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Volume 40

Frugal Innovation and Innovative Creation

Paul Bouvier-Patron

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Introduction

In order to innovate, the frugal approach meets the dual objective of seeking a competitive advantage while lowering the costs of innovation, and a new potential for innovative creation (see Chapter 7) likely to promote innovation (see Chapters 5 and 6) that respects the Natural Environment (NE) (see Chapter 1). In this book, therefore, it is not a matter of addressing, per se, frugality or the circular economy, or even the figures (the subject of numerous publications) of pollution, waste or recycling, which are staggering in their volumes, even though, when it is possible, the recovery of existing waste, at best and on average, does not exceed 50%. This invites us to reflect on the need to produce and consume differently. The point of view adopted is to place ourselves halfway between economics and management. The key actor is the company or companies, but more specifically, innovative companies in their interactions with the NE. Taking into account NE can be perceived *a priori* as a costly constraint, especially in an innovation process that is already intrinsically very costly. Technological innovation, which is very popular in the West, always comes at a very high cost. Therefore, is it possible to produce an innovative product that respects the NE at an acceptable cost? This question will be addressed throughout the book and can be answered or solved as long as we accept a questioning of the classic scheme of innovation in business while adopting a consequentist approach (see Chapter 1 and Appendix 2; Bouvier-Patron 2014, 2015a).

The first positive response in this sense, found by the companies themselves, is to operate in a network *(network of companies:* NoC) generally articulating complementary skills. Each company in the network is refocused on its business and, potentially, a leader in its field (by concentrating its resources, skills and efforts, particularly in terms of innovation) on its distinctive specificity.

The coordination of distributed competences is a clever way of controlling the costs of innovation of a good produced within a network. This decisive inter-organizational dimension is not, however, sufficient to deal with the question of the NE and is therefore only one step in the process.

The second positive response is potentially the mobilization of technology (via ICT and DT, respectively: information and communication technologies or ICT; digital technology or DT) favoring fluid interactive coordination, more or less virtual, and drastically reducing the costs of design by the FabLab while relying on a mutualization of exchanges of information, skills and knowledge through innovation communities (extending beyond and/or transversing the companies). The communitarization of innovation with a decentering towards design/conception is an original and adaptive device, but one that does not necessarily yet integrate the question of the NE while accelerating the technological race.

The third positive response, still in the making, consists of moving towards a technical-organizational reappraisal through a form of frugality likely to promote innovation, but integrating from the outset the consideration of the NE.

Frugality is a recent concept, but is no longer a new concept in its classical terminological sense (for the classical version, see Basu et al. (2013)). One contribution of the present work is to insist on the possible articulation of frugality with the consideration of the NE: hence, the advanced concept of *frugal environmental innovation* (FEI) (see Bouvier-Patron 2017b, 2020). From then on, by crossing frugality and taking into account the NE, the nature of the innovation induced comes back to questioning technology insofar as it is, finally, a matter of being interested in the *satisfactory technological level* (in the sense of satisficing (Simon 1976, 1978)). Far from being anecdotal, this new look refers to a

reflection on the usefulness of an unbridled recourse to technology in western or westernized societies.

In order to understand the process towards this *frugal environmental innovation* or FEI, it is necessary to go back to the foundations of innovative creation (Chapter 7) and to unveil its fundamental forces. Of course, both technology and an appropriate form of organization (some forms of organization being more conducive than others) contribute to innovation; but the latter is incorporated into innovative creation, the two key drivers of which are elementary practices (radiating whatever the more or less technological and/or more or less organized modality): *bricolage*[1] and *improvisation* (Chapter 7).

Thus, bricolage and improvisation are two crucial levers that operate, regardless of the type of innovation, the place, or the time, both in the design of the product and in the very functioning of an organization or inter-organization. Bricolage and improvisation are thus essential as cogs in the dynamic complexity of organizations: whether we are engaged in an expensive technological approach or in a frugal practice and whether or not we integrate the NE.

In order to allow the path followed to succeed, it is necessary to break down the problems and present them one after the other until the solution is possible through FEI, but this relies, like all innovative solutions, on two essential springs: bricolage and improvisation.

The specific form of frugality sought, the FEI, examined in Chapters 5 and 6, must take into account the NE (Chapter 1), long considered a free resource and which turns out to be an exhaustible good: this is a characteristic with multiple consequences on the societal level and which proves to be, from a strictly rational point of view, a new constraint to be managed in the business equation. It is therefore also a new challenge for the company, even though the problem has been pointed out for a long time. Recycling at the end of the chain (never guaranteed) is necessary to mop up the existing but (beyond the imperfections and problems of such a practice) must be revised. The challenge must now be to innovate products and technologies that respect the environment from the outset, while thinking *ex ante* (through design) about the end of life. The path is stimulating but not easy. Theoretically, the necessary revolution in thinking for this paradigm shift is reflected in the dual concept of *positive private good* (PPG) and *consequentism* (see Chapter 1). To achieve this type of PPG, given the accepted practice in the West, a technological response is possible through the coupling of ICT and DT from FabLab (Chapter 2). The FabLab is a means that mobilizes ICT and DT, assuming a collaborative and open interactive organization with decentralized expertise oriented towards experimentation for the creation or innovative design and then the conduct of projects (with or without a commercial purpose) where technological bricolage and improvisation are essential. The 3D printing used in the FabLab is an increasingly effective support tool, but its impact on the NE is still unknown. The same is true for the ICT and DT that allow for dematerialization and virtualization (thus minimizing a form of impact on the NE) but that induce the use of elements that are not very respectful of the NE: instruments (computing machines, networks of machines, portable terminals, connected objects, sensors, batteries, relays, systems and transmission flows, such as 5G), dynamic interactive storage of the Cloud linked to Big Data (multimedia mass digital data) and the energy needed to power and manage the overall operation.

The technological combination of ICT and DT is accompanied (Chapters 3 and 4) by a new way of innovating through the communitarization of upstream (community of practice; see below) and downstream (community of use) innovation. Innovation is affirmed as a collaborative, open process, and associates use from the design stage. The organization of innovation mobilizing resources and means in this collaborative and open framework is a crucial issue, especially as the design approach invites multidisciplinarity and the need to perceive complexity, hence the innovation platform dedicated to a project and/or

specialized in a field. Innovative creation and innovative design actively mobilize, in this context, the bricolage and innovation so vital for the maker or hacker.

