Did you inscript your tacit knowledge?

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Abstract

The management of knowledge is increasingly considered as a main source of competitive advantage for corporations. It is argued that organizations enjoy a competitive advantage if they know how to expand, disseminate and exploit organizational knowledge internally. Moreover, organizations can achieve their strategic goals by encouraging knowledge sharing, flexibility and adaptation to change. Furthermore our position is that tacit knowledge sharing can lead to knowledge stratification. And that it is likely to lead to encode knowledge in behavioural schemas, apparently similar to organizational routines, but as a matter of fact more complex and refined: the cognitive scripts. Even if apparently similar to organizational routines, the scripts strongly differ from them in terms of power of replication, of inertia degree, of search potential. The present study focuses on the analysis of the script localization in the organization as an important starting point for the understanding of the dynamics of knowledge stratification and encoding. Thus hypothesizing kinds of knowledge re-use within spin off decisions, as well. The plausibility of the mentioned hypotheses are tested by a multivariate statistics approach.

Keywords: organizational routine, script, academic spin off, inscription, collective knowledge

1. Introduction

There is a growing debate on the relationship between codified and tacit knowledge and on the role of codification in the dynamics of knowledge reproduction, or exchange. In this context, it would be a mistake to emphasize too much the "storage and transfer aspect" as the main competitive advantage of codified knowledge over the maintenance of knowledge in tacit forms such as organizational routines.

By overemphasizing the use of codification as means for storage and transfer, it would not do enough justice to the key role of knowledge codification: to make new cognitive devices emerge likely to produce knowledge. In one simple word, the knowledge "representation" problem. Particularly, codification provides a spatial device to screen and classify information, opening new opportunities for the modelling or representation of knowledge, a condition for quick knowledge production and accumulation. Knowledge representations are made as a prelude to the act of codification, while acts of codification shape the nature and appropriateness of knowledge representations. The value of knowledge representation moreover depends upon on the extent to which it can be successfully employed in an "inscription process", a learning and operating activity, involving the execution of scripts in order to simplify the cognitive effort of the individual in every managerial operation.

Our aim is furthermore to study the role of academic communities of practice in stimulating both tacit knowledge stratification and inscription processes. As well as to hypothesize kinds of knowledge re-use behaviours within spin off decisions.

Our focus provides us with a departure point for re-examining the interaction between individual skills and organizational capabilities as the basis of organizational routines. Then, we focus on a "script based" approach: scripts emerge from our empirical researches as a more dynamic evolution of organizational routines (Dell'Anno & Del Giudice, 2002; Maggioni & Del Giudice, 2004; Dell'Anno & Del Giudice, 2004; Dell'Anno, Van der Sijde & Del Giudice, 2005; Maggioni & Del Giudice, 2005; Maggioni & Del Giudice, 2006). Our position is that the local context in which routines emerge and learning takes place does matter, and leads to behavioural schemas (i.e. the cognitive scripts) that strongly differ from them in terms of power of replication, of inertia degree, of search potential. By following this approach, we point on the analysis of the script localization in the organization as an important starting point for the understanding of the dynamics of knowledge inscription. Moreover, our aim is to deepen in the specific overlapping levels between organizational routines and cognitive scripts, guiding scientific work in local academic communities, and managerial scripts required in order to identify and exploit new technological opportunities in a specific industry. These are expected to account for variations across different academic communities in the support, which is provided for the development of the organizational capabilities of spin-off firms in this industry.

2. What routines are: collective performance of a script or conscious and collective repetition of action?

Most of the criticism of codification could be applied to individualistic treatments of tacit knowledge. Tacit knowledge explains why firms hold together, project teams need to co-locate and technology transfer seems to be difficult. While tacit knowledge no doubts plays a small but important role in these processes, these are many more important causal processes at work, such as those relating to social interaction between individuals (Nightingale, 2003). So, when Nelson and Winter (1982) are discussing what routines *are*, they support Polanyi's idea that knowledge is an embodied process and that all our conscious attention is dependent on a whole range of unconscious, tacit processes (Polanyi, 1969)[1].

Comment [M1]: Non è molto chiaro

The following literature review on cognitive scripts and organizational routines represents an overview for applying the "inscription" concept to a *micro-level* perspective, by emphasizing the cognitive processes of the individuals (Ashforth and Fried, 1988); it can be useful for better focusing on a *macro-level* that may emphasize structural and institutional constraints (Nelson and Winter, 1982), as well. The analysis levels are obviously blurred, because "context" factors influence script selection and performance (Gioia & Poole, 1984) and the cognitive processes of individuals can enact situational structures (Weick, 1979).

Cognitive scripts

The first conceptualization places routine in the neighbourhood of concepts such as the script.

Cognitive scripts are a category of schemas, which entail also plans, categories, implicit theories, prototypes and heuristics (Wofford, 1994, p. 181). Schemas are knowledge structures in memory that people use to understand their environment, handle problems, and form expectations on results. A script is then "a cognitive memory structure consisting of the objects, events, roles, conditions, sentiments, and outcomes that occur in a sequential pattern in familiar tasks and situations" (Wofford, 1994, p. 181).

