

# Exaptation in management: beyond technological innovations

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## Abstract

**Purpose** – Although exaptation is recognized as a means of creation capable of generating significant economic implications for organizations, this mechanism has not been explored in depth in the field of management, where it remains restricted to innovation and product research and development. With this limitation in mind, this study aims to explore and discuss exaptation along with other entities that are more greatly concerned with the interests of and direct contact with practitioners and academics in the field of management, such as processes, data, tacit knowledge and skills.

**Design/methodology/approach** – For the purposes of this study, a comprehensive review of the literature on exaptation was conducted, and 46 entrepreneurs from companies of different sizes and segments were interviewed.

**Findings** – The results of the review of the literature and interviews with entrepreneurs helped to identify and describe 13 cases of exaptation associated with nine different kinds of organizational entities. For four of these entities, which are closely associated with management, the restrictions of the business environment regarding the exaptation of these entities are discussed, together with the more favorable organizational structures for their occurrence.

**Practical implications** – This paper discusses the exaptation to the four types of entity closely linked with management: tacit knowledge, data, process and skill. For each one of these entities the following is discussed: the organizational characteristics that hinder the exaptation of the entity in question and the managerial actions that could alter these characteristics and facilitate the occurrence of the exaptation mechanism with the entity in question.

**Originality/value** – This process led to the development of an algorithm for analyzing the exaptation mechanism and the adaptation of the attributes associated with the agent-artifact[entity]-context tripartite to describe and analyze exaptation event, including another attribute: the type of entity.

**Keywords** Creation, Context, Agent, Exaptation, Latent function

**Paper type** Research paper



## 1. Introduction

Exaptation: (*biology*) the process by which features acquire functions for which they were not originally adapted or selected. (*Oxford Dictionary, 2017*)

The term exaptation was coined recently, defined by the paleontologists [Gould and Vrba \(1982\)](#), and its meaning continues to develop, with a history of confusing and even contradictory texts ([Garud et al., 2016](#)). “There seems to be little methodological and epistemological criteria that help operationally identify and analyze exaptations” ([Andriani and Carignani, 2012](#), p. 4). In the field of social sciences, the term exaptation is not widely used and its potential remains latent ([Andriani and Carignani, 2012](#)). In management journals, there are few texts on the theme: 12 articles, as we will see in the literature review presented in the Findings section. These articles mostly focus on the application of exaptation with technological products, more specifically innovation, targeting professionals in the field of product engineering or research and development (R&D). As it is characterized as an important creation mechanism, with attributions of new functions for the entities ([Lane, 2011](#)), some of these articles explore the potential for exaptation in terms of economic implications, pointing out several significant examples, such as Viagra ([Dew et al., 2004](#)). Other articles address its importance in entrepreneurship, placing it among the ten main mechanisms in the making of entrepreneurial entities ([Venkataraman et al., 2012](#)). The utility of exaptation in organizational contexts comes from the potential to maximize the use of and returns from already available resources as well as avoiding unnecessary investments in new resources. This utility is independent of the size or economic sector of the firm.

In the field of management, there are many opportunities to research and practice exaptation, as organizational environments are characterized by a large number and great diversity of entities ([Van Aken and Romme, 2009](#)). Many entities of interest to management are intangible, such as methods and processes, as observed by [Gregor and Jones \(2007, p. 319\)](#), compared with the artifacts in the field of software engineering: “the field of management is less concerned with the design of products than with methods or processes”. The application of exaptation in the extant literature is limited in both range and relevance regarding entities of interest to the responsibility of managers. Despite this, existing work suggests the potential application of exaptation to other organizational entities. [Dew and Sarasvathy \(2016\)](#), for instance, mention the possibility of exaptation of processes skills and the organizational itself as a whole. [Lane \(2011\)](#) describes organizations as entities composed of structure, function and process, claiming that they are open to exaptation. [Cattani \(2005\)](#) stresses the possibility of the exaptation of a set of skills and knowledge of organizations. In the bibliographies of these three articles, we found only one article that deals with exaptation of an entity typical of administration, published in an administration outlet; [Dew and Sarasvathy \(2016\)](#) cited [Marquis and Huang \(2010\)](#), which deals with exaptation of processes.

It is important to observe that the literature involving cases and examples of exaptation in organizations comes from the field of engineering and is associated with product innovation. To cite two of the most cited examples, we have one from chemical engineering, the exaptation of the molecular entity sildenafil citrate, applied initially to the function of pulmonary arterial blood pressure control and later to erectile dysfunction ([Dew and Sarasvathy, 2016](#)) and one from telecommunications engineering, the radio frequency magnetron, initially used in air traffic control radar and later for cooking, generating a new category of equipment: microwave ovens ([Mastrogiorgio and Gilsing, 2016](#)). In this paper, we do not consider exaptation involving entities like molecules or radio frequency, which are

found in technological applications. Instead, we investigate the incidence of exaptation in other entities of direct interest to administrators, like data, skills, tacit knowledge of employees and organizational processes. Thus, our objective in this research is to develop content and discussion of exaptation in the areas of administration, those closest to the interests and concerns of administrators. Our purpose is to show researchers and practitioners in administration that exaptation may be used in organizations far beyond laboratories and new product development, being applicable in the direct responsibilities and activities of managers.

For exaptation to occur in organizations, not only is an entrepreneurial attitude required to intentionally activate a latent function of the entity (Villani *et al.*, 2007), but also a “prepared mind” that allows the entrepreneur to identify the possibilities of exaptation around him (Andriani *et al.*, 2015). Mastrogiorgio and Gilsing (2016, p. 1421) defined this demand as the domain of analogical ability, in other words, “ability to draw analogies between different technological domains”. Focusing on exaptation in the specific context of administrator or manager, this research seeks to facilitate the development of a “prepared mind” for these professional. The cases identified and described in this research may provide examples for administrators, facilitating analogies to the entities found in her daily work and increasing the potential for identification and execution of exaptation activities which speak to needs and opportunities in her organizations.

To frame a more effective contribution to the management literature by working with lacunae in the extant literature (Locke and Golden-Biddle, 1997) in different entities of interest to administration, we decomposed our principal objective into two specific objectives:

- (1) to structure and describe the cases identified in the literature and together with entrepreneurs, categorizing them according to the type of entity that was the object of the exaptation and identifying the kinds closely linked to management and the actions of managers; and
- (2) to discuss the characteristics that obstruct the understanding and practice of exaptation along with different types of entities closely linked to management in theoretical frameworks and administrative practices.

By doing this, we can identify organizational structures that allow it to be promoted, discussed and understood in the context of management.

## 2. Literature review

### 2.1 Entity and entity type

We used the concept of “entity” following the principles of data modelling from the field of computer science: “an entity is a “thing” which can be distinctly identified. A specific person, company, or event is an example of an entity.” (Chen, 1976, p. 10). Another concept from data modelling used in this research is “entity type” (Bornberg-Bauer and Paton, 2002, p. 167):

[...] an entity type provides a description of the properties that are shared by a collection of entities in a domain. For example, Protein could be an entity type, with attributes including sequence, name, molecular weight, accession number and species. A single entity type is expected to have many instances, each of which gives values to the attributes specified in the corresponding type.