The resulting downstream use (Chapter 4), through the tools available (for the user via the Internet – essentially the smartphone and the laptop – as well as the frequentation of social networks) generates a creation of value increased by the virtual in an expanding bubble that is limited only by the imagination of those who offer and seek it. Let us note that classical marketing or online marketing, whether strategic or operational, can rely on artificial intelligence (AI) to articulate the collection, processing and use of mass data for all kinds of commercial (or other) purposes. AI, in a multidisciplinary perspective, consists of implementing a certain number of techniques and/or technologies, allowing machines to imitate the human brain and/or to create a form of intelligence by elaborating usable knowledge. The degree of machine expertise is correlated to the evolution of the technologies themselves: from imitation/reproduction by predefined programming at the beginning, we are now moving on to Deep Learning which aims, through learning by mobilizing Big Data, at a form of autonomization of artificial creation and decision-making. The fields of application of AI are numerous. One of the most striking, in everyday life, is, for example, facial recognition. The growing use of AI touches various and sometimes unexpected fields. We will illustrate the question of the use of AI by marketing (conclusion of Chapter 4) by addressing a symptomatic case, that of the virtual influencer. The issue of virtual influencers, far from being marginal, deserves great attention as a point of intersection: technology (or often combinations of technologies including AI and social networks); strategic marketing; consent (permission marketing; see below); experiential (experiential marketing proposing the immersion of the prospect and/or customer, in an attractive interactive sensory and emotional universe, providing an unforgettable experience where the individual pilots their real, augmented, virtual or simulated experience), which can also make sense within the framework of a communal referential of the post-modern tribe type (see Chapter 4).

The media noise about a particular application (e.g. TikTok) concerning potential abuses (or risks of abuses), in terms of the use of personal data, is not the exception but the norm. The risk (potential or proven) is present. Only the ethical rules (notably of the provider or of a brand), when they exist and are respected, are a remedy to abuse, but the technology allows this abuse. Beyond the ethical stakes and the use of personal data (with or without user/client consent[2] as a dividing line as well as a new way of marketing), the power of commercial potential is multiplied.

Whatever the criticism or relativization to be made, the technological means engaged (from the most basic to the most advanced) are still based on *human innovative creation* approaches (at least as long as the machines are not at the origin of the creation, because, to this day, all machine creations result from algorithms programmed by humans and, eventually, allowing the machine to understand with the help of the supplied databases): human creation where bricolage and improvisation have their place.

The level of value to be elaborated does not contravene this rule as long as humans control the system and the communitarization of innovation is based on the interweaving of levels where enlightened amateurism, decentralized expertise or strong professional expertise are side by side, intermingled and fructified by mutually supporting each other.

Also, in the face of technological excess (or technological hubris), a return to common sense through frugality (Chapter 5) can be an alternative without sacrificing anything to the desired result. Obviously, frugality in its basic definition is not enough to develop an alternative, especially when the alternative sought must incorporate consideration of the NE: hence, the concept of the FEI. This specific frugality to be convoked, the FEI (Chapter 6) as a specific EI, represents a dosage or *satisfactory technological level,* as it is adapted to innovation, which respects the NE in a consequentist approach.

The key problem is therefore to find the *satisfactory technological level* (in the sense of satisficing (Simon 1976, 1978)) within an open interactive collaborative organization based, in particular, on serendipity (discovery by chance), trial and error, or resourcefulness (or system D).

In the end, this raises the essential question (Chapter 7) of the basis of innovation, whose roots and very dynamics are based on the springs of bricolage and improvisation in an open, interactive and collective organizational framework. The proposed focus revisits the very understanding of innovation.

For now, let us emphasize the very nature of the dynamic complexity of organizations (Bouvier-Patron 2001, 2014) as a receptacle for innovation and for carrying out the necessary transformation and/or change.

The organization, itself a complex entity, enables innovation through a dynamic ability to create, interact, open up, learn, be agile, discover by collaborating and, if necessary, redeploy. A complex innovative project mobilizes a lot of resources in a time frame that may or may not be under control. If, for an expected result (with no guarantee of success), time is constrained, the resources to be committed will be much greater, with a high number of trial and errors and waste or losses, and this is the general case in competitive situations. Apart from NASA (a public agency coordinating its private suppliers) with a substantial budget in the 1960s, only a few rare for-profit organizations (e.g. SpaceX, but again with public funds) venture to plan innovation on very complex projects; this also presupposes a form of innovative monopoly (in Schumpeter's sense), having a head start, with potential competition being sufficient to stimulate the effort without being able to threaten the project. However, as a general rule, in a hyper-competitive world, the company finds it impossible to plan innovation. At best, the company can create favorable organizational and technological conditions to stimulate the innovative effort (e.g. 3M). In any case, both the cost of access (in terms of means to be put in place, investment in machinery, skills and knowledge, training of people) and the intrinsic cost of carrying out an innovation before it is put on the market are high, without even prejudging the subsequent commercial success.

In a competitive situation, the ability to be proactive is the organizational breath that also gives the company an adaptive capacity to adapt to the context, whatever the path taken in the past, and to anticipate the future (not in a planned way, as this is generally impossible, but at least by not closing off options that could prove useful later).

At the abstract level, this factor of permanent evolutivity while preserving a core corresponds to a dynamic complexity close to self-organization (see below).

We will first discuss the evolutionary logic of organizational forms before underlining the bases of dynamic complexity that allow us to understand uncertainty and the need to renew skills.

I.1. Organization of the company and organization of the form

The National Institute of Statistics and Economic Studies (INSEE[3]) mainly classifies companies or enterprises by size, according to the number of employees (individual enterprise (IE); $x < 25$, very small enterprise (VSE); $x < 250$, small- and medium-sized enterprises (SME); $x < 5{,}000$, intermediate (ISE); $x > 5{,}000$, large enterprise (LE)). However, the underlying assumption of homogeneity of behavior according to size is questionable for the analysis of competitive strategy and/or value creation (where what matters most is the ability to create a nontrivial and/or innovative product). Size, taken as an explanatory variable of success, is in fact an *ex post* observation, which does not

integrate the choice for any organization to grow (or not), and is neglecting the fact that success is always relative to the success criterion used. Moreover, starting from the different sizes does not allow us to explain the transition process from small to large companies. Especially because, for a given size, sector specificity can play a role as a key explanatory variable of success. Moreover, the contextualized singularity of a particular market imposes itself on each company present on that market, regardless of size. The only intangible rule identified is that, within the organization, codification and formalization (of procedures, rules, skills, processes, products) are essential for growth (Chandler 1962). In a population of companies (taken at random), a correlation may exist between age and size but this is not always proven. In this same population, for a given size, several different *organizational forms* are generally present. Historically, from a timeline since the beginning of the European industrial revolution (noted IR*), from 1770 onwards (and rather 1790 in France), we can see a trend in the evolution of forms through choices of adaptation to new phenomena (more or less brutal) or to different circumscription parameters (contingency). The trend is the reflection of decentralized behaviors that converge in the same direction. The dynamics of evolution and decentralized change are initiated by each company as a proactive or adaptive entity in an environment that is co-constructed and shared by all and that can be subject to sudden external shocks. A historical overview allows us to understand that a company can be born at the beginning of the industrial revolution, transform itself as its market expands (quantitatively, qualitatively, geographically) and reform itself (or adapt in the event of a crisis or problem) in order to avoid disappearing without this being a general rule.