Louis (1980) noted that relatively inarticulate cognitive scripts, which are coherent sequences of events expected by the individual, likely to drive many behaviours. Taylor and Fiske (1978) asserted that most of our every day decisions are made 'off the top of our heads'. The scripts underlying these decisions are reviewed only when the individual senses "something out of the ordinary". A cognitive script is then a conceptual structure that allows individuals to approach familiar events in a relatively similar fashion. More specifically, Choo (1996) argued that "a cognitive script is a sequence of actions and events in an individual's knowledge structure that enables that individual to understand a specific situation or context *and* guides his or her behaviour in that situation or context" (p. 339). Moreover, Edwards (1994) noted that scripts are generalised event schemes, which are derived from concrete experience of events and thus represent "how the world works" (p. 211).

[1] Tacit knowledge is a category of unconscious neurophysiological causation that provides the basis and context to action and conscious mental stages.

Nooteboom (2000) recently visualised scripts as a set of events, or *nodes*, which produce outcomes that are then introduced in the next node of the script or nodes outside the current script. A simplified version of the visualisation that he proposed is then provided in Fig. 1:

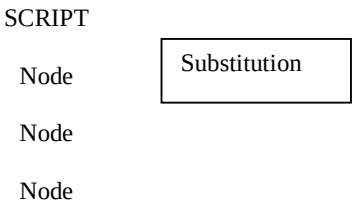

Fig. 1: visualisation of scripts (Nooteboom, 2000, p. 126)

Nooteboom (2000) described scripts as "one's cognitive, categorical framework or absorptive capacity" (p. 126). He argued that scripts can be seen as series of nodes, which correspond to sets of events or actions. These events or actions can be "substituted" into the nodes, and thus become part of the script. Nooteboom furthermore argued that nodes produce outcomes that can then be substituted in subsequent nodes. It is also possible that outcomes of a particular node are substituted into nodes of different scripts, or in no other script at all. Nooteboom's view is relevant to our paper since it emphasizes that actions can be invoked "automatically", if they result from the substitution of outcomes of earlier nodes. In earlier studies, Shank & Abelson (1977) and Gioia & Poole (1984) regarded scripts as cognitive representations of rule-guided, stereotypical sequences of events and actions. Shank & Abelson (1977) treated scripts primarily as cognitive phenomena, contrary to Barley & Tolbert (1997), who propose that scripts are "observable, recurrent activities and patterns of interaction characteristic of a particular setting" (p. 98). They focused more on the embodied actions in the scripts. Gioia & Poole (1984) pointed out that a script contains knowledge on sets of events or behaviours ("weak" scripts according to Gioia & Poole, 1984) and their sequence ("strong" scripts, Gioia & Poole, 1984, p. 449). They provided a definition that focuses both on the mental storage of scripts (the cognitive component) and on the resulting behavioural regularities. They defined a "script" as "a schema held in memory that describes events or behaviours (or sequences of events or behaviours) appropriate for a particular context" (p. 450). Moreover they discussed the notion of "scripts" instead of "cognitive scripts". Gioia & Poole emphasised the sequence of events or behaviours, instead of their cognitive representations, as well. Although these last are practically difficult to separate, this paper focuses on 'scripts' in order to underscore the idea that scripts can be more than cognitive structures. They can be part of habitual action in a very realistic manner, just as Barley & Tolbert (1997) propose. However, it cannot dismiss the associated cognitive phenomena, as these

cause specific behavioural regularities to be displayed. Knowledge on how and when scripts are invoked, and when they are not, is needed to provide explanations of changes in repeated behaviours.

The definition of scripts that is used in this paper accommodates processes of cognitive adaptation that individuals can experience when confronted with novel situations. These cognitive processes include the processes that lead to "automatic" script performance or conversely, cognitively controlled processing of situational information. This is coherent with Gioia & Poole (1984) early assumptions: "scripted organisational behaviour is often performed unconsciously […], although active cognition is involved during the process of script development and when encountering unconventional situations" (p. 449). As such, the associated cognitive dimension is an important part of the present study, although primarily related to the invoking or dismissing of scripts as well as the "invention" of new scripts. Therefore, we would approach a slightly adapted definition of a script: "a regularly performed schema held in memory that describes events or behaviours (or sequences of events or behaviours) appropriate for a particular context". This definition focuses not only on its *cognitive representation*, but also on the *regular performance of the schema*, producing potential behavioural regularities, that can result in the production of routines, as the next paragraph will argue.

Routines

It appears that a number of authors in the managerial literature employ the word "routine" in the same manner as others employ the term "script". In the present study, routines are collective, observable behavioural regularities, whereas scripts are the underlying individual cognitive regularities that may or may-not accompany routine behaviour.

Similar to scripts, routines allow actors to make complex decisions, without resorting to extensive search behaviour for alternatives and preferences. Their value lies in the reduction of the "complexity of real-world decisions to manageable levels by limiting the scope of the "problematic search" for solutions" (Sharp, 1994). Nelson and Winter (1982) argued that routines reduce decision complexity by providing a narrow range of environmental signals (cues) that indicate possible causes for action (see also March & Simon, 1958). The price that one has to pay for increased simplicity is that actors do not oversee all possible alternatives, but only parts thereof. Stein (1997) noted that the cognitive processes of reduction and elaboration can lead to choice biases, as well as influencing the sensory inputs we give attention to and those we do not. Giddens (1984) from his side saw routines as the very fabric of social structure. Structure exists because of the continuous production and reproduction of action. Yet, at the same time, routines enable the continuity of the personality of the agent. With different words: routinization enables structure as well as personality of those operating under the influence of structure.