### 2.2 Exaptation: agent, artifact and context

Exaptation involves discovering and putting into practice an entity’s latent functionality, with the entity beginning to perform a totally different function from performed hitherto. Let

us take as an example the exaptation that occurred with the drug sildenafil citrate, which was originally marketed to treat pulmonary arterial hypertension (Revatio) and later identified as suitable for treating erectile dysfunction (Viagra). The same active principle was applied originally in the field of cardiology and later in the field of urology (Dew and Saravathy, 2016). Thus, the Latin prefix “*ex*”, meaning moving away from, exiting, extracting, which before the word aptation comes to indicate that the entity is shifting from its original purpose to perform another role in a new context. Therefore, in an exaptation kind of innovation technological continuity and functional discontinuity are observed (Andriani and Carignani, 2014). This is the opposite of what is observed in adaptation type mechanisms, in which new forms perform old functions. In exaptation, new functions for old forms are observed (Dew and Saravathy, 2016).

Exaptation is pervasive in the business world and is subject to application by managers in different organizational entities (Dew *et al.*, 2004). These entities may be “artifacts, technologies, processes, skills, organizations, and resources for emergent uses that they were not (initially) designed for” (Dew and Saravathy, 2016, p. 167). These numerous forms of occurrence are more commonplace in the business environment than might be imagined and are often confused with and referred to as mechanisms of adaptation (Dew *et al.*, 2004). For exaptation to occur, it is necessary for its agent to have an entrepreneurial attitude, as highlighted by Ganzaroli *et al.* (2014, p. 256): “exaptation does not only require luck, but also and foremost entrepreneurship”. For the entrepreneur, exaptation is especially attractive because “extracting such latent value is, theoretically, cheaper than creating new artifacts for new functionalities as the creation process itself is costly” (Andriani *et al.*, 2015, p. 2). Because of its potential to aid entrepreneurs in building new ventures and new markets, exaptation is considered one of the ten principal techniques of entrepreneurship (Venkataraman *et al.*, 2012).

An entity that undergoes exaptation must be coopted by the group of customers that demand that function in that context, as it “must have a function and must enhance the fitness of its bearer to qualify as an exaptation” (Buss *et al.*, 1998, p. 539). This helps to distinguish exaptation from bricolage, which is also recognized as “an *ad hoc* quick fix that is ephemeral” that “was not designed” and “never became the basis for new commercial products” (Garud *et al.*, 2016, p. 160). Exaptation involves delivering an effective solution that is as good as or better than the other solutions available for that function in that specific context. The importance of the context is critical here. It is one of the three components of the agent-artifact[entity]-context tripartite described in the “integrated model of exaptation” of Andriani and Cattani (2016) for the description and synthesis of the exaptation mechanisms. In this model, the following definitions for the three central concepts are given:

- (1) agent, the one who has some level of mastery of the entity and uses her analogical skills to identify a new function;
- (2) artifact, characterized as the entity employed in a new function, in other words, the one that suffers a functional shift (in this study we refer to an artifact as an entity that encompasses the tangible and intangible equally); and
- (3) context, the space in which the entity comes to be used by the agent, other than the original purpose for which it was conceived.

An important premise of this model is that “functions are not a property of the artifact [entity] but instead express a relation between the artifact and other artifacts and/or agents within a specific context” (Andriani and Cattani, 2016, p. 122).

### 3. Method

To identify, analyze and discuss cases published in the literature that characterize new attributions to entities of interest to managers, also including those that were not given the label of exaptation recently imported from paleontology, we began with a review of the literature. An initial search identified the presence of the word exaptation in the title, abstract or keywords of articles. This step was taken in May 2017, in four digital libraries of scientific articles specializing in the field of Management: EBSCO, JStor, ProQuest and Academy of Management Publications. The authors used skimming to read the articles that resulted from the initial search (Duggan and Payne, 2009), reading the abstract, introduction, section headings, subsection headings, tables and figures. At this time, the articles related to management and related fields (accountancy, economics and engineering) were separated from the other fields, such as biology, linguistics and psychology. Following these two selection processes, the articles were distributed among the authors for intensive reading. The dimensions for the content analysis of the texts were defined as six codes to be observed:

- (1) the type of exaptated entity;
- (2) exaptation agent;
- (3) initial function (original);
- (4) final function (exaptated);
- (5) form of exaptated entity, whether preserved or altered (reduced, increased or adapted); and
- (6) performance in the new function of the entity, if equal or superior to the other entities already available.

To identify articles with examples of exaptation published before the introduction of the term in the field of management, the authors resorted not only to their own personal files but also consulted their peers, teachers and specialist researchers, in a diversity of entities and subfields of Management. They asked their peers to identify cases in the literature that characterized events involved in exaptation. For this, a brief 10-min description was given in private to each of the peers who were consulted, presenting the classic cases of technological exaptation and some cases of exaptation of entities of interest to management, which were identified by the researchers themselves in the first instance. For the researchers to analyze all the cases identified, either under the name of exaptation or some other name, a sense making analysis of alternate templates was applied (Langley, 1999). After consolidating the characteristics of the exaptation mechanism identified in the literature review, a template was developed in the form of an algorithm to distinguish the exaptation events from the other mechanisms for the creation of entities. The algorithm employed as a template is described in Appendix 1.

The logic of the algorithm was developed, tested and refined as the researchers analyzed the first texts. One of the challenges of this process would be to define the level of difference between the original and final functions. According to Andriani *et al.* (2017, p. 324):

[...] the decision of whether two functions (of the same artifact) are sufficiently different is based on judgment, and there are borderline cases in which the decision may be somehow arbitrary.

The perception of this difficulty in practice led us to define the six analysis codes associated with the dimensions for the content analysis already described and understand the importance of correctly identifying and describing them. For example, we cite the case of competence transfer that occurred at American Airlines (AA). When the company achieved

a high level of competence in the management of ticker reservation, it created a spin-off of this area, treating it as a new business unit, with consultancy for reservation management in the hotel sector and the entertainment industry (Probst *et al.*, 1999). The discernment of the analysis occurred when we identified the type of entity involved, defining it as a process (reservation). Following this, in the second question of the algorithm (according to the rhombus in Appendix 1), it was perceived that the later function was not sufficiently different from the original. Both deal with reservations, only changing the object, shifting from plane seats to seats in theaters, cinemas, cabins on a ship or amusement parks. Thus, the case was classified as exploration of new possibilities for a differentiated competence of the company. With exploration closely linked to adaptive systems (March, 1991), the case of AA is more like a mechanism of adaptation to make reservations in new contexts.

To verify with experienced entrepreneurs, examples of applying exaptation mechanisms in their ventures we used focused interviews (Flick, 1998) with entrepreneurs who had at least 42 months' experience (Reynolds *et al.*, 1999). In the focused interviews, entrepreneurs were asked to describe the history of the creation and evolution of their families of products and services. This helped the researchers to become more familiar with the business of the entrepreneurs, introducing the theme of exaptation more comprehensively, using examples and the daily situation of the entrepreneurs. Thus, in the first part of the interview, the researcher presented examples of exaptation and eight other kinds of creation mechanisms used by entrepreneurs for the development of families of products and services. The purpose was to present with the entrepreneur with the action of application, the transposition of an exaptated entity as something pertinent to other creation action, in other words, another form of diversification of families of products and services. Therefore, in addition to transporting/ applying, actions involving copying, creating/developing, improving, simplifying/reducing, adapting, composing/combining, using and reusing were also discussed. We associate them, respectively, with the mechanisms of creation by copy, new product development (NPD), improvement, frugal innovation, adaptation, new combination, nonadaptation spandrels and nonadaptation junk, all described in Appendix 2.