Thus, a company born in the industrial revolution can still exist today (e.g. DuPont de Nemours, a company founded in 1802 by a French nobleman who emigrated to the United States of America) or can have completely disappeared. The creation of companies has been numerous in all eras, but mortality has also been high in all eras. A major question remains that of the growth of the company, by transition, from the individual company or the start-up to the large enterprise (LE) when its deliberate choice is to grow (some choose not to grow). The corollary of this analysis is the speed of transition from one form to another.

The diachronic perception of the dynamics does not prevent a synchronic perception, at a given moment, with a cross-sectional view showing a diversity of sizes (IE, VSE, SME, Int., LE) of enterprises – which are not at the same stage of evolution and/or do not want to grow (enterprise keeping a small size to maintain a limited production and quality to preserve knowledge, a know-how, an authenticity) – but also a diversity of forms.

Comparing implies taking companies of the same age, in the same sector, on a particular market, in the same cultural context and in a homogeneous geographical area (within the Organisation for Economic Co-operation and Development (OECD), for example, as it is delicate and anachronistic to compare European and Chinese companies).

We can also try to detect a general law of the demography of the organizational forms of companies (apart from the temporal dimension and historical anchoring) rather than looking for criteria of birth, evolution and disappearance of companies (beyond even a particular case of company).

The concept of the company, in the modern sense, makes sense with the industrial revolution. Any company, at this origin, marries the *simple* form (which today corresponds to the IE, the SME or the start-up). The economic life not being an eternal homogeneous ether, the evolution is permanent. Any historical transformation has an irrevocable character (Georgescu-Roegen 1971). Permanence seems to be that of the socio-ideological substratum of market transaction (relatively immutable) since at least A. Smith with his famous book, published in 1776. Each period of time is affected by a combination of specific variables and requires appropriate responses from companies, not taking into

account the anticipations of the most proactive actors (the latter will be ahead of others and will do better than others but will not escape the general context of the moment).

It would then be futile, beyond the birth of a form (a form espoused by symbiosis or impelled by necessity at one period), to predict the death of the form:

- on the one hand, because the forms coexist synchronically, through a distribution of roles in the economic and managerial universe;
- on the other hand, because, at the diachronic level, the required evolutions telescope the forms and produce mutations from one form to another without ever liquidating the previous form or forms.

Over the period 1790–2010, the simplified typology of the organizational forms of industrial companies can be broken down as follows: simple (S), functional (F), divisional (D), matrix (M), network (N) and virtual (V). The holding form (H), which is excluded here, allows for lubrication and flexibility of the economic machinery, via legal and fiscal advantages, but at the risk of emptying the company of its industrial substance for the management of a financial portfolio (which is denounced by Chandler 1977), one possible role of which is the conservation or transmission of patrimony. We can therefore attempt to establish a *theoretical table of the demography of the organizational forms S, F, F', D, M, N, V of companies.* The evolution is not automatic, but merely shows a trend. It would take a long time to explain the phases of transition from one form to another. Each pure form represents a typical model. Each typical model is the result of reflections and/or managerial practices, at a given period, taking into account the experience acquired from previous forms, in order to respond to unmet structural needs. Each model is associated with academic authors (who generally observe rather than anticipate evolution). Only practitioners (such as Ford for the F-form or Sloan for the D-form) were designers, practitioners and anticipators.

The simple S-form (from the IE to the SME) is emblematic of the original capitalism of the beginning of IR (IR*), which persists today and which Knight (1921) defends.

The functional form F was set up at the end of the IR by: Taylor (1911) in terms of the organization of work (through parceling out with the aim of productivity); Fayol (1916) in terms of hierarchical rationalization; Ford in terms of supply, via a business model[4] (a model for all based on the productive efficiency of volume and standardization) as well as, at the commercial level, via the creation of a solvent demand (purchasing power through an attractive salary). This is perfectly in line with a project emblematic of the industrial revolution, namely the democratization of the product, i.e. the sale to all of a good previously reserved for the elite (for instance, the automobile in the case of Ford as a company).

These last three creators provide complementary contributions from an efficiency perspective (at the risk of excessive verticality and task specialization leading to staff exhaustion and demotivation). The reforms implemented to correct the excess of the F-form, based on the work of E. Mayo (whose initial objective was to seek, by means of environmental factors, the conditions that would allow productivity to be increased), led, later on, to the hierarchical-functional Staff & Line form, denoted here as F', where expertise, the quality of the work environment and the reintegration of laterality into the organization made it possible to improve the functioning of the F-form, but did not transform it into its substance.

The divisional form (D), introduced by Sloan (head of General Motors and Ford's competitor) to promote product differentiation as early as the 1930s (and even more so with the advent of pull marketing after World War II), was later theorized by Chandler

(1962, 1977) as an essential key to the growth of the company open to the world. This form is still one of the most widely used by companies today.

The matrix form (M) emerges at a singular moment in the history of humanity to carry out a particularly complex project, unprecedented on the scale of the planet, articulating complex complementary sub-projects: to make humans walk on the moon (requiring the solving of so many problems: the rocket, its propulsion, the lunar landing module, the diving suit, the return to the Earth, etc.).

NASA was the instigator of this M-form. Only a few private companies, resolutely oriented towards innovative projects that are technologically, commercially or culturally complex, have adopted this M-form today.

The forms mentioned so far refer to an intra-organizational logic. A significant evolution has been to no longer simply consider the intra-organization but to consider the inter-organization following the example of the network form. The N or network form (*network of companies* or NoC) has imposed itself by being inspired by the Japanese *J* resilient customer–supplier industrial network organization, which makes it possible to offer high-quality products at a price that was then inaccessible to other western firms, as well as to innovate at distributed costs. This *J* model, theorized by Aoki (1986), constitutes a major evolution in industrial organization by systematizing the pairing of business refocusing and outsourcing (which implies strategically defining the business and outsourcing all activities that are not part of it, while preserving, if possible, secondary activities that are useful for the renewal of the business); the outsourced parts remain necessary for the realization of the final product. With each company being refocused on its core business, networks of complementary activities are formed. The network, around a coordinating actor, brings together competent and innovative complementary actors.

Outsourcing takes place outside the company's borders in the local or national space. If outsourcing takes place outside the national framework, it is referred to as delocalization. Delocalization is increasingly disputed, but the return of products to western countries is to be distinguished from inversion and from reversion (see Chapters 5–7). Depending on the needs of the *business model* chosen, no function can escape *a priori* to outsourcing (e.g. outsourcing research and development (R&D) is no longer necessarily a marginal phenomenon (Bouvier-Patron 2009; Appendix 3).