Sharp (1994) suggested that routines can be seen as Standard Operating Procedures (SOPs) that facilitate decision making in the face of complexity and

uncertainty. In this, he makes no distinction between formal routines and factual routines. Burns & Scapens (2000) and Cohen & Bacdayan (1994) did make this distinction. They perceived routines to be the informal counterpart of formal rules of behaviour. They separated Standard Operating Procedures from routines-in-use. From their perspective, rules are the formalised statement of procedures, whereas routines are the procedures actually in use (Burns & Scapens, 2000, p. 7). A somewhat different concept of routine behaviour has been provided by Louis (1980). She observed that in normal every day action, individuals operate in "a kind of loosely pre-programmed, non-conscious way, guided by cognitive scripts" (p. 239). She suggested that conscious thought does not play a major part in these activities. Following this approach, Porac et al. noted that "many experienced employees perform their work with highly routinized behavioural patterns and thus may not engage in much causal reasoning simply because work has become "scripted"' (1983, p. 286). They referred to scripts, but related notions have also been used, including schema (Weick, 1979) and habitualization (Berger & Luckmann, 1979). These concepts are more individually oriented than the concept of routines noted above.

Routines, whose development and application by organizational members is facilitated by written rules[2], not only confine the activities of individuals but also enable them[3] (Adler & Borys, 1996). Rather, the process causing some rules to be evoked more than others point to routines can occur due to the performance of scripts. This duality is one of Gidden's (1984) core concepts. Routines cannot always be made explicit, for they also encompass "tacit knowledge" (Nonaka & Takeuchi, 1995). This aspect was touched upon when Nelson and Winter (1982) argued that routines are the skills of an organization. The performance of an organizational routine involves the effective integration of a number of component subroutines (themselves further reducible) and is ordinarily accomplished without "conscious awareness" – that is, without requiring the attention of top management. This sort of decentralization in organizational functioning parallels the skilled individual's ability to perform without attending to the details" (pp. 124-5).

Finally, Stinchcombe's (1990) notion of routines illustrated the latter: "a skilled person becoming really expert and fast at doing some number of distinct tasks". Stinchcombe recognised that the skill of skilled workers is only in part attributable to action routines. In part, the skill of skilled workers is also dependent on "the many principles of decision which tell workers when to use one routine, when to use another" (1990, p. 33). Implicitly, Stinchcombe distinguished between (action) routines and scripts on the same basis: the motor skills of acting and the cognitive skills of deciding.

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[2] March (1989) observes that routines can be related to rules. Rules in themselves are not routines, as there are multiplicities of rules applicable to each situation.

[3] Thus, scripts extend formal rules: containing information on how to behave when certain rules apply, scripts extend formal rules into minds of individuals.

This points us to a distinction that appears to be relevant: routines resulting from the collective performance of a script vs. the conscious and collective repetition of action[4].

3. *On the processes of representation and reproduction of knowledge*

The complex relationships between scripts and routines emphasizes that the individual and collective levels are not independent of each other, but interact with each other iteratively and continuously.

Our primary contention about *how routines are used* within the firm provides us with a departure point for re-examining the role of script construction, which serves to reproduce and extend the repertoire of individual and collective capabilities.

Our purpose is then to develop an analysis of the processes of composition and delivery of scripts ("inscription"[5]) in relation to a major influence on the acquisition and exercise of skills (that are not or cannot be completely specified) and on methods of coordination for assembling these skills into routines.

We especially stress the cognitive and organizational mechanisms mobilized by the codification process. The formation and use of knowledge depend on the nature of the organizations and other collective sets. Knowledge, as a result of a social process, raises itself considerable cues for further analysis; particularly, the need to understand how knowledge can be transmitted from the level of the organization to an individual, and reciprocally, seems to be an intriguing one. The managerial researches (Nonaka and Takeuchi, 1995) showed that this transmission would require different conversion mechanisms (tacit to codified, codified to tacit, etc.) to operate within a given organization and between different organizations. They clearly emphasized that the individual/collective dimension strongly interferes with the tacit/codified dimension.

Our research idea is then the following: by holding the knowledge transfer "tools" an individual implies obviously the mastery of codes and/or languages but it also includes knowledge about the mode of conversion of knowledge that are the ways through which individual knowledge becomes collective (and reciprocally), tacit knowledge becomes explicit (and reciprocally), etc.

However, it is necessary to make a distinction (Steinmueller, 1999): between the process of *extension* (i.e. the process of *using the representation*) and

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[4] From the point of view of economics, we can refer to the definition of Cohen *et al.* (1996, p. 683) in the sense that routine is a capacity to generate (collective) action, to "guide or direst an unfolding action sequence, that has been stored in some localised or distributed form". Then, routines guarantee the regularity and predictability of individual behaviour necessary for collective action.

[5] "The composition and the delivery of scripts consist of sequences of words, gestures, pictures, sounds and other expressions that can be symbolized and which facilitate the reproduction of human works and expressions" (Foray and Steinmueller, 2003, p. 299)

the knowledge reproduction process. And, of course, between the process of *representation* (i.e. the process of *creating the codes*) and the knowledge reproduction process itself.