The list of creation mechanisms we describe in Appendix 2 is not meant to be exhaustive. It is meant only to illustrate some of the different kinds of procedures for creation of products and services used by entrepreneurs as a means of facilitating discussion during the focused interviews. Although these mechanisms are more frequently cited in the innovation literature and used in R&D applications, exaptation is also found in other areas relevant to administration scholars and practitioners. For example, the logic of exaptation is cited as one of the transformation strategies employed by expert entrepreneurs in the discovery and creation of new markets (Goldenberg *et al.*, 2001; Dew *et al.*, 2011). In Dew *et al.* (2011, p. 242), exaptation is seen as one of a "variety of transformation procedures performed by the expert entrepreneurs" to identify and create new markets. They include exaptation with a number of specific mechanisms associated with new markets including stereotyping, free associating, prototyping and globalization operations (Dew *et al.*, 2011). Although exaptation is the only construct included in both lists, there are some other mechanisms which, despite different names, present the same semantic value and are associated with the same logic in terms of the behavior of the entrepreneur.

We chose to present to the interviewees the typology of mechanisms for creating products and services (Appendix 2) and not the typology for creating new markets because the former is simpler and closer to the daily life of the diverse community of entrepreneurs that composed the sample of our research. Dew *et al.* (2011) point out that the typology of transformation procedures is associated with events which are rarer – the creation of new markets – associated with expert entrepreneurs as highlighted by Dew *et al.* (2011). The

presence of exaptation in both typologies is important to be analyzed. Its presence as a mechanism of new market creation approximates exaptation to the concerns of marketing and economics. In Dew *et al.* (2011, p.231), abstract, the authors stress the importance of exaptation to the field of economics: "The generation of new markets is an emerging area of interest among researchers working in the traditions of evolutionary economics". These multiple uses of exaptation indicate its importance to contemporary society and its importance to scholars and practitioners in administration.

In the second part of the interview, the entrepreneurs were asked to comment on the mechanism employed to create and expand each family of products and services that they developed and sold in their ventures, identifying the kind of creation mechanism used. We classified the families of products and services created by the entrepreneurs according to the different types of mechanism used. The resulting list was then presented to the entrepreneurs and they were asked to judge their level of mastery and knowledge of each of the nine mechanisms using a Likert scale, giving examples to portray their mastery irrespective of whether the experience was linked to new products and services. This procedure involved 46 entrepreneurs, as described in Table I. The interviews took place from May to August of 2017 at the workplace of the entrepreneurs, with an average duration of 87 min.

	Years	Quantity	(%)	Business segment	Quantity
<i>Experience as entrepreneur</i>	02–05	10	22.0	Accountancy	3
	06–10	05	11.0	Animal health	2
	11–15	06	13.0	Architecture and Landscape	3
	16–20	04	8.5	Body esthetics	2
	21–25	04	8.5	Clothing	1
	26–30	06	13.0	Construction	3
	31–35	05	11.0	Consultancy	1
	36–40	03	6.5	Difficult access services	1
	41or more	03	6.5	Engineering	1
				Entertainment	1
<i>Schooling</i>	Primary	04	8.5	Food	5
	Secondary	09	19.5	Foreign trade	1
	Higher	33	72.0	Furniture	1
				Gifts	1
				Healthcare	5
<i>Sex</i>	Male	29	63.0	Hotels	1
	Female	17	37.0	Law	2
<i>Total families of products and services developed by the entrepreneur</i>	1 family	04	8.5	Packaging	1
	2 families	06	13.0	Photography	1
	3 families	18	39.5	Printing	1
	4 families	12	26.0	Research	1
	5 families	02	4.5	Security	1
	6 families	02	4.5	Software	1
	7 families	01	2.0	Solar energy	1
	8 families	01	2.0	Training	1
				Transport	1
				Vehicle services	2
			Wholesale	1	

**Table I.**  
Description of the 46  
entrepreneurs  
interviewed

Having identified the different cases in the literature and from the entrepreneurs, we had the content necessary for the first specific goal:

[...] to structure and describe the cases identified in the literature and together with entrepreneurs, categorizing them according to the type of entity that was the object of the exaptation and identifying the kinds closely linked to management and the actions of managers.

For all the cases identified, we proceeded to analyze the essence of the exaptated entity to distinguish the cases associated with entities of interest to professional managers and the field of management from those associated with entities of interest to other professionals in other fields, such as exaptation of techniques specific to psychology or psychopedagogy. Having documented and separated only the cases of interest to managers, we clustered these cases by type of entity of broad interest to managers. In other words, entities in all the organizations irrespective of their size or sector.

With the cases of exaptation in management identified and classified by entities of interest to management, we had the input necessary for activities associated with the second specific goal (“to discuss the characteristics that obstruct the understanding and practice of exaptation along with different types of entities closely linked to management in theoretical frameworks and administrative practices”). This was discussing the characteristics that obstruct exaptation of the types of entity closely linked to management in theoretical frameworks and administrative practices, identifying organizational structure to promote its occurrence, and discussing and understanding it in the context of management. For each kind of administrative entity identified, the researchers resorted to their personal contact networks in several subfields of management to look at the conditions that hinder conventional companies when it comes to the exaptation of that specific type of entity. For each obstructive aspect, we also questioned the possible administrative practices and actions that could emerge in the organizational environment to eliminate or lower the barriers to exaptation. The information was given to the group of researchers-authors, who organized and consolidated the information from their peers. These ideas were also critiqued, reflected on and integrated. All of these activities associated with data collection and analysis are summarized in the visual research chart in [Figure 1](#).

## 4. Findings

### 4.1 Identified cases of exaptation of administrative entities

From the literature review on exaptation, we identified four articles containing examples of four different exaptated entities, all of them different from the classic examples of technological products. Two of these four entities are closely linked to management. In other words, they are present in organizations of any size or segment: process entity and skill entity. The other two entities identified were concept entity and communication channel entity. When analyzing cases published under a name other than exaptation, we identified one case involving an entity closely linked to management: the data entity. When gathering data in the field during interviews with entrepreneurs, we identified another eight cases of exaptation, two involving entities closely linked to management: skill entity and tacit knowledge (of employees) entities. The other six cases identified with the entrepreneurs involved the following entities: professional techniques, with three cases; material input, with two experiences, and one case involving the production equipment entity. Thus, we identified a total of 13 cases, associated with nine different types of entities. Of these 13 cases, 5 are associated with entities closely linked to management: data, process, tacit knowledge and skill, the latter with two occurrences identified. These five cases are described in [Table II](#), while the others are described in [Appendix 3](#).