The turn taken by companies in the 1980s, consecrating the network form (N), generates a more open organization crossed by a widespread innovation. Basically, there is a new economic and social dynamic referring to a possible new industrial revolution. The network form can give rise to a bifurcation on a variant: the virtual form (V). The virtual form corresponds to an extension of the network form in a dematerialized way by first mobilizing ICTs (then the DTs): the Internet in particular. The abolition of the physical and/or geographical and cultural frontier of the enterprise is the most visible characteristic of this form, in addition to the preponderant role taken by technology at all levels. This is obviously true beyond the lone *start-up*.

Recent developments, incorporating ICT and DT, tend to associate a geographical place of collective creation and a geographical virtualization to extend the community and the exchange of information or practices: a network form incorporating an open FabLab is an illustration. All organizations are concerned, the only question being whether the FabLab is outside the walls or within the walls of the company. *Innovation platforms* (Merindol and Versailles 2017), specialized by major innovative project (thus reviving the matrix form but beyond the intra-organization), make it possible to geographically localize and mobilize skills (from various horizons and specialties), as well as methods (ICT and DT technologies; FabLab-type organizational methods; test centers; showrooms) in a spirit of communitarianization of innovation.

Everything here seems to be focused on fluidity, agility, adaptation, experimentation, learning and evolution, relying on the structuring concepts of bricolage and improvisation, within the framework of an open community and mobilizing the technological means of ICT and DT as the key to innovative creation. If the ICT and DT dyad is a promising combination that should be valued, three-dimensional printing (or 3D printing within DT) will play a growing role in the industrial organization and the organization of the firm because it generates a revolutionary way of designing and producing. 3D printing emerged in the early 1980s for rapid prototyping.

The major characteristic of 3D printing (Berchon 2014) is the method of *additive manufacturing* (AM) – adding material layer by layer – as opposed to the usual *subtractive manufacturing* method known in the processing industry since the beginning of IR (IR*) – by progressive removal of material or deformation of material. All known 3D printing technologies today are based on the formation of the virtual 3D object in successive 2D thin layers: the layers are deposited one after the other, by fixing them to the previous ones, to constitute the final real object. Three main 3D printing techniques, which appeared successively, coexist today:

- *Fuse deposition modeling* (FDM) where a filament of synthetic material, usually plastic, is melted through a nozzle. Trademarked by the Stratasys company, this process was improved in 2005 with the *Replicating Rapid Prototyper:* the first printer with documentation freely available on the Internet and a machine itself under GNU GPL license[5]; and others are now available in open source.
- *Stereolithography apparatus* (SLA) using in general a special resin sensitive to ultraviolet (UV) treatment. The patent was filed in 1984 by the founder and director of 3D systems.
- *Selective laser sintering* (SLS), a technique similar to the previous one, but where a laser agglomerates a powder rather than resin. Intended for R&D, these printers have the advantage of allowing the choice of printing materials as long as they can be reduced to a homogeneous powder.

This last process is also valid for metal *(Direct Metal Laser Sintering,* DMLS), a key area of research and development. Boeing and EADS are now using the technique to build aircraft parts.

3D printing, initially adapted to specific local unit production, is seeing its limits being exceeded at all levels:

- reduction in the cost of machines and raw materials;
- choice of the size of the series (small or large);
- increase in precision, quality and speed of printing, as well as in the choice of materials or colors;
- the possibility of printing any type of object by its nature or size (the technique of contour crafting, via a 3D printer larger than the desired object, makes it possible to build a house, for example);
- design software that is less and less complex to use and/or recourse to scanning or to digital model files available on the Internet;
- for objects linked to combinations of ingredients that cannot be printed in one piece, each ingredient can be made alone and then assembled.

The network–virtual–FabLab–3D articulation is a powerful economic vector with immense potential for transforming industrial organization (but the health and NE impact of 3D

printing has yet to be assessed). The breakdown between industrial production in companies (in whatever form: S, F, F', D, M, N, V) and domestic production (household, family, artisanal: traditional and/or virtual) and/or henceforth also in open collectives or even in solidarity and social forms can play like a cursor that can call into question the founding model of development known since the beginning of the industrial revolution (IR*). The division between this new mode of production and the old one may be sectoral (due to the importance and necessity, or not, of equipment or infrastructure industries; or for collective or voluminous objects) or according to the typicity sought and/or the small series for micro–markets. The company will remain as a physical place of production, but it may be reserved for certain productions of equipment or intermediary goods or downstream, as an interface with the final customer (unless we are betting that the latter will replace everything else and become its own producer in all fields).

The network form, by its flexibility, and without specifying its morphology *a priori,* can be sufficiently generic to think of its deformations, by decomposing/recomposing the enterprise organization in different ways. The superimposition of the virtual form on that of the network completes its protean character. 3D printing opens new perspectives in terms of the design and production of artifacts.

On the demand side, if the former customer becomes the designer, producer and user of their own needs, and if everyone has ICT- and DT-related means at home or in a shared place, the whole production-distribution-sales chain will be modified.

Individualism, an essential value in the West, already at the center of political revolutions at the end of the 18th century, the concern to differentiate ourselves socially and economically in the 19th century, and then the rise of the consumer society in the 20th century, now sees a technical, practical and ethical solution with ICT and DT. The individual can envisage a project and/or a specific fabrication, alone at home (Do It Yourself, DIY) or in a collective (Do It With Others, DIWO) at the FabLab, generally by joining a *community of practice*[6].

The network form extended to the *virtual* form generates a new potential of creation/production/distribution through ICT and DT.

The brakes to the hyper-decentralization generated are rather physical constraints measurable in terms of health risks (still to be evaluated), space (to install and carry out the desired production), human-machine cohabitation, nuisances (storage, sensitive nature of inputs, upstream or downstream pollution of inputs or outputs, noise pollution, health risks). This is why IE, VSE and SME companies are still led to play a key role as an interface: through design/production, upstream, with final customer downstream.

The current period is a potential source of a new economic and social dynamic that can be drawn around three main scenarios (and a possible evolution from one to the other) depending on the intentionality of the actors and their effective actions:

- continuation of the current trend where large key companies have large R&D center(s) operating within classical customer-supplier networks and/or feeding a nebulous virtual quasi-network to ultimately serve the end customer (whose role is rather passive);
- dominance of a few large technological companies, upstream of other (large or small) dependent ones, the former piloting a real and virtual nebula, leaving a superficial congruent portion to individual initiative; with relay SMEs serving the final customer;
- decomposition and/or sustainable splitting up of large companies (at least in the OECD), except around a few technological cores driving the virtual economy (e.g. the GAFAM, Google, Apple, Facebook, Amazon, Microsoft or Intel), to the benefit of a complex and decentralized nebula shaped by the in-built dynamics of technology and

the virtual economy, where all the individual or collective actors become entrepreneurial-bricolagers.