There is an implicit strategic dimension in the second situation insofar as the adopted codes and modes of conversion should take into account the abilities of the receiver. And in this respect, codes, and especially languages, are not neutral means to transmit knowledge. They include intrinsically a representation of the world and mobilize different amounts of cognitive resources, both for the emitter and for the receiver.

We wish furthermore to emphasize that the devising of an effective script for transferring knowledge (such as problem-solving) is rather different from that of creating a sort of blueprint or instruction manual described by Nelson and Winter (1982) as instances of explicit information. The knowledge conveyed through the inscription process[6] amounts to "skills". The problem is that the word "skills" may seem ambiguous; it encompasses the *capacities*, like simple information recovery, as well as much *more cognitively complex activities*, such as problem-solving. Our contention is that scripts can be and are devised to encompass the full range of activities encompassed by skills. This is because scripts may incorporate heuristics, experimental investigations, analogies, metaphors or other figurative expressions that employ the natural language abilities of the intended recipient. In this sense, devising an appropriate script involves anticipating the mature understanding of an individual who has already mastered a body of knowledge. The potential for developing scripts that take account of the cognitive capacities of the receiver raises doubts about Nelson and Winter's concerns about the difficulties of articulating knowledge, including time-rate difficulties in utilizing explicit information or the difficulties of parsimonious description. Nelson and Winter are more successful in reminding readers that scripts, regardless of how they are acquired, must be "internalized" in much the same way as an actor may mediate between the memorizing of a text and the actual performance of the part (Foray and Steinmueller, 2003).

The main questions that arise about the effectiveness of scripts are whether the individual delivering it will be able to master the outlines of the script in sufficient detail to execute it. As well as, whether those receiving the "performance of the script" will succeed in comprehending its intended purpose and internalize the knowledge that it is meant to reproduce. It is certainly possible to devise "bad scripts" that are too detailed to be effectively executed or that are incomprehensible to or unusable by their audience. These possibilities should not be taken as demonstration of an inherent impossibility to articulate knowledge in explicit or codified forms through the use of appropriate scripts. Nor should the variability with which individuals are able to comprehend scripts and thereby acquire knowledge,

[6] The process of inscription is complex. It involves transforming knowledge into a form that enables effective performance of complex tasks by individuals who may or may not have a clear understanding of the underlying principles of design or operation of the component of the system that they are callen upon to operate or maintain.

the observable differences in "talents", be taken as evidence of a fundamental inability to articulate knowledge.

Our intention in this paper is localize reproductive behaviours in the processes of inscription and the alternatives to inscription that involve ad hoc social interaction processes.

4. The role of "communities" as context for the emergence of scripts.

According to our vision, is essential to identify the places where the modes of conversion of knowledge are activated, where the translation of local codes to organizational language (and reciprocally) is made, etc. We suggest that generally the level of interaction of small groups (communities) is essential to understand the process of transformation and transmission of tacit knowledge from the individual to the organization (and reciprocally).

Following this approach, we took inspiration from those authors working on communities of practices or epistemic communities. Every organization is made up of many communities of practice (i.e. groups of people committed to the same practice and sharing similar working visions), in which learning is not a matter of conscious design or recognizable rationality and cognitive frames, but a matter of new meanings and emergent structures arising out of common enterprise, experience and sociability–learning by doing (Cohendet & Llerena, 2003; Ancori, Bureth & Cohendet, 2000).

The role of work-based communities in generating knowledge has been studied with reference to different fields (e.g. to the context of physicists and molecular biologists (Knorr Cetina, 1999); to the researchers engaged in the design of a new technological artefact (Garud & Rappa, 1994); to the aerospace engineers (Constant, 1999)). Scholars labelled these communities differently, according to the mode of identification of their members and to the nature of their work. Epistemic cultures is Knorr Cetina's term to describe communities identified with the process of creating knowledge itself, e.g., research scientists.

The concept of epistemic community heavily relies on the socialization of knowledge, emerging overbearing from routines and repeated interactions, rather than encrypted in rules or in an organizational design. They comprise "agents who work on a mutually recognized subset of knowledge issues, and who at the very least accept some commonly understood procedural authority as essential to the success of their collective building activities" (Cowan et al., 1999).

The concept of community[7] enriches the organizational representation of knowledge-based activities. The epistemic community is more than a coordination

[7] The japanese term "*ba*", introduced by Nonaka and Konno (1998) as a useful way of referring to the virtual and real spaces needed to nurture learning and knowledge creation, seems to have some similarities with the concept of a "community of practice", where members of a community learn by participating in the community and practicing their jobs.

devise insofar as it incorporates learning infrastructures. These embedded infrastructures of learning are built into the routines and the daily practices of members, and features all the communities of practice that are to be found within and across organizations.

As a result, we have gradually shifted our research focus toward studying how organizations evolve by adapting knowledge bodies, shared by their members; we empirically recognized that the organization must develop common rules, common knowledge, collective learning and incentive schemes to cope with the need for circulation and creation of knowledge; and that in this respect, many of these processes take place at the collective tacit level.