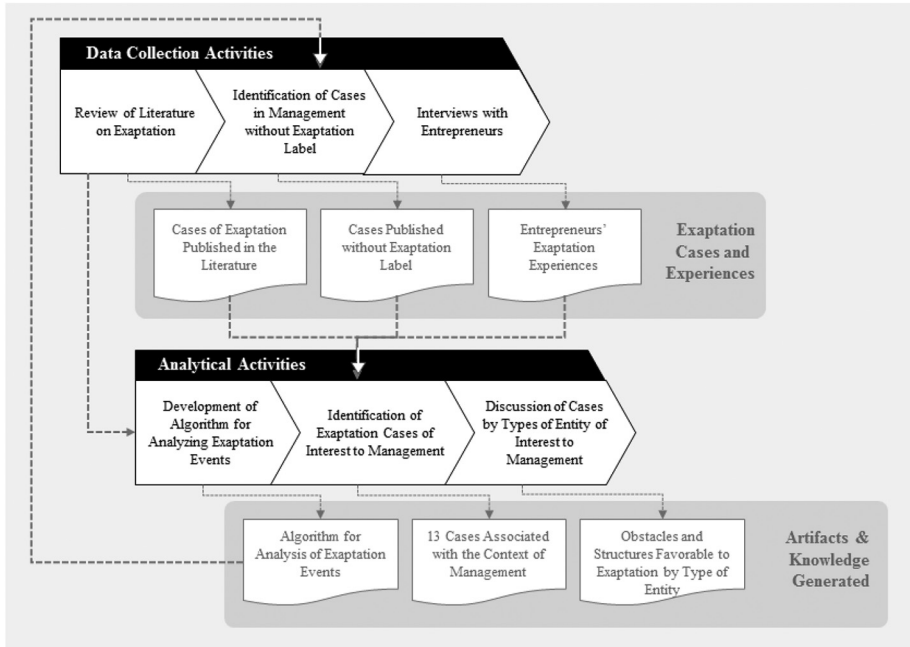


Figure 1. Visual research chart

#### 4.2 Discussion so far in management journals

For all the articles resulting from the skimming research, identified as pertinent to the context of management, the background of the journal was checked in terms of its associated fields of science. For this purpose, we consulted in the Scimago Journal Rank the metadata subject area associated with each journal. This process identified 11 different journals in the field of management that published 12 articles on exaptation: *Academy of Management Journal* (Marquis and Huang, 2010), *Economics of Innovation and New Technology* (Bonifati, 2010), *European Management Review* (Villani et al., 2007), *Innovation: The European Journal of Social Science Research* (Ganzaroli et al., 2014), *Journal of Economic Behavior and Organization* (Dew et al., 2008), *Journal of Evolutionary Economics* (Dew et al., 2004), *Journal of Management and Governance* (Abatecola et al., 2016), *Organization Science* (Andriani et al., 2017), *Research Policy* (Andriani and Carignani, 2014; Mastrogiorgio and Gilsing, 2016), *Technological Forecasting and Social Change* (Banerjee, 2012) and *Technovation* (Desouza et al., 2007). With the exception of the article by Marquis and Huang (2010), addressing the exaptation of a process, all the others looked at cases and examples associated with technological product innovation. In short, the exaptation literature available in the field of management is restricted to few articles and from a pragmatic viewpoint exclusively addresses cases and examples focusing on the innovation of technological products. This confirms the claims of Dew et al. (2004), who found that, despite the importance and pertinence of exaptation to entrepreneurship and companies, little attention has been paid to exaptation in the context of management by academia.

Entity		Context	
Name (source)	Type	Initial function (original)	Final function (exaptated)
Supermarket sales (Peppers and Rogers, 2011)	Data	Registering sales data for financial control and replenishing stock (merchandise retailer)	Registering sales data to analyze the lifecycle of the consumer and identify insurance needs
Evaluation of an external entity of a bank's head office (Marquis and Huang, 2010)	Process	Banking Institution in the USA Bank branch management (control and monitoring entities outside headquarters but belonging to the bank)	Using the same process for bank acquisition management and integration (evaluation of external entities)
Enzyme production (Dew and Sarasvathy, 2016)	Skill	Ms Kiran Mazumdar-Shaw (founder of Biocon) Ms Kiran Mazumdar-Shaw had knowledge and practice of enzyme production techniques applied to the brewery industry	Ms Kiran Mazumdar-Shaw studied in Australia to become a brew-master in India. A friend saw the potential of her technical skills with enzymes and invited her to form a company in the field of biotechnology
Vertical climbing (Entrepreneur #13)	Skill	Entrepreneur #13 initially founded a mountaineering company and later a company that provide industrial climbing services (chimney, silo, roof, tower, ...)	Entrepreneur #13 climbed mountains on the coast of São Paulo (Brazil) when he was approached by the owners of a company that inspected and surveyed ships. They asked if he could help them to inspect the hulls of large ships. The first difficult access training job resulted from this contact. They went to an old building (building shell) and trained company employees to conduct surveys and inspections

(continued)

**Table II.**  
Examples of exaptation of entities closely linked to management

Table II.

Entity	Name (source)	Type	Agent	Initial function (original)	Context Final function (exaptated)	Comments on the case
Understanding of a regional road system (Entrepreneur #14)	Entrepreneur #14 founded a bus rental company (transport for industry employees)	Tacit knowledge	Entrepreneur #14 has an employee who worked as a bus driver on different routes for over 15 years in the same region	Entrepreneur #14 asked the employee to prepare routes to provide estimates for the company's services to customers of the bus rental company	Entrepreneur #14 noticed that the driver, after 15 years, had a vast store of knowledge of the regional road system. Thus, the driver was assigned the task of preparing routes requested by customers. Even though applications such as Google Maps and Waze are available, this professional remained invaluable because of his additional knowledge, including the width of roads and turns, height of wires and bridges and safety in the region, aspects that have to be considered when preparing each route requested by customers	

#### 4.3 Knowledge and practice of exaptation by entrepreneurs

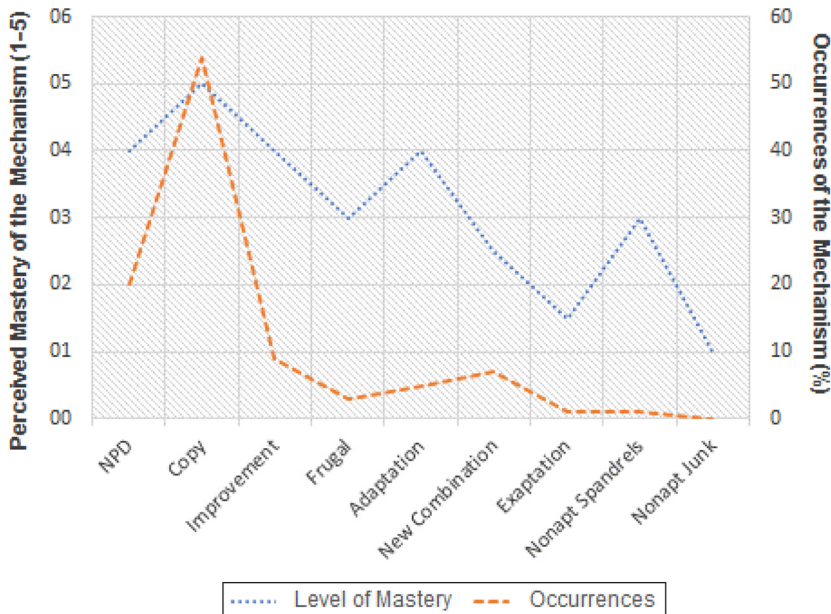
During the interviews with 46 entrepreneurs, the history of the creation mechanisms they employed to launch 155 families of products and services was recounted. Many of them resorted to copy mechanisms (54 per cent) and NPD (20 per cent), as shown in Figure 2. The exaptation mechanism was identified in the origin of only 2 of the 155 (1.3 per cent) families of products and services described by the entrepreneurs. At the end of the interview, we asked the entrepreneurs about how well they considered themselves informed and competent to handle each of the nine creation mechanisms. Their responses are summarized in Figure 2: the copy mechanism is the one they have mastered best, with a median of 5, while the exaptation mechanism has a median of 1.5 on a scale of 1 to 5, with one corresponding to “no level of knowledge” and 5 “total knowledge of the mechanism”. Thus, we can affirm that the entrepreneurs consider themselves not well informed and competent with regard to exaptation (1.5), which is in keeping with the fact that it has been used little (1.3 per cent) as the principal mechanism for creating families of products and services.

### 5. Discussion of exaptation mechanism with entities of interest to managers

In this section, we analyze the cases described in the previous section to achieve the second specific research goal:

[...] to discuss the characteristics that obstruct the understanding and practice of exaptation along with different types of entities closely linked to management in theoretical frameworks and administrative practices, identifying organizational structures that allow it to be promoted, discussed and understood in the context of management.

