts by players to organize and imbue experiences with meaning' (Garud et al. 2014, p. 1181). The theory of the amphibious scientist becomes 'significant' through collective narration: different actors 'scattered' in the rising biotech market find a common identification point and converge on it to give it a shape (DBFs). The process of progressive agreement of new supporters to 'represent concretely' the actor-network produces a 'scientific caravan' (a 'bandwagon effect') or an 'ecology of action' (Law 2009) having an inherent narrative nature. Dimensions in the entrepreneurial narration are those identified by Garud and colleagues (2014, p. 1181):

- the relational aspect, namely 'the constitution of agency through existing and anticipated relationships across social and material elements';
- the temporal point of view, which refers 'to the various accounts of the past, present and future that are offered as innovation unfolds';
- the performance aspect that 'highlights how narratives serve as triggers for action towards goals that are forever changing'.

In the case of IGA and IGA-Tech, we could appreciate how the amphibious scientist 'in action' has shown the typical dimensions of a DBF struggling with all the specific needs of a body that is, in turn, composite and temporary. Each component of the two entities contributes to the narration as an 'amphibious entrepreneur' in the context of a hybrid organization and with respect to the processes of the recombination of practices that, for the features of the body, leave room for negotiation with the same actors in order to adapt to local circumstances. The same intermediaries of the translation process are stakeholders in the narration: they define the audience, contribute to retain it, allow connecting financial, technical and human resources, make the innovative process intelligible for stakeholders and return plausibility and coherence to the collective stories. If intermediaries do not produce anything, translation stops. In addition, intermediaries have the function of *translating* the collective action into stories that imply 'time, timing, and temporality' (Polkinghorne 1988). Time in the sequence of events merges with entrepreneurial experience; moreover, time of narration emerges in terms of temporality in the form of 'founding myths' or 'historical passages' in the roadmap of the company (both commercial and scientific). Finally, from a performance perspective, recruitment and mobilization are two narrative phenomena, traced back to what Pinch and Bijker (in Bijker et al. 1987) call: 'rhetorical closure' and 'problem redefinition',' mechanisms that, in the translation process, stabilize an artifact. John Law (2009) recalls that in the ANT, relationships do not stand alone, but they should be 'enacted into being' to produce social order (*performativity*).

Implications and future research. The narrative perspective of entrepreneurial innovation and the ANT research strategy can lead to interesting implications for at least three levels: the policy level, the academic entrepreneur level and the research level. First, the most interesting stories can be extended to the level of institutional innovation and 'collective action'. Furthermore, from the academic entrepreneur perspective, processes of growth and development paths can be classified as relational and qualitative growth to manage heterogeneity in terms of 'social boundaries' and 'collective practices'. Finally, in a logic of complementarity, the research perspectives that are based on the dichotomy 'discovery-creation' may find interesting developments through the comparison with process perspectives.

NOTES

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1. Source: http://www.genome.gov/10001772.