5. Academic "communities", scientist - entrepreneurs and spin-off firms

The spatial dimension of knowledge flows is conditioned by the social organization of the individuals who collectively generate the knowledge. Firms accrue defendable advantages when social identification within the firm is strong and firm-specific organizing principles guide the development and application of new knowledge (Kogut & Zander, 1992). But the identification of employees with wider work-based communities increases the porosity of firm boundaries around the creation and transmission of knowledge.

The problem of knowledge exploration and exploitation in the context of work-based communities has recently surfaced in studies of science-based firms, which rely on science, and hire scientists, to innovate.

By analysing the early development of science-based firms spun-off from university laboratories, recent studies have pointed out how "founding laboratories" constitute a key source on which science-based firms rely for their comparative advantages, highlighting the tacit knowledge regarding founding ideas which founders bring into a firm.

However, these are important differences between the concepts of community of practice and *ba*. Whereas a community of practice is a place where members learn knowledge that is embedded in the community, *ba* is a place where new knowledge is created. Whereas learning occurs in any community of practice, *ba* needs energy in order to become an active boundary *ba* where knowledge is created. Whereas the boundary of a community of practice is firmly set by the task, culture, and history of the community, the boundary of *ba* is set by its participants and can be changed easily. Instead of being constrained by history, *ba* has a here-and-now quality. It is created, it functions, and then it disappears, all as needed. Whereas the membership of a community of practice is fairly stable and whereas new members need time to learn about the community of practice and become fully participatory, the membership of *ba* is not fixed, for participants come and go. Finally, whereas members of a community of practice belong to the community, participants of *ba* relate to the *ba*.

Focusing primarily on the role of science transfer support institutions, these studies have largely left unexplored, the role organizational structures governing scientific research itself play in supporting entrepreneurial activities of scientist.

Our study discusses and empirically verifies how academic communities inside universities, in which scientist nevertheless have been guided in their research by organizational routines that overlap with routines required to identify and exploit new technological opportunities in a specific industry, place top scientists from these communities in a comparatively advantageous position to build up spin-off firms.

Research methodology and sampling procedure

The approach followed in this research[82] has consisted in a back-survey. The first step has been the selection of entrepreneurial contexts marked by two eliciting conditions: a widespread entrepreneurial framework and a corporate willingness to transfer knowledge. The research has focussed in particular on the effects of a cross-fertilization approach in academic contexts favouring the development of a fertile soil for the exchange and for the stratification of knowledge which will then be reflected in individual's managerial behaviours (Prahalad & Hamel, 1990). This study has aimed at understanding whether it is possible that the result of an inscription process in an academicc community of practice can lead to a spontaneous process of corporate creation through spin off. As a main result of an inscription process we looked at the codification of tacit knowledge stratified and exchanged among the members of a same research workgroup in a cognitive script.

Following this approach, the first step has consisted in searching, by the means of informal in-depth interviews, within the academic organizations promoting spin off processes (Universities, Laboratories and Research Centres), informal highly iterative practices or procedures, tacitly accepted, shared in communities of practice and encoded by individuals. In simple words, we just searched for inscription processes, stemming from knowledge socialization, that which might lead the individuals to activate spin off initiatives. In brief, this research aimed at investigating the possibility of transferring successful tacit scripts (emerged from an inscription process) making up the cognitive map of the parent organization, as well as of reproducing these scripts through spin off processes. The analysis, based on an empirical inductive model, has stemmed from direct field observation supported by a previous bibliographical survey by also considering that empirical studies on

[8] This research has been developed thanks to funding of Italian *Ministero dell'Università e Ricerca (MIUR)* as part of a two-year National Research Project (Prin Cofin 2001 and 2003) and has involved the Faculty of Economics of *Seconda Università degli Studi di Napoli* as project coordinator and the *Nikos Center* at the University of Twente, the European most remarkable spin off incubator, and the Department of Marketing and Entrepreneuship of the Grenoble Graduate School of Business (*Group ESC Grenoble*). The research contact database is being continuously updated: in consideration of the scientific results obtained and the innovation of the hypothesis formulated, the research as such may be considered still in progress.

organizational learning and knowledge transfer are quite scanty in the European managerial literature, most of the research about entrepreneurship and organization originating in the USA.

One of the critical phase of our work has consisted in identifying the target to be researched. In order to obtain a significant classification of the spin off processes, a number of geographical areas has been first selected by taking into account the number of spin off cases already occurred in the local academic context. Secondly, some of these geographical areas have been sorted out for their relevant scientific value, as being marked by significant homogeneous features (criteria for their selection have included the yearly average number of spin offs as reported in scientific literature, their relevance on the web and in the relative scientific literature, etc.). In particular, three "macro-areas" have stood out: Europe, the USA and Canada. In each of these areas some sub-regions have been further identified and selected. Lastly for each of the selected regions the local academic organisations have been identified which would result involved in processes of know-how/technology transfer and spin off. Starting from those premises, our sample has been assembled by gaining contacts of similar institutions spurring technology transfer and spin off promotion from various databases: AUTM (Association of University Technology Managers), Nikos Center (University of Twente), Simon Fraser University, Southern California Biomedical Council, INFM.

As concerns this analysis, the investigation has covered geographical areas and institutions having homogeneous distinctive features in terms of academic spin off processes. As a whole 252 organizations have been selected as involved in academic spin off processes, whether as parent organizations and as spin offs, all of them concerned with IT, TLC and Life Sciences.