At the industrial level, the S, F, F', D, M, N, V forms of enterprise will remain. The probability of each scenario occurring will depend on the progress of technology, especially 3D technology, and its dissemination to the end customer, as well as on access, via the Internet, to the democratization of 3D modeling. This raises the recurring question, since the beginning of the Internet and digital technology, of the management of proprietary solutions and, alternatively, of the possible use of free software through open source. In any case, each form corresponds to a pivotal point in the evolution of the historical context. The proposed summary Table I.1 is indicative and can be read in columns.

The company in the modern sense appears with the industrial revolution (in the phase: IR*), and any company, at this origin, is an IE that marries the simple form.

The non-liquidation of the previous form (immortality of the form but potential mortality of a singular enterprise) is tangible even for the functional form (F) announced as dead at the end of the 1960s in the West (because it was rendered bloodless by its organization), is present today in growing countries such as China, India, Bangladesh or Brazil and can find a new youth in Japan with the very advanced robotization (labor substitution by capital).

Table I.1. *Table of demographics of organizational forms*

(source: author)

Forms	S (IR*)	S	F, F'	D	M	N
Birth trend	(1790)	Creation	1900	1950	1970	1980
Evolution: growth	(1850)	If ≥ 5 years	1914	1980	Possible but rare	1990
Evolution: transformation	1900	Choice to maintain or Δ form	1960	1990	Possible (return to D or to N)	Potent and perma
Stabilization	If life and if choice	If life and if choice	1940	1960	1980 (as well as punctual)	2000
Death of the form	Never	Never	2030 for BRIC? ... but pursued with robots in Japan	Never	Never	Never
Mortality company associated	High but creation and after 1900 where concentration	Raised (bankruptcy) ... but creations	Raised from 1970 onwards bankruptcies	Low and/or redemption or merger	Low Abandonment for reversion	Low Recom (morta nonsei

Japan, with a declining demography (and not compensated by immigration, voluntarily, for the sake of cultural identity), can find its economic salvation via the functional form by using massively in the near future robots (instead of people), which can constitute, in addition to the return to the myth of the flexible company without people, an essential competitive advantage (strong decrease of the wage bill and/or of the charges on the personnel or even decrease of claims or conflicts, of accidents and professional diseases).

Japan is at the forefront of the design and development of robots and does not hide its ambition to replace people with them whenever possible. In this context, there is no reason not to (re)mobilize the purely functional form to produce goods. The organizational question is then settled from a certain point of view, with the same causes producing the same effects; this perspective engenders even more of the systematic exhaustion of resources (once all people have been mobilized, all other economic factors are exploited (and/or wasted) and all natural resources are destroyed). The search for a viable alternative is the subject of this book.

However, before this new perspective, in order to capture the essence of change, now going back to a more abstract level, it seems essential to us to seek in order to characterize the complexity and the organizational dynamics.

I.2. Increasing interactions between firms

Economic dynamics are characterized by the complexity of growing and evolving interactions (intra- and inter-firms) within a competitive as well as cooperative environment through open innovation, the adoption of rival technological options, spatiotemporal contextualization, the key role of the inter-organizational network, contingencies and customer demand. The managerial issue is the articulation of complexity and the stability/dynamic dyad; this generates change.

I.2.1. *Complexity and stability/dynamics dyad*

Simon (1947, 1957, 1969, 1980, 1982) is one of the great architects of the organizational complexity sciences, whose flagship concept is that of the open system.

At the basis of complexity theory, we find Von Bertalanffy's systems theory (1968) (where any system is composed of five elements: inputs, process, output, environment, objective), as well as Wiener's (1948) science of systems (or cybernetics, a concept coined in 1938), which explains the system as a set of interacting elements, the whole having properties (characterizing the dynamics of the system) that each element does not have in isolation. A distinction is made between a closed system and an open system: the difference between the two is the openness to the environment. The *system* can then be defined as a *set of elements in dynamic interactions forming an entity (with an external limit) organized according to a goal.* We also obtain, as a joint product, the definition of the organization (by specifying that the goal is intentional and emanating from a human collective) and even, at the same time, of the company (by specifying, moreover, that the goal is lucrative).

The properties of an open system are as follows: finality (a goal); equi-finality (different ways are possible to reach this goal); complexity (see below); feedback (existence of feedback and acting information); homeostasis (the capacity to reach an equilibrium despite the turbulence of the environment); and non-summability (the whole is greater than the sum of the parts).

For the rest, we will remember that complexity is constituted by a large number of elements (potentially varied in nature) in interaction, generally open to the environment, in a dynamic process that can be unpredictable.

A fundamental law of complexity, established by the neurologist and engineer Ashby (1958), in the footsteps of Wiener (1948), is *the law of required variety of the system.* "Variety" is the count of the number of different behaviors and states measured for a given system.

This law states that the *more complex a system is, the more complex the system's control system must be* in order to respond to the multiple potential disturbances (from the

environment, for example). It is therefore imperative to preserve the internal variety of an organization in interaction with an environment (potentially infinitely complex) in order to allow regulation. Moreover, Ashby (1952, 1958) proposes the distinction between adaptation and learning where learning is the strong concept: the system first treats a perturbation as minor (single loop) and then, if it leads to failure, it learns and treats it as major, generating a modification of the action pattern (double loop).

There are therefore two forms of feedback according to Ashby (1952): single loop to avoid repeating the error made; and double loop to significantly modify the action pattern. Machine learning, through the programming that follows, aims to imitate the functioning of the human brain (which will lead to AI).

The combination of the two effects at a higher level, the triple loop (mobilized for organizations by Argyris and Schön (1978)), makes it possible to insist on the importance of the operational proposition of learning to learn as a generic skill. The limit of the approach lies in the trial-and-error selection procedure through answers drawn from a prior reservoir and through an automatic procedure. Organizational learning, in the absolute sense, should be a controlled process (whether the change is internally generated or externally initiated by positive capture or forced import), inherent to the functioning setup in a particular organization and allowing for adequate management in the face of uncertainty and for any source of uncertainty. In other words, the art of steering under uncertainty cannot normally be linked to pure luck but should result from the intuitions and procedures learned (and, logically, regularly updated by the collective of actors constituting the organization under consideration), experimentation, learning, bricolage and improvisation.

Opportunities are offered by the economic environment, regardless of the weight of the past, the trajectories or the orientations chosen, but on condition that they can be seized. The ability of firms to reposition themselves and/or capture new opportunities is essential in the framework of strategic management (Ansoff et al. 1976; Ansoff 1979) and/or in competitive positioning strategy (Porter 1980, 1985). However, this is only fully possible with open (and proactive) organizations, which think in terms of skill renewal and learning (Penrose 1959).