For this purpose, we have subdivided the discussion according to the four types of entity closely linked with management: tacit knowledge, data, process and skill.



**Figure 2.** Level of mastery and occurrences of creation mechanisms according to the entrepreneurs

### 5.1 Exaptation of tacit knowledge (of the employee)

As observed in the field, Entrepreneur #14, owner of a bus rental company, observed that after a bus driver had driven buses on different routes in the company's region for over 15 years, he had accumulated considerable knowledge of the local road system. When no knowledge of the road system was available either in software or on paper, the company always asked this driver to map out routes to prepare estimates for customers. After a time, during which the company frequently consulted the driver, they realized that he would add more value to the organization as a traffic operator, preparing routes for trips and providing customers with cost estimates. Even after the advent of applications for mapping routes, such as Google Maps and Waze, this professional continued to be invaluable to the organization. He has distinct and integrated knowledge regarding aspects such as the width of roads and turns, the height of electrical wires, bridges and footbridges, safety in the region and other aspects not available from applications that influence the mapping of each route requested by customers. It should be highlighted in this case that the company did not possess any data or information; the employee did. This explains the expression "exaptation of tacit knowledge" (of the employee), as registered in the examples of [Table II](#).

Employee competences can be characterized by knowledge, skills and attitudes ([Le Boterf, 2000](#)). Organizational recognition of the competences of each employee occurs naturally and spontaneously in small companies, where there is closer contact between managers and employees, as observed in the organization of Entrepreneur #14. For the managers of medium-sized and large companies, the literature recommends action in the sense of identifying, registering and updating the profiles of all employees regarding their skills, knowledge and attitudes ([Capaldo et al., 2006](#)). Administrative approaches that value human capital are increasingly important and receive more attention from academics and practitioners in management, as this resource is viewed as an essential part of the intellectual capital of organizations ([Edvinsson and Malone, 1997](#)). Thus, administrative practices such as competence management and the management of intellectual capital favor the occurrence of the exaptation mechanism applied to the tacit knowledge entity. These practices also encourage the registering and monitoring of employees' knowledge, skills and attitudes.

### 5.2 Exaptation of data

From the literature review, especially the literature not labeled as exaptation, one data exaptation event was identified. In their book, [Peppers and Rogers \(2011\)](#) described the experience of British retailers Tesco with intensive data analysis of its customers' purchases, which had hitherto been used for financial and stock control. By monitoring the evolution of these data, an analysis was developed of the customer profile and lifecycle stage, as described and exemplified in [Table II](#). Following these analyses, Tesco became a new entrant in the insurance market, with differentiated information in relation to established companies in this sector. This was possible because of the exaptation of operational data stemming from Tesco's relationship with its retail customers, enabling the organization to know the insurance requirements of its customers beforehand ([Peppers and Rogers, 2011](#)).

Most work on exaptation appears in journals in the field of engineering and innovation and does not directly mention the concepts and practices of information and knowledge management. However, there is a clear alignment of concepts and practices associated with the treatment of data in the organizational environment that can be understood as an instrument of exaptation, as highlighted by [Andriani and Cattani \(2016, p. 119\)](#):

One such mistake is to overlook that the range of possible applications for a firm's knowledge base is typically wider than its current applications. Firms can in fact capitalize on previous investments by transferring knowledge already available in-house to new applications, a capability that [Garud and Nayyar \(1994\)](#) have defined as transformative capacity.

In the taxonomy for management schools of knowledge management, there is a type known as the Strategic School, in which some companies pay considerable attention to their data, treating them as the main asset of the organization ([Earl, 2001](#)). In the Strategic School, the focus is the mindset, in other words, a fixed state of mind, a mental attitude of the organization's employees when considering and treating the organization's data as the essence of the firm's strategy. "The strategic school is essentially concerned with raising consciousness about the value creation possibilities available from recognizing knowledge as a resource" ([Earl, 2001](#), p. 228). Companies that value and work with their data can go beyond improving products or generating new products and services, positioning themselves strategically in a new sector with a differential in relation to those already established in the sector, as in the case of Tesco.

### 5.3 Skill exaptation

During the literature review, we found a case of skill exaptation in the text of [Dew and Sarasvathy \(2016\)](#). When interviewing Entrepreneur #13, we identified another case. Both are described in [Table II](#). In these cases of skill exaptation, the opportunity did not occur through the direct actions of the entrepreneur, but from the action of a third party with demand for the entrepreneur's skill, as shown in the comments on these cases in the fourth column of [Table II](#). In the case of Entrepreneur #13, the service of climbing to provide services to industry in difficult access locations began with an invitation from the owners of a company that inspected and surveyed ship hulls, who went to the hills on the coast where the entrepreneur was climbing as a sporting activity. In the case of Kiran Mazumdar-Shaw, a friend recognized the potential of her technical skills with enzymes and invited her to open a company in the field of biotechnology ([Dew and Sarasvathy, 2016](#)). Although in both cases the experiences resulted in success for the entrepreneurs, the way in which the opportunities were identified was not ideal. They depended on a third party outside of the organization or the entrepreneurial being. We will now discuss propositions to make skill exaptation less random and less dependent on a chance act of a third party.

Exaptation being a mechanism of heuristic creation goes against common sense, associated with the mainstream of the rationalist paradigm for problem solving, which demands a clearly defined objective. In the constructivist approach, the entrepreneur uses diverse creation mechanisms, such as adaptation, improvement and reduction until the desired goal is achieved. Although there is no initial objective in exaptation or guide to induce actions, we should not consider it as a random creation mechanism associated with the entrepreneur's luck. As highlighted by [Andriani et al. \(2015\)](#), a "prepared mind" is needed. Preparation is fundamental, especially for those with fewer resources. Let us take the example of freelance entrepreneurs whose main resource (often their only resource) is their skill at a certain activity. To train such professionals in the exaptation mechanism, it is very important to transmit the concepts of the literature on effectuation, contrasting it with the literature on causation ([Fisher, 2012](#)). They need to be aware that it is possible to apply effectual logic to develop exaptive strategies ([Dew et al., 2008](#)). They need to be aware that for this only their current skills are required, with no need for a financial outlay. If one of their skills is analogical ability, they can apply it to their other skills and knowledge. In other words, this is the exaptation of their competences to optimize their current operations or

even create new lines of products and services. They can even begin to operate in other contexts, others business sectors (Dew *et al.*, 2008).

#### 5.4 Process exaptation

Of the different types of entity analyzed, the process was the most recurrent in terms of the available literature in articles and book chapters. Of this set, only one article was identified as an example of the occurrence of the exaptation mechanisms: the one used to evaluate the entities outside of the headquarters of a bank (Marquis and Huang, 2010), described in Table II. Many cases involving processes were characterized as improvement, frugal or adaptation mechanisms, as in the case of the AA reservation process mentioned in the Method section. Despite only one occurrence, the potential for exaptation of the process entity should be stressed. There is a growing background of methods, techniques and tools for organizational processes. In this shift, the following actions should be highlighted: workflow, business process improvement, business process design, business process notation, business process management system, business process execution language and others (Wong *et al.*, 2014). These initiatives have not only promoted the explanation and specification of processes, such as the evolution of metadata and meta-information, they have also organized them into repositories of content on processes (Hoang *et al.*, 2014). This scenario, linked to the development of protocols and tools to search, analyze and share this content, should promote the reuse of specifications and algorithms on processes. This will facilitate the identification, transposition and application of these into other contexts, including functions different from those for which they were conceived.