Empirical analysis

The first step of the analysis has consisted in an exploratory study aiming at investigating the main effects of an inscription process. This phase has involved the building up of a set of data from which the information required might be extracted to be measured. The means employed to obtain the scale development has been the in-depth interview (Glaser & Strauss, 1967; Eisenhardt, 1989)[9].
In this phase the gathering of data has indeed consisted in carrying out a number of in-depth interviews of researchers of 11 European institutions dealing with academic spin offs (3 of them as mother organizations, 8 as spin offs). On sampling the following criteria have been taken into account (Bardin, 1977):

a) sample representativeness[10];
b) sample exhaustiveness;

[9] S*cales* and *items* have been set according to the guidelines of Churchill (1979) and Gerbin & Anderson (1988).
[10] The compliance of this requirement has been guaranteed by selecting enterprises having differing organizational features (turnover, n° of employees, capital stock).

c) data homogeneity[11].

The in-depth interview, which is largely used in management research (Evrard et al., 1993), has been chosen as a means of investigation as it allows the interviewed to freely express their opinions on a set of topics submitted by the researcher (Bailey, 1994). In particular, the topics submitted to the managers have been the following:

- their description of the knowledge stratification process;
- their description of the inscription process;
- the effects of sharing practices in research workgroup on knowledge socialization and stratification;
- their description of the cross fertilisation process within the parent institution;
- their perception of a firm-specific know–how ;
- the perception of the effects of holding or not an academic-specific knowledge
- the perception about the possibility of setting up a spin off enterprise thanks to the know-how acquired.

Interviews as surveyed have been first read perfunctorily in order to get a general idea of the responses to the topics submitted.
This process has allowed the identification of a series of relevant data which have then been grouped into categories (the sentences of the interviewed have been thoroughly analyzed for the underlying logical schemes to surface). The first part of the study has thus allowed the researchers to get to some conclusions about a researcher's learning process of a script.
Before describing the phase of development of the scales and items which have marked the exploratory factor analysis, some general considerations are necessary.
Generally speaking, literature has demonstrated that behavioural scripts consist in some basic repetitive actions performed by all the individuals concerned (Abelson, 1981).
However, the sequence of actions in a script may vary depending on the individual. One of the objectives of the present study has been to check the possibility for a simple script (e.g. an operating procedure) of generating a complex one (the capacity of the researcher to reutilize the know-how acquired, including the tacit one, to start a new autonomous enterprise).
This process is even more interesting if the role of the mother institution encouraging the stratification of knowledge among its researchers is taken into account.
From the analysis of the interviews carried out, the research design and the relevant variables are easily outlined. First of all the script is generated by the knowledge of critical specific processes that can lead the researcher to a business idea (usually researchers have less managerial skills than product/process management

[11] An homogeneous set of data means that the same topic has been submitted to all the interviewed by the same surveying technique.

knowledge). Secondly, holding a script spontaneously urges the researcher to evaluate a possible change (as a matter of fact the process is usually gradual: at first the employee holding a script and aware of the script underlying relevance weighs the chance of exploiting the knowlege acquired while working with the parent institution to turn into an entrepreneur himself).

In-depth interviews carried out have been used to arrange an initial set of scales and items relative to the various constructs. Then the items have been revised and the irrelevant ones have been cancelled. The outcome has been an online questionnaire[12] organized in 41 items.

As concerns the process of operationalization of variables, one of the critical choices has concerned the number of points of the measurement scale. In this study, in order to combine accuracy of data, with flexibility of the replies, differential semantic scales have been adopted ranging from 3 to 5 points (in literature these scales are considered easy to understand and employ, being "universal" and providing a satisfactory degree of facial validity (Bagozzi, 1994a)[13].

The interviewed invited to reply to the questionnaire via e-mail were given access to the web pages activated while data were automatically gathered by the

[12] Data acquisition has been obtained through an ASP database to be filled in on http://www.maggioni.org/mq/uneng1.asp .

[13] Bitner (1990) suggests to resort to direct observation for detecting the behavioural pattern of an employee within his organization (a similar stance is argued by Evrard et al. (1993), p. 128). As however direct observation is time-consuming and expensive (Evrard et al., 1993), it could not be applied to this research and instead a "method of sample calibration" has been opted for which joins the benefits of direct observation with the advantages provided by the employment of questionnaires. The method applied has required that script knowledge be measured against a calibration sample (in this case ten Italian high-tech enterprises, originating from spin offs). Taking as a reference the stratification of knowledge as well as the generation of the script in enterprises affected by spin off processes, script knowledge has been measured both through perceptive measurements and observed ones (perceptive measurements have been obtained through items concerning stratification processes of knowledge in employees and the reproduction of the script in a new enterprise, whereas the observed measurements have been obtained through the analysis of the knowledge as stratified by the employees as related to their functions and to the results of the spin offs). Next the convergence of the two measurements has been tested (as suggested by Heeler & Ray (1972, p. 362). This method resorts to quasi-experimentation and pursues the target of testing the relation between perceptive and observed measurements, verifying whether perceptions of individuals (obtained through a questionnaire) are reflected in their behaviour (surveyed through direct observation). At the end of this study, after submittal of the questionnaire, the calculation of the correlation between two undisclosed factors, knowledge of the script perceived and observed, has given a high coefficient ϕ (=0.94). The significant convergence of the two constructs has been guaranteed by the fact that at a 95% confidence level (2 standard deviations) the ϕ range has resulted equal to $1{,}05 < \phi < 0{,}87$. As the interval contains the value 1, the two factors appear not separated (Bagozzi, 1994b). In other terms perceptive and observed measurements of knowledge converge, thus suggesting a substantial matching of the statements of the individuals involved in spin off processes and their actual behaviour.