Everything moves, but decision-making implies the existence of relative stability (useful for creating value) at a given moment: hence the stability/dynamics dyad. Simon (1980, pp. 52-57) explains this clearly: the process of evolution leads to global qualitative leaps from simultaneous adaptations of each element that is at the basis of it; however, this is only possible because there are stable principles that ensure and preserve the potentiality of this evolution. It is a question, for example, of the genes in biology (Simon 1980, p. 56)[7].

In economics and management, finding the equivalent principle is very difficult, but it could well be (Simon 1980) organizations and markets (which are always regulated in one way or another – the more they are deregulated, the more the state is the guarantor of the last resort – to restore stability, even when there are profound changes in the system, often perceived as crises). North (1990) and the institutionalist current have explored this axis. Moreover, Simon (1980), Powell (1990) and others reject the market-organization dichotomy[8] (initially established by analytical convenience as well as by neglecting the essential role of the environment and interactions).

In a dynamic framework where interactions are increasing between actors, within organizations and between organizations, coordination configurations are renewed through bifurcations. We must therefore consider the dynamics of business organizations (generally in cooperative interactions: Ring and Van de Ven 1992, 1994)[9]. In this context, the role of interaction, self-organization, learning and renewal plays a major role. If we take a closer look, the trade-off to be made is a double consideration (apparently

contradictory), which can be summarized as the stability/dynamics dyad. This is in line with the intuition of Weick (1979, p. 215), for whom the need for the firm to function requires a trade-off to be found between stability and flexibility: the stability/dynamics dyad.

Simon (1976) suggests using procedural rationality in the context of bounded rationality, where it is important to insist on the fundamental character of the processes of stabilization of the environment[10], as well as of the moments of rest (suspensory) between two search procedures (launched by the company) when we accept the idea that the firm is subject to a bounded rationality of the actors since Simon (1972, 1976, 1978, 1979, 1982, 1986). The clarification concerning stabilization is of great importance, because by sometimes focusing on sectors of the economy that are subject to rapid rates of change and to the weight of permanent disequilibria, we often come to consider that there is a perpetual search.

First of all, the existence of a search should not be confused with the statement of the obvious that it is not possible to predict, locally or globally, the future behavior of the economic system (even though we try to build possible scenarios). Secondly, it is even more important to remember that the setting of objectives, their attainment and their possible revision are inescapable phenomena of human activity requiring the formation of anticipations and conjectures about the future, and that this attitude contributes to what tomorrow will be like. The close interweaving between the necessary principles of stabilization so that organizations can function, and dynamics so that they can evolve obliges us to consider a rereading of the firm. Naturally, the field covered, in order to envisage new angles of analysis and with the help of tools linked to new approaches, is vast, and we propose to explore a necessarily restricted domain: that of the firm and its economic environment, or rather, in order to avoid remaining in this misleading dichotomy, which is the source of many misunderstandings, that of the firm in interaction with other firms in a given environment. This interactive dimension is not thought of in a static way and is necessarily based on dynamic reasoning in which the dimensions of learning and change play a full part. Let us look at the foundations of a first alternative paradigm to the standard approach, then at the hinges of the evolution of thinking about the firm, before tackling the contributions of complexity to the theory of the firm and of organizations.

I.2.2. *Reform of the standard framework*

The positioning of standard analysis (or reference analysis) in economics has the merit of clarity and efficiency by relying on robust analytical and mathematical bases with the search for the necessary and sufficient conditions for the existence and stability of an equilibrium, from the microeconomic point of view (producer and/or consumer), as well as from the macroeconomic point of view: with n agents supplying and buying x goods (products and/or services) that can be exhaustively counted (in understanding), on m markets and p prices; these prices allowing, via the markets, the coordination of the n agents between them through their exchanges on the x goods, the vector of prices having to be such that it allows the supply-demand equilibrium. This initial framework is called *pure and perfect competition.* The refinements made to incorporate observed facts, while maintaining more or less the reference framework, lead to a more open variant of *imperfect competition,* to take account, for example, of *imperfections* in competition (Cournot 1838; Chamberlin 1933), *outsourcing* (Marshall 1890; Pigou 1920; Samuelson 1954; Coase 1960), *indivisibilities* and *returns to scale* that disrupt marginalist reasoning (Sraffa 1926).

The question of the existence of *collective goods* also arises[11] (Samuelson 1954), of *information asymmetries* (Knight 1921; Akerlof 1970) or, more recently, the recognition of

the importance of the existence of *network infrastructures* and *network outsourcing* (Katz and Shapiro 1985; Farrell and Saloner 1986).

Developments on *information asymmetries* are absolutely central to contemporary analysis, and it is interesting to note that they result from pioneering work that was initially little considered (Akerlof 1970) or has been relatively forgotten since its publication (Knight 1921).

It is not advisable to link information asymmetries and agency theory because taking into account information asymmetries has a meaning and a usefulness in itself (whereas agency theory[12] is a particular reading of the implementation of the management of a contract on the insurance model). The question of informational asymmetries reveals its full importance in strategic interactions via game theory (where it is even more important to take into account the relational symmetry/ asymmetry: (Bouvier-Patron 1995)) than in a hierarchical and fixed reading of a relationship (as established by the principal-agent or agency theory).

The agency theory is closely linked to the insurance question[13] where the premium that can be paid, once the participation constraint has been met, is conditional on the revelation of information and/or a private characteristic. The insurer seeks to have as many insureds as possible so that the premium to be paid is as small as possible while remaining acceptable, if not attractive. The premium must not be too high so that people can continue to insure themselves (participation constraint); unlike in certain medical specialties where the cost for the doctor to insure themself is too high (or for art museums with their paintings). The agency theory is useful, provided that its limits are understood and that no attempt is made to generalize the approach to any situation.

In the case of *adverse selection*, the principal's satisfaction depends on hidden information known by the agent but not observable by the principal (or even observable but not verifiable): the objective is therefore to induce the agent to reveal this information. The contract is thus designed in such a way that the agent reveals the desired private information (the most cited example being that where the employer (principal) is unaware of the productive characteristics of the employee (agent) and must set up a contract with the appropriate incentive constraint).

In the case of *moral hazard*, the variable hidden from the principal is the agent's own action (and no longer information): thus, for any job proposal, the employer is taking a risk because the employee may not make the effort (a "shot in the dark") but receive the wage (at least as long as they are not detected, because the risk for them would then be dismissal). The level of the wage (and the risk of losing it) can be the incentive to reveal the effort.