Winter and Szulanski (2001) stress that the replication of processes is a “familiar phenomenon” in organizations, confirming the wide diffusion and use of the copy mechanism in organizations, as can be seen in Figure 2. The debate in academic circles urges managers to go beyond simple replication of processes – that is – to go beyond exploitation, recommending exploration (March, 1991). Exploration is defined “by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation” (March, 1991, p. 71). These terms do not suggest meanings which can be directly linked to functional discontinuity – a central characteristic or exaptation. For this reason, it is important to promote the noun exaptation in the vocabulary of administrators, highlighting the dyad of technological continuity and functional discontinuity as one mechanism of creation.

#### 5.5 Exaptation as a mechanism overlapping others

In the texts on technological innovation, it is pointed out that exaptation is never an isolated creation mechanism. From the perception of functional alteration of a given entity, there is a need for actions to adapt it so that it can exercise a new function, in other words, exaptation being succeeded by an adaptation mechanism (Andriani and Carignani, 2014; Shumacher, 2012). For the exaptation mechanisms identified in the interviews with the entrepreneurs, we explored the actions of these entrepreneurs to enact the exaptation imagined by the entrepreneur. From this procedure, we observed that not only does adaptation occur, but various other creation mechanisms are also activated from the conceived exaptation. Table III describes the other overlapping creation mechanisms that were identified in the interviews with the entrepreneurs. It is interesting to highlight the intertwining of the different creation mechanisms in acts of exaptation, as this characterizes the risk that someone analyzing the act might understand it and classify it in different ways because of the diversity of overlapping creation mechanism. In short, it is a complex event, with many interrelated actions and requires conceptual support. In this sense, this study proposes to

Entity (entrepreneur)	Type	Creation Mechanisms Overlapping with the Case of Exaptation Description
Vertical climbing (Entrepreneur #13)	Improvement	At the time of the exaptation (2005), in Brazil there were no technical recommendations or norms for climbing as a sport. In industry, there were only some recommendations. The team had to specialize by doing training courses overseas: High Rise and Confined Space Rescue by ROCO Rescue (USA); Confined Space Rescue at Texas A&M University and Emergency Services Training Institute (USA)
	Adaptation	Behavioral. When climbing for leisure, the environment is more relaxed: there is greater tolerance of latecomers to begin activities and the communication pattern is full of slang and informality. The industrial environment required adaptations considering that punctuality is important because of the large number of actors involved in the activity and the formal communication pattern. This led Entrepreneur #13 to hold speech courses to improve communication with practical and theoretical courses given in the industrial environment
	Adaptation	Technological. The norms of the industrial environment are more demanding in terms of equipment. Climbing ropes for sport are 9 mm and have greater elasticity, while in the industrial environment the ropes are 11 mm and less dynamic. Carabiners and safety belts also have specific dimensions and are heavier. In an industrial environment, boots must be worn
Understanding of a regional road system (Entrepreneur #14)	Improvement	Developed interpersonal relationship courses for attending meetings with company clients to understand the transport requirements of client company employees. Training in the use of the computer (workstation) to use itinerary preparation software identifying the homes of clients' employees
	Adaptation	Stopped working day shifts and night shifts to work exclusively during the day. Requires dialogue with customers to understand their demands and dialogue with the bus company's administrative professionals who work during the day
Programmable calculator (Entrepreneur #2) a	Frugal Innovation	Using software, he diverted the initial activation of the calculator (initial boot) to another part of the memory, where the applications were stored. This avoided activating native functions recorded in the ROM. In other words, it disabled the forced use of several native functions to obtain more space and processing capacity for its applications
	New Combination	He inserted a radio plate (WI-FI) into the calculator to communicate data to the rear server that processes customer orders; he integrated the code reader for some restaurants that had barcodes on their menus. He also developed the integration of equipment as a magnetic reading device (slot reader) and with RFID tags
	Adaptation	Concealing several keys of mathematical functions on the programmable calculator keypad by applying the pad printing technique to facilitate the operation of the equipment in the field. Using programming resources, he altered the functions of each key to have a complete set of alphanumeric characters

**Table III.** Creation mechanisms overlapping with exaptation

**Note:** <sup>a</sup>This case is described in [Appendix 3](#)



make a small contribution through examples from the organizational area and the introduction of the algorithm to analyze possible exaptation events ([Appendix 1](#)).

### *5.6 Adjustment of attributes that describe the entity in question*

Of the experiences analyzed in the cases outlined above, the researchers observed the importance of correctly defining the type of entity to be considered in the analysis, at the risk of undue classification of the mechanism employed by the entrepreneur. Let us take the example of the kind of entity associated with the case of the bus driver employed by Entrepreneur #14. If instead of considering the type of entity as “tacit knowledge”, we had considered it as “employee”, we would have classified the action as an adaptation rather than exaptation, as we would have changed not only the function of the employee but also his form. As highlighted in [Table III](#), the employee needed to develop interpersonal relationship skills to attend meetings with client companies (hitherto, talking was not a desirable function for a bus driver, who drove in a space on the bus reserved only for himself). He also had to adapt to new working hours. By altering the focus of the analysis, identifying the type of entity as tacit knowledge and not as employee, the case can be presented as exaptation: “new functions for old forms” ([Dew and Sarasvathy, 2016](#)); in other words, the essence of the entity used in the creation mechanism, tacit knowledge, remains unaltered.

In the field of management, where the practitioner (manager) handles different types of entities, many of them intangible and complex, it is fundamental to have a more specific qualification of the concept of entity, associated with the agent-artifact[entity]-context tripartite of the “integrated model of exaptation” ([Andriani and Cattani, 2016](#)). In this respect, we consider it necessary to include the attribute “type of entity” to describe the entity of the case to be analyzed. Therefore, this attribute should be added to the other two attributes of context that have already been mapped by the models developed by authors of technological innovation, the initial function and final function, as described in [Table II](#).

### *5.7 Managerial implications*

For the four types of entity closely linked with management (tacit knowledge, data, process and skill) we analyze in this subsection:

- the organizational characteristics that hinder the exaptation of the entity in question; and
- the managerial actions that could alter these characteristics and facilitate the occurrence of the exaptation mechanism with the entity in question.

### *5.8 Entity tacit knowledge*

The obstacles to the exaptation of tacit knowledge (of employees) include:

- the people management area ignores the value of explicit knowledge of company employees; and
- practices related to exploitation of existing knowledge as yet have seen little use in organizations ([Akhavan et al., 2006](#)).

To promote the exaptation mechanism with the knowledge of company employees, positive actions would be:

- to develop the concept of valuing assets that are already available in the organization as inputs for creation, in other words, using effectual reasoning as an instrument of intrapreneurship, valuing the knowledge of employees as an important individual asset to be made explicit; and
- practice competence management, describing the intangible assets of each individual as resources that constitute their competence (knowledge, skills and attitudes) subject to exaptation.

### 5.9 Entity data

The obstacles to the exaptation of data include:

- predominance of the traditional culture of data processing, where this resource is perceived as indirect material only to support production activities rather than an input, a resource available for creation; and
- a limited view of data collection by the organization because of technological restrictions that lead the information system to create data silos, hindering more complex creations that require the reading and combination of data form different context.

To promote the exaptation mechanism with the data entity, the positive actions are:

- adoption of a strategy for knowledge management of the Strategic School type (Earl, 2001) that values data as an important organizational input; and
- making a technological environment available, such as a data warehouse, which allows an integrated view of the different data sets of the organization.