database specifically arranged for. A special on line section has also been devised where results of the interviews have been displayed as updated in real time by means of simple three-dimensional bar graphs, diagrams, pies, etc. The database and the online questionnaires have been linked to a simple statistical processor monitoring the progress of interviews in real time and providing an immediate empirical result via a user-friendly graphic display.

420 researchers of institutions involved in spin off processes (20% of which from spin off companies) have been invited to answer the questionnaire. The answering rate has been quite high, thus demonstrating the interest of the interviewed in the research (Average AR = 55%). As a whole 231 questionnaires have been returned to be analyzed.

Research hypotheses

The present research has first investigated the possible consequences of organizational learning on the employee. The *spin off* capability of favouring the transfer of *firm specific* knowledge as condensed in a script has been analyzed by formulating two basic hypothesis:

H1: Tacit knowledge stratification in academic communities of practice spurs the individual to a spontaneous process of cognitive script encoding (i.e. inscription process)

H2: Individuals that encoded a cognitive script thanks to an inscription process are very willing to create spin off enterprises[14]

Statistical analysis and discussion

Exploratory Factor Analysis

Hypothesis have been tested by means of multivariate statistical analysis techniques (in the analyses reported the 13.0 version of SPSS software has been employed). In order to obtain relevant results the sample employed has been divided into two datasets: an *exploratory dataset* (n = 120) and a *confirmatory dataset* (n = 111).
An *exploratory factor analysis* has been thus conducted for determining which *scales* might be relevant for devising the model and for testing the hypotheses. Cronbach Alpha analysis has showed a general consistency of the items selected (see Tab. 1). Items inconsistent with the model proposed have been then eliminated as well as those having a poor correlation with the other items measuring the same construct.

[14] Particularly, referring to the present research, the inscription process mentioned in H2 is an *individual* process but stemmed from a *collective* knowledge sharing (see H1).

On termination of the exploratory factor analysis the internal consistency of all the scales selected corresponded to a *cut off loading point* > 0.70 (Nunnally & Bernstein, 1994) (Tab. 1).

Exploratory Factor Analysis[15]

Scale/items	F1	F2	F3
Tacit knowledge stratification *(α=0.93)*			
(1) I used to share and exchange tacit knowledge by working in group	0.93		
(2) I regard knowledge sharing as main reason for tacit knowledge settling	0.91		
(3) I regard participation to working group as an important factor of tacit knowledge increase and improvement	0.95		
(4) I regard personal involvement in advanced projects as an important factor of tacit knowledge settling	0.86		
(5) I regard personal development of common research as an important factor of tacit knowledge increase	0.91		
Willingness to spin off *(α=0.87)*			
(1) I regard exploitation of specific know how acquired as main reason for urging an individual to spin off		0.91	
(2) I regard technical know how and training as important factors for spurring individual to spin off		0.85	
(3) I regard personal contacts (developed during my work at the parent company) as an important factor in order to make individual willing to spin off		0.90	
(4) I regard confidence in my business idea as main reason for urging an individual to spin off		0.87	
(5) Some individuals in the organisation are more willing to promote spin off processes		0.85	
(6) Some functions in the organisation are more willing to promote spin off processes		0.89	
Cognitive script acquisition *(α=0.91)*			
(1) I learned and used behavioural schemas for my job at the parent organisation			0.75
(2) I regard the schemas that I used for my job more complex than simply organizational routines			0.84
(3) I used for my job tools that, once learned, reduced my cognitive efforts			0.87
(4) I learned and used behavioural schemas during my job that improved by using			0.77
(5) I improved my behavioural schemas by sharing my knowledge with other collegues			0.89
Eigenvalue	3.20	2.87	5.45
Percent explained variance	9.4	8.3	15.2.

Tab. 1. *Exploratory Factor Analysis*

Confirmatory model: test of the hypotheses and discussion of the empirical results

The exploratory factor analysis performed has highlighted the relation between the scales and the items. The second phase of the empirical analysis has, instead, thoroughly deepened the scales obtained, to the purpose of testing the assumptions made. The confirmatory model has been applied to the whole sample (*confirmatory dataset*) as available (n = 111).

[8] In brief the "tacit knowledge stratification" scale refers to the individual script summarizing the tacit knowledge stratified during his employment with the parent organization. The "cognitive script acquisition" deals with the encoding of the tacit knowledge acquired in a cognitive script. Likewise the positive correlation between the mentioned scales describe the inscription process. The above mentioned scales are described also by a number of other items. For briefness' sake only the most relevant of them have been reported in Tab. 1.