The principal–agent model intends to apply to the intra- (e.g. employer/employee) as well as to the inter-organization (e.g. principal (DO)/subcontractor (ST) where the principal gives a task to the ST agent who performs it). We can define subcontracting as a situation of *two distinct decision-making entities in an economic relationship – called the principal – where we delegate a task (more or less complex) to the other – called the agent (who performs it) and is therefore unable to know or estimate without error the characteristics of the agent and/or their actions, while their income depends on it*. The principal therefore implements a contract that incorporates a participatory and incentive mechanism in order to encourage the signing of the contract, on the one hand, and the revelation of hidden information by the agent and/or to encourage them to undertake the best action on the other. However, the agency model intends to govern all client–supplier relationships, whereas it should only apply to a marginal fringe of the spectrum reduced to DO/ST relationships (thus to quasi-integration (Houssiaux 1957)) because it stumbles on the strategies, *bargaining power* and *skills* of providers (see Bouvier-Patron 1994a, 1998b, 2002, 2011a, 2013, 2017a). Moreover, as soon as subordination has to give way to

strategic inter-actions, game theory eliminates the idea of *economic agents* to retain only *actors* whose strategic role is restored, at least partially, by noncooperative games.

Contemporary contract theory, at the heart of important advances in economic science, also often favors agency theory, whereas the primary orientation of the logic of contractualization (since Coase 1937), and the most interesting one at that, is based on *incomplete long-term contracts.*

The dual prism of game theory and incomplete contracting has led to particularly remarkable advances in industrial economics and the theory of the firm (Tirole 1988; Holmstrom and Tirole 1989). Nevertheless, game theory is designed to search for computed solutions (unique and stable) in an abstract way with an effort of realistic contextualization. It is rarely about forging and exploiting strategic tools that model the functioning and real life of organizations. However, real actors make bets in a context of radical uncertainty. This is not captured by pure standard theory, revisited or enriched by postulating that firms maximize their profits (or earnings) and survive, sequentially, only by respecting this rule. In the real world, an organization is born, lives and can die, with more or less success in its development and its business, in a variable temporality and sometimes suffering very significant failures without ever being able to maximize and, what is more, in an immediate way.

The evolutionary theory (two of whose main roots are to be found in Schumpeter (1939) and Penrose (1959)) undoubtedly represents, since the publication of Nelson and Winter (1982), an alternative path to the standard theory. Nevertheless, it must be considered as an ambitious but rather incomplete and imperfect attempt. At the outset, two key arguments are put forward, as a basis for the alternative, to explain evolution and change:

- instead of optimization, individual behavior (and then, at the higher level, inter-individual interactions relies on the *level of satisficing* (Simon 1976, 1978, 1979, 1980, 1982), as well as on *routines* and the *tacit character of knowledge* to be able to innovate (March and Simon 1958; Polanyi 1966);
- the *survival* of a firm in a market is possible without its conduct being governed by the (profit) maximization rule.

These are two important breaks with standard theory. Perhaps paradoxically, it is also the treatment of interactions and routines that deescalates a very serious limit to the approach proposed by Nelson and Winter, as interactions are simply ignored (because they are locked in the black box of routines already retained) and any significant intra-organizational conflict remains within certain limits and follows a certain trajectory consistent with the routine in progress[14].

Strategic interactions and conflicts disappear in the framework of evolutionary theory in favor of general principles of *selection* (which comes exclusively from the environment with an induced causality that brings us back to a crude contingency theory at the organizational level) and *adaptation* (concerning organizations comprising individuals walled up in their firms and their routines within a trajectory). The evolutionary edifice, as it stands (and even conceding that it is not a finished theory), thus ignores degrees of strategic freedom and conflict.

It is particularly unfortunate that the evolutionary paradigm suggests that individual free will disappears in favor of a naturalistic logic in terms of biological robot species. Biological robots (of evolutionary theory) are replacing mechanical optimizing robots (of standard theory), thus ignoring the importance of strategic interaction and conflict in organizational functioning, complexity and dynamics. Thus, the evolutionary and standard paradigms constitute useful reference points for analysis without being very convincing (Paulré 1999; Bouvier-Patron 1999). An important point, however, has been the explicit

recognition by the evolutionary current of the greater validity, in economics, of the Lamarckian hypothesis in relation to the Darwinian hypothesis concerning evolution[15]. The example generally used is that of the giraffe's neck. In Darwin's explanation, all neck lengths exist at the outset, but selection favors the long neck that allows giraffes to grab foliage from above (inaccessible to other herbivorous animals) in a context of scarcity of foliage in the African bush and with the benefit of being able to eat in safety, stabilized on all four legs, while being able to retaliate if necessary or to flee. In Lamarck's explanation, the need to grasp foliage from above implies an animal intentionality. This intentionality, linked to a vital need, implies a push of the neck in time (from generation to generation by continuous improvement) where each useful organ develops.

In any case, in view of the increasing interactions (notably because of the relations between organizations), conflicts, complexity and dynamics in the observable economic universe, there is a general disqualification of the standard economic or even evolutionary explanatory framework.

In both cases, there is determinism: the mechanistic scheme of standard theory or the selection scheme by the environment in evolutionary theory. The useful framework must integrate interactions, conflicts, complexity and dynamics.

In fact, the standard approach was renewed by the theory of imperfect competition (as early as Cournot in 1838, but which was rediscovered late) with market imperfections (through, in particular, *outsourcing* with Marshall in 1890 and *information asymmetries* with Akerlof in 1970). If everything is reduced to individual maximizing behavior, the theory of contracts *(first* or *second* rank), used within the theory of agency, can mechanically deal with the problems of moral hazard and adverse selection, when the interest of game theory is, precisely, to insist on strategic interactions (by preserving maximization). Evolutionary theory refutes maximization but eliminates strategic interactions. For more realistic behaviors, the theory of organizations is not out of the field but is much more used in management than in economics. Here, Simon (1947) opened the way to a better construction of an economic and managerial theory of organizations, much more mobilizable than the one linked to the neo-institutionalist current á la Coase-Williamson, which is a very particular, albeit widespread, part of it (contemporary institutionalism being better represented by North (1990)). The fundamental contribution of Coase (1937) is indeed the highlighting of the incompleteness of contracts, which is still an open and fruitful paradigm today; mobilized by Williamson (1985) in the coordination of specific assets but taking up work on strategic interaction, such as that of Schelling (1956, 1960) concerning a relational model (with *hostages* and *hold-ups).* To muzzle interactions, authors close to standard microeconomics (Klein et al. 1978; Grossman and Hart 1986; Riordan 1990), invoke the *difficulty of writing a contract that should lead to internalization* (or *vertical integration).* This is a denial of reality. As for Hart and Moore (1990), they develop a contractual axiomatic around *complementarity*[16] of *essential assets*[17] and the question of *replaceability* (indispensable versus dispensable)[18].