### 5.10 Entity skill

The obstacles to skill exaptation include a description of skills closely linked to the process and function currently performed by employees, without capturing their essence, obstructing their understanding and application to the new context and with a new function; the people management area does not have an explanation of the skills of the company's employees.

To promote the exaptation mechanism with the skill entity, the positive actions are:

- developing the concept of valuing the organization's already available assets as input for creation, in other words, working on effectual reasoning as an intrapreneurship tool, valuing skills as important individual assets to be explained; and
- practicing management by competences, describing the intangible aspects of each individual as constituent resources of their competence (knowledge, skills and attitudes) and subject to exaptation.

### 5.11 Entity process

Obstacles to the exaptation of processes include intangibility of processes because of a lack of specification. Even when there are specifications, they are often outdated and do not correspond to what actually occurs in the operation of the company. To promote the exaptation mechanism with the process entity, the positive actions are adoption of

technological environments to manage processes, associating execution and monitoring of processes with their specification, requiring integration and synergy between the specified process and the process being executed.

## 6. Conclusions

The discussions in the previous section contrast with the extant literature on exaptation, which mostly focuses on entities directly associated with technological products of big organizations, with high investments in R&D. We discussed exaptation citing companies of different sizes from different sectors, involving other types of organizational entities, more specifically those that are the direct responsibility of or highly dependent on the actions of managers. In terms of implications for future research, our contribution is to present and provide examples of entities of interest to and direct usage by managers which may favor the use of exaptation. The means related activities carried out by different areas of the organization may also benefit from the use of exaptation mechanisms. That is to say, exaptation may be used beyond the company's core activity and beyond the area of product engineering or R&D.

Examples of the cases collected from the entrepreneurs and the literature, classified by types of organizational entities, aid the perception and debate of limiting aspects of companies in terms of the practice of the mechanism of creation through exaptation. We based our discussions on theoretical frameworks and recent administrative practices, pointing out means for reducing the barriers against the exaptation of each type of entity. Current literature is often criticized for being limited to good stories of innovation episodes to stimulate good insights that might spur organizational innovation ([Andriani and Carignani, 2012](#)). Thus, we made an effort to go beyond these limitations to provide a more pragmatic viewpoint of the actions of the manager with regard to exaptation. In terms of teaching, we understand that the article also helps teachers of management to address exaptation, using types of entities other than the innovation of technological products. This allows teachers of management to select the type of entity that is more convenient according to their expertise, the program for their discipline and the profile of their students.

In this study, we did not address how to practice and develop analogical ability. However, we addressed a necessary input for its occurrence: providing information to a manager or future manager, knowledge of organizational entities subject to exaptation. Besides highlighting the different types of examples of possible entities for exaptation, we addressed administrative approaches and practices that require the organization and its employees to adopt an analytical posture in terms of having knowledge of entities. All the administrative approaches or disciplines discussed in the previous section also require the structuration and description of the content of the entities associated with their respective fields. This is an ontological issue of understanding and making understood the different instances of the different organizational entities by all those involved in the implementation and use of administrative practice. The correct functioning of these practices requires wide-ranging reflection of the entities involved, breaking them down into as many attributes as necessary, giving these a set of descriptive properties. In practice, it requires conceptual modeling of data associated with the entities, which can be researched, read and understood by everyone in the organization. This makes it easier for company employees to know more about the entities available in the organization, both tangible and intangible, and how to enable them for the practice of the analogy, considering that analogies can only be developed from what is known.

### 6.1 Limitations and continuity of the study

The evolution of the 155 families of products and services developed by the 46 entrepreneurs interviewed led to some perceptions that we cannot affirm because of the limitation of the sample size, but which we believe deserve further future research in terms of sampling. We would highlight three of our perceptions:

- (1) The more experienced the entrepreneur and the number of assets available, the greater the likelihood of exaptation. Here we start from the premise that experienced entrepreneurs have had contact with a greater number and diversity of entities which might offer opportunities for exaptation. This is consistent with prior work on entrepreneurial bricolage which suggests that the larger the “trove” or set of accumulated odds and ends, s/he possess the broader the range of problems s/he can address (Baker and Nelson, 2005; Stinchfield *et al.*, 2013).
- (2) The exaptation mechanism is characterized as more likely to be a one-off or rare event in comparison with other creation mechanisms.
- (3) The more wide-ranging and complex the organizational entity, the more difficult it will be to exapt it, making, for instance, the exaptation of the process entity more difficult than the skill or tacit knowledge entity.

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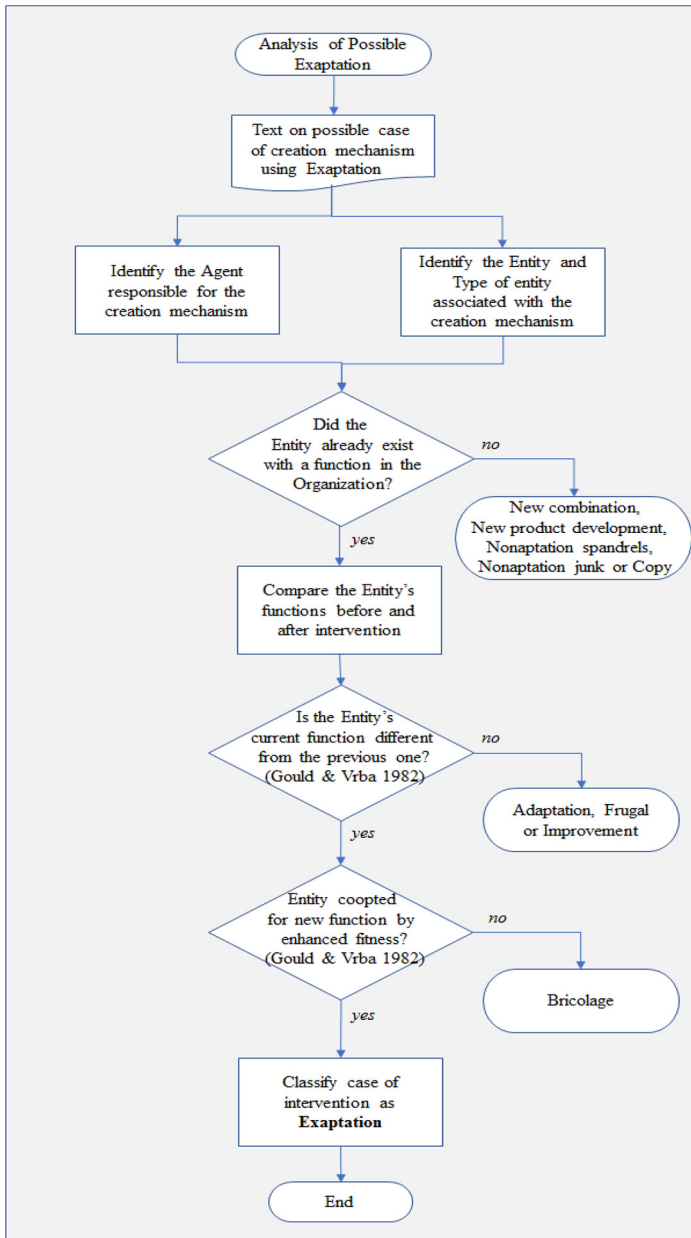


Figure A1. Algorithm for analyzing the exaptation mechanism



**Appendix 2**

Other creation mechanisms addressed in the interviews with the entrepreneurs:

- *Adaptation*. Unlike exaptation, where function follows form, in adaptation a form follows function. In other words, the form of the entity is altered to deliver the same function to customers with the same demand (Andriani and Cattani, 2016). In adaptation, the focus is on the pre-existing fitness function (Andriani et al., 2015). According to Dew et al. (2004, p. 72) adaptation “is actually better described by the term “aptation” rather than adaptation, since the etymology of “aptus” is “fit”, whereas “adaptus” refers to the process of increasing fitness by designing for a particular function”.
- *Copy*. Entrepreneurial copycats are those that begin a business with routines, competences, products and services that vary minimally in a particular market (Koellinger, 2008). Copying can occur in different ways, for example, by applying reverse engineering.
- *Frugal innovation*. Act of excluding non-essential functions that existed in the original product or service and/or replacing parts with cheaper analogous parts (Sarkar, 2011) to meet the needs of consumers with low buying power in a previously discriminated and neglected market (Zeschky et al., 2011).
- *Improvement*. Actions of improvement are intended to make something that already exists better and basically continue doing what it does, only more efficiently, more quickly, at a lower cost, better functions and more accurately, [. . .] (Tidd et al., 2005).
- *New Combination*. A subclass of NPD is new combination, as proposed by Villani et al. (2007). In this way of framing NPD, the new product or service results from the integration of technological elements or processes that already existed previously. However, they were originally conceived and developed by different entrepreneurs. In this creation mechanism, the entrepreneur operates more as an integrator of already existing entities.
- *New Product Development (NPD)*. This mechanism involves activities distributed over three stages: predevelopment stage, development stage, commercialization stage (Langerak et al., 2007). The resulting product or service “can be new to the business, new to the market, or new to the world”. In other words, there is no need to be something new to the market and the world (Najafi-Tavani et al., 2013, p. 3397). The aspect to highlight is that NPD results in something new at least to the one who develops it, in the context of this study, the entrepreneur.
- *Nonaptation Junk*. Also known as technological nonaptation, it is characterized as unexpected results obtained through technological research, often associated with new product development (NPD). Innovations based on nonaptation junk make use of inputs described as “materials and knowledge that just lies around” (Garud et al., 2016, p. 152). The best-known case is the experiment conducted at 3M that resulted in a “glue that did not glue”, which was later recovered and constituted the Post-it note.
- *Nonaptation Spandrels*. Creation using a resource hitherto without use, in other words not (from the Latin non) or without aptation. Gould (1997) adopted the term spandrel from architecture to illustrate how an empty space, initially without use in buildings, was later filled with mosaics and paintings and came to have an important esthetic function in buildings (Villani et al., 2007). The prototypical example presented by Gould (1997) is Saint Mark’s cathedral in Venice, whose domes were built three centuries before the mosaics that now adorn them (Garud et al., 2016).

Entity	Type	Agent	Initial function (original)	Context (exaptated)	Comments on the case
Moving assembly line (Mastrogiorgio and Gilsing, 2016)	Concept	Ford Automobile Industry	Ford became aware of the moving assembly line used in the meatpacking industry in Chicago	Analogously, Ford adopted the moving assembly line to make cars	Until then, Ford had deep experience in handcrafting a car (static car in the garage) but no experience with a moving assembly line
Printed text (Bonifati, 2012)	Communication channel	Press of Dominican convent of San Jacopo di Ripoli (in the city of Florence in 1471)	Printed texts for the purpose of teaching, religious devotion and leisure (vernacular poetry)	Printed texts for political and religious debate	In the 1490s, the Dominican friar, Girolamo Savonarola (1452–1498) used printing to divulge his verbal sermons that contained strong criticism of the morality of the church
Programmable calculator (Entrepreneur #2)	Equipment	Entrepreneur #2 created a company for training with programmable calculators and later a company to develop software for programmable calculators	Entrepreneur #2 used the programmable calculator to give programming classes to engineering students and professionals	Entrepreneur #2 used the programmable calculator to collect data to record orders in a restaurant and for electricity and water consumption in buildings	Entrepreneur #2 held programming courses for programmable calculators (HP 48 Series) and perceived the opportunity to create layers of internal software for the calculator, transforming it into a data collector focusing on mobile computation demands, as in the case of orders in restaurants and the reading of water and electricity consumption for utility companies
Resource for decorating environments for work on landscaping (Entrepreneur #10)	Material input	Entrepreneur #10, architect and provider of projection and execution services for landscaping	Entrepreneur #10 used vases for plants in the landscaping environments that he develops	Entrepreneur #10 used vases to return water from a hydraulic pump installed in a lake projected by him in a landscape	Entrepreneur #10 used the vase to give an effect of a pot that gushes water endlessly. The return from the water circulation pump in the lake pours the water into a vase that is slightly tilted with the lip pouring water into the water mirror

(continued)

**Table AI.**  
Other examples of exaptation of entrepreneurial resources different from technological products

Table AI.

Entity	Name (source)	Type	Agent	Initial function (original)	Context	
					Final function (exaptated)	Comments on the case
Resource used in intestine surgeries (Entrepreneur #83)	Entrepreneur #83, veterinary surgeon with a clinic to treat pets	Material input		Entrepreneur #83 used cannelloni for feeding purposes	Entrepreneur #83 began to use cannelloni as an instrument to support the suture of two parts of the intestine of a pet after a piece is removed	Entrepreneur #83 noted that cannelloni, as it is internally drained and has different dimensions, could be used to support for the suture and hold together the two emended parts of the intestine in the early healing until the cannelloni is absorbed by the intestine itself
Neuro-functional reorganization (Entrepreneur #56)	Entrepreneur #56, speech therapist with a speech therapy clinic	Technique		Entrepreneur #56 applied a technique to stimulate the central nervous system to treat patients with autism	Entrepreneur #56 applied the same technique to help children with urinary incontinence	Entrepreneur #56 serves a wide variety of customers at his speech therapy clinic. He discovered that the technique used to treat autistic patients could also help children with incontinence. A speech therapist would normally not provide this kind of treatment, but the principle is the same. Some synapses that were not established in infancy are reviewed with various repetitive exercises to help mature the part that was not stimulated until the child has control over the muscle that controls the urinary function

(continued)

Entity	Name (source)	Type	Agent	Initial function (original)	Context	Final function (exaptated)	Comments on the case
Stimulus for corporate innovation (Entrepreneur #50)	Entrepreneur #50, engineer and specialist in innovation	Technique		Entrepreneur #50 conceptualized and presented practical examples of a technique for the development of innovative teams on an MBA program for executives	Entrepreneur #50 applied the technique to consultancy work in companies to help implement corporate innovation programs	Entrepreneur #50 applied the technique to consultancy work in companies to help implement corporate innovation programs	After an MBA class, a student of Entrepreneur #50 invited him to hold a consultancy in his company, a corporate innovation program in which he applied the method taught in the MBA classes. Ever since, the engineer has also worked as a consultant
Psychopedagogical diagnosis (Entrepreneur #41)	Entrepreneur #41, psychopedagogue with a psychopedagogy clinic	Technique		Entrepreneur #41 applied a technique to identify children's difficulties in learning school subjects, including behavioral disturbances and interpersonal relationship problems	Entrepreneur #41 applied the technique to identify the potential careers of teenagers	Entrepreneur #41 applied the technique to identify the potential careers of teenagers	Entrepreneur #41 always worked children with learning difficulties and their families. In these sessions, she noted that the diagnostic tests did not only identify children's difficulties, but also their facilities and innate competences. She noted that the children demonstrated skills and competences of their own for certain types of profession and began to orient the parents in this sense. Soon, the parents of teenagers were seeking her to help their children when they were in doubt over their career choice

Table AI.

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