The test of H1 and H2 hypotheses has been performed by means of a classic *confirmatory model* (test ϕ). These choices perfectly comply with the indications thereon proposed by the relevant literature (Gerbin & Anderson, 1988)

On modelling, the *fit ratios* have showed satisfactory values and therefore the framework of observed variables as selected has not been changed[16]. Results obtained have showed the reliability of any dimension of the model; at the same time also the composite reliability (a LISREL measurement, similar to the Cronbach Alpha) has resulted as generally high (Tab. 2). Lastly, the variance obtained for each dimension has generally resulted greater than 0.60, which means that variance was common to the indicators of each dimension (Fornell & Lacker, 1981)[17]. Accordingly the model devised consists of two stages: a first one - (H1) – in which the individual improves and increases his personal knowledge by sharing tacit knowledge in academic communities of practice; moreover, he encodes it in a cognitive script (i.e. *inscription process*). A second stage - (H2) - in which the cognitive script holder becomes willing to turn himself in an entrepreneur within a spin off enterprise, probably because aware of the relevance of the knowledge encoded in his own scripts. Furthermore, H2 requests a specification. The knowledge encoded in cognitive scripts by spin off promoters should be considered "relevant" in order to develop their business idea; otherwise, they would not imagine to turn their research in a firm. This issue can be furthermore justified since in academic and research contexts it's common that scientific knowledge likely to lead to a product (or to a process) at the bottom of a business idea. Then, our research framework can be finally outlined: the tacit knowledge stratification because of the participation of an individual to a community of practice (or to a workgroup) sums up in a cognitive script. Furthermore the holding of such "relevant" script generates a spontaneous entrepreneurial behaviour.

Generally academic institutions tend to encourage circulation of knowledge throughout the organizational framework to the purpose of favouring development and innovation. All that brings about an unavoidable increase of the tacit knowledge transfer among the operators of the academic institution. Our main research hypothesis is that individuals, by being exposed to that knowledge flow, spontaneously will manage their work by developing behavioural scripts aiming at reducing their cognitive efforts[18] (H1). This is just what we defined "inscription" process: once gained and improved his personal tacit knowledge thanks to the interaction with members of a community of practice, the individual encode it in a script that can help him to work "better".

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[9] Although χ^2 has given high statistical values (χ^2 = 37.25, *df* = 110, *P*<.*01*), other *fit ratios* have confirmed acceptability of the model (Tucker Lewis Index = 0.84; Comparative Fit Index = 0.91 (Bollen, 1989). The χ^2 value is conditioned by the size of the sample selected.

[17] In this study for simplicity's sake values relative to χ^2 *difference tests* are omitted.

[18] Every implementation of a process require cognitive efforts that can be reduced through the learning and the use of cognitive scripts.

The confirmatory model therefore helps acknowledge the validity of the second hypothesis (H2) too: individuals that encoded a cognitive script thanks to an inscription process are very willing to create spin off enterprises. Thus it is easier in research laboratories where individuals are directly involved in critical processes that can originate business ideas. It is worth underlining here that the hypothesis H2 does not exclude the involvement of classic motivations for an individual to undertake an enterprise. The gist of the empirical analysis has been however to demonstrate a possible correlation between the holding of cognitive scripts and the willingness to spin off depending on the will of the newly-born entrepreneur to re-use critical knowledge.

The confirmatory model devised (Tab. 2) highlights the mentioned close relations, thus confirming the mentioned hypotheses (H1: tacit knowledge stratification, willingness to spin off => ϕ= 0.79; H2: cognitive script acquisition, willingness to spin off => ϕ= 0.87). And moreover demonstrating the attitude of the individual who has learnt and processed a script (that he believes to be at the bottom of a valid business idea) to turn himself into an entrepreneur, tracking the success of his research in the academic institution.

	ϕ estimates[a]		
Model's dimensions	1	2	3
Tacit knowledge stratification (1)	1.00		
Willingness to spin off (2)	0.79 (21.87)[b]	1.00	
Cognitive script acquisition (3)	0.87 (19.54)[b]	0.72 (16.27)[b]	1.00
Standard deviation	1.28	1.47	1.83
Composite reliability	0.84	0.81	0.93
Variance extracted	0.48	0.62	0.55

[a] The first figure indicates the value of the ϕ coefficient. The second is the value of the *t*
[b] Relevant for *P <.01*

Tab. 2. *Confirmatory Model*

Conclusions

The above developments suggest that knowledge is closely dependent on the cognitive abilities of the actors who hold it, and that it cannot be separated from the communication process through which it is exchanged. This perspective helps to underline the cognitive and strategic implications of the transformation of knowledge and explores the conditions and the consequences of the transformation of knowledge from the individual to the collective level (and reciprocally). The concept of community enriches the organizational representation of knowledge-based activities. Our approach highlights the key role that research communities play in supporting the growth of science-driven industries. As the discussed

empirical analysis indicates, 'chunks' of typically tacit experiential knowledge, captured and organized in scripts, which scientists in such communities develop, provide these scientists with significant comparative advantages in developing the recreation of productive knowledge from the template site in spin-off firms. In fact, the cognitive script holder becomes willing to turn himself in an entrepreneur within a spin off enterprise, probably because aware of the relevance of the knowledge encoded in his own scripts. Further researches can be more focused on the "relevance" of those scripts for the developing of a business idea via spin off (in a knowledge re-use perspective). Moreover, they can point on how much does it weight holding such relevant scripts on spinning out decisions.

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