Let us distinguish between *ex post* complementarity and *ex ante* complementarity, because Hart and Moore's definition of complementarity can only be used *ex post,* i.e. once coordination has been achieved between several firms. This coordination makes it possible to have at our disposal all the skills required to develop a product (through client-supplier relations between, on the one hand, the firm that wishes to develop the product, called the *coordinating actor,* and, on the other hand, the other firms that provide the other required skills). This idea is translated by the generic concept of *specific relationship* (in Williamson, for example): as a result, complementarity exists (as a consequence) of the construction of relationships linked to the joint elaboration of the product. Once this construction has been made, the definition of complementarity in the sense of Hart and Moore is applicable. Hart and Moore's concept of *replaceability* applies

only to an agent towards an asset, but not to an asset towards another asset. For Hart and Moore, this makes it possible to distinguish a productive structure composed of asset(s) with individuals that are, or are not, replaceable from the point of view of access to these asset(s). However, it is even more important to study the *replaceability* of an asset with respect to another or other assets, and if we replace asset by *skill,* we obtain the key idea of the *replaceability, or not, of a skill.* With the idea of the *non-replaceability of skills in the broad sense,* we arrive, at the same time, at the strategic idea (as opposed to the technical angle adopted by Hart and Moore) of *ex ante* complementarity in the sense of Richardson (1972): a coordination of complementary skills, distributed in distinct firms, in order to produce a common product at a later date. However, it is not *ex ante* and/or from a logical or technical point of view that *non-replaceable skills in the strict sense or essential skills* (by analogy with Hart and Moore's (1990) definition of *essential asset)* are identified, but rather according to the competitive context and the power relations in presence.

These power relations are expressed by the respective *bargaining power* of the different actors (Porter 1980; Aoki 1986; Asanuma 1989; Bouvier-Patron 1994a, 1998b, 2002, 2011a, 2013, 2017a)[19]. Several cases can be envisaged: firstly, that of a complementary skill that is engaged but difficult to substitute by another. This is what the situation of the monopolistic upstream service supplier accounts for; as opposed to competition in skills, which leads us to consider their substitutability by others, depending on the existence of several firms capable of supplying these skills.

Richardson (1972) contrasts similar activities with complementary activities and thinks of industrial organization through inter-firm relations based on the necessary articulation of complementary activities distributed in distinct firms to produce a product.

In summary, we can retain Hart and Moore's (1990) concept of complementarity as *ex post* complementarity. On the other hand, we will oppose *complementarity of skills* (in the sense of Richardson and expressed in a similar way in Hart and Moore (1990), by the idea of *non-replaceability)* to *replaceability of skills.* With regard to the competition of skills, we can consider the substitutability of each of them according to the existence, or not, of firms that are substitutable from the point of view of their respective skills.

The choice between several suppliers *ex ante* often leads, once the relationship with one of them has been established, to the constitution of a *specific relationship* by the effect of *first mover advantage* (Lieberman and Montgomery 1988). The established relationship is a source of learning and mutual enrichment. Of course, potential competition is always latent (and acts as an incentive before, during and after): a pro-tendering procedure remains possible and actionable in case of problems. However, if a supplier already has *ex ante* a strong skill *(ex ante* complementarity of essential skills between customer and supplier), the substitutability of this skill becomes very difficult. This more or less amounts to an upstream situation of monopolistic supply. Potential competition only becomes possible again via an *ex post* bidding procedure if there is the same level of skills available but at a cost that is generally much too high (due to the loss of relationships, without even considering the cost of establishing a new relationship with the new selected supplier).

In short, a firm must produce a product based on the synthesis of several ingredients required to obtain this product. Each ingredient is realized with the help of one or more skills not necessarily existing within the firm realizing the product (especially as the massive tendency to refocus on the business of the 1980s and the generalization of the network form) and must call upon providers whose skills are based on specific knowledge held by particular individuals or groups of individuals. There is *idiosyncrasy* [20] in the sense that the use of specific knowledge is impossible without the actor(s) who hold(s) this knowledge.

A set of skills organized in a firm, at a given moment, is called the firm's *business* if there is an identification between these skills and the strategic image chosen by the firm's management team. This choice, sometimes strongly dependent on the past, defines a specific knowledge and/or know-how on which the *reputation* is based (Kreps and Wilson 1982a). The business is based on some or all of the skills held: any skill belonging to the business is such that if it were removed, the company would lose its reputation. This would have the consequence of considerably damaging its turnover, as a result of the eviction of its clientele towards competitors with a stable reputation.

There are therefore also skills that are essential for the development of the product and that are not part of the business, on the one hand, and/or are not held by the same firm, on the other hand. In this case, this means that, since they are not held by the firm and although they are indispensable to the development of the product, they must be provided through client-supplier relations, provided that they have access to them. Thus, some of these skills are said to be *essential* (by analogy with the definition of Hart and Moore (1990)) insofar as the final product cannot be produced without access to the skill, and this within the framework of coordination between the client and the supplier (with, potentially, a control that can be strengthened by *property rights):* vertical integration can therefore be posed concerning skills that are essential to the development of the product but that are not held by a single firm. The inter-firm relationship can be based on a wide range of possibilities (from ST to partnership), or it can be based on mutual control (in the case of a joint-venture) or unilateral control (if one of the parties takes control through property rights, from an equity stake to influence, to direct or to decide, to vertical integration).

All skills belonging to the business are normally held by the firm, but not all the skills required to develop the product are. Thus, theoretically, the question of vertical integration potentially arises for those skills that are indispensable to the development of the product but that are not held by the firm that wishes to develop the product. However, the actual practice is different.

Analytically perceived by Hart and Moore (1990)[21], the customer-supplier relationship is envisaged on a more pragmatic level by Richardson (1972) and is at the basis of resilient functioning (Aoki 1986) when, on the other hand, beyond even the theoretical eventuality, vertical integration is sometimes promoted, *a priori,* as a necessity (see Williamson (1985)) without much linkage to observable reality.

It is true that the potentially integrating firm may ask itself the question of acquiring an additional skill belonging to the business of another firm, but without this leading to the vertical integration of the target firm. External core or *essential* skills (by analogy with Hart and Moore) are not integrated for strategic reasons linked to two causes: *the non-integration of skills into the business of the potentially integrating firm and/or the insufficient bargaining power of the potentially integrating firm*[22] vis-à-vis the third party holding the skill.

Vertical integration is often impossible. This is due to the difficulty of circumventing the *bargaining power* of the supplier, which is based on the skill level held, and the difficulty of replacing it. To appropriate such a skill is only feasible here at an exorbitant internal organization cost and dissuasive *a priori.*

In the case of vertical integration (i.e. when the two causes above, which have become clauses, are waived or not applicable), Hart and Moore (1990) indicate the possibility (for the integrating firm) of keeping, in whole or in part, the skills of the integrated firm and/or of keeping (or firing) the management team of the integrated firm. In practice, this will be done without any assurance *a priori* of the efficiency of the operation once the integration is complete.

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