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Organizational learning under conditions of organizational impermanence: A longitudinal analysis of project firms formation and dissolution*

Simone Ferriani

Cass Business School

City University London - 106 Bunhill Row - London EC1Y 8TZ UK

Tel: +44 (0) 20 7040 8217 - E-mail: s.ferriani@city.ac.uk

&

Dipartimento di Discipline Economico Aziendali

Universita' di Bologna - Piazza Scaravilli, 2 - 40126 Bologna

Tel: +39051 2098073 - Fax: +39051 2098074

Raffaele Corrado

Dipartimento di Discipline Economico Aziendali

Universita' di Bologna - Piazza Scaravilli, 2 - 40126 Bologna

Tel: +39 51 2098059 - Fax: +39 51 2098074 - E-mail: corrado@economia.unibo.it

Carlo Boschetti

Dipartimento di Discipline Economico Aziendali

Universita' di Bologna - Piazza Scaravilli, 2 - 40126 Bologna

Tel: +39 51 2098070 - Fax: +39 51 2098074 - E-mail: cboschetti@economia.unibo.it

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Abstract

In the last two decades a lot of research has been devoted to unveiling the processes through which organizations learn and store knowledge. This research is typically concerned with organizations lastingly engaged in the provision of goods or services. Permanency is usually presumed in order for the encoding of inferences from history to take place. But what if organizational permanency cannot be assumed ex-ante? *Project firms* represent an interesting case in point. A project firm is a transient form of organization that ceases to exist as soon as its single target is achieved, as such it does not exhibit stable structures nor does it exhibit ostensible history-based paths upon which to build its choices and nurture its organizational knowledge. This apparent paradox can be resolved, in part, by extending the view from the isolated project to the relational context in which project firms operate. Using longitudinal data from the U.S. feature film industry, we show that the process of organizational formation and dissolution that characterizes this context is underpinned by patterns of enduring collaborations among interdependent industry participants. We build on these findings to speculate on processes of learning and remembering that interpenetrate project firms' boundaries, by being embedded within a texture of stable interpersonal ties.

Key words: organizational learning, project firms, repeated collaborations, organizational impermanence, film industry.

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1. Introduction

In the last fifteen years, the concept of organizational knowledge has attracted wide interest among management scholars. Understanding how organizations learn and store their knowledge has become a central concern as research emphasized the critical role of organizational knowledge and learning in organizational effectiveness (Fiol and Lyles, 1985; Levitt and March, 1988; Argote et al., 1990; Argote, 1999). While this tradition is grounded in a variety of studies spanning many settings and organizational contexts, it is notable that researchers in this field typically focused on the same type of organization that is, an organization created to endure and persist over time.

Obviously, as organizational learning is a lifelong time-consuming process it appears sensible to concentrate one's research efforts on organizational entities that have at least some interest in surviving, if not growing. Long term survival is often claimed to be a main goal for business organizations. In fact, when an organization dissolves this is usually regarded as a failure. It is then not surprising that by tradition organizational learning theorists are primarily focusing on permanent organizations, which are initiated with at least some expectations of long life duration (Lundin and Söderholm, 1998; Lundin and Steinthorsson, 2003). Yet, we believe that this bias towards organizational permanence has somehow obscured just as fascinating issues of learning and knowledge management in conditions of *organizational impermanence*.

Organizational impermanence is not a trivial phenomenon. Nowadays economy is ripe with organizational forms whose key feature is precisely to be temporary. Whether they are called temporary systems (Meyerson et al., 1996), cheetah organizations (Engwall and Svensson, 2000), project-based enterprises (DeFillippi and Arthur, 1998), synthetic organizations (Thompson, 1967) or single-project organizations (Faulkner and Anderson, 1987; Baker and Faulkner, 1993), these forms of temporary design typically appear in the volatile context of market-based free-lance contracting, where they are deliberately created for a limited purpose and disbanded upon its completion. In order to cope with highly dynamic environments, wherein product demand shifts rapidly and unpredictably, elements are combined, taken apart and recombined, in a continuous process of organizational formation and dissolution (Baker and Faulkner, 1993). Examples of settings in which these types of forms prevail include: construction, (Eccles, 1981), music

(Faulkner, 1983; Lorenzen and Frederiksen, 2004a, 2004b), film production (Faulkner and Anderson, 1987; Jones, 1996; DeFillippi and Arthur, 1998; Lampel and Shamsie, 2003), television (Starkey et al., 2000; Sydow and Staber, 2002), advertising (Grabher, 2001).

The concept of organizational impermanence, as epitomized by the above examples, challenges some of the key assumptions of the organizational learning thinking that inform much current debate on knowledge management. Organizational learning is an elusive notion, but in a general sense it involves a form of organizational retention or collective memory of a company's *past experiences* (Nelson and Winter, 1982), that is of the knowledge produced in the context of the shared activities of its individual members or collaborators (Cohen and Sproull, 1996). Temporary organizations, however, do not have a permanent memory where to store their experience, nor may they encode inferences from history as there is no ostensible past to build upon and drive their behavior. They depend on an elaborate body of collective knowledge and diverse skills, yet there is mostly not sufficient time to clarify abilities and competences of members in order to plan for a detailed division of labor (Lindkvist, 2003). Most importantly, there is no time to engage in the usual forms of confidence-building activities that contribute to the development of trust in more traditional, enduring forms of organization (Meyerson et al, 1996). These considerations raise important questions for organizational researchers: What mechanisms (if any) allow these systems to retain their practices, combine their knowledge assets and consistently integrate them into valuable organizational practices? How does organizational learning and remembering occur under conditions of organizational impermanence? With only few exceptions, the extant research has not yet addressed these issues. Besides, the existing attempts to fill this gap are either purely conceptual or grounded in single cases and qualitative evidence, while there is virtually no empirical evidence based on large sample quantitative analysis.

In this study we seek to tackle the above issues by analyzing the collaborative relationships established by key participants in the U.S. feature film industry over a 5 year period (1993-1999). Using block models and other social network analysis techniques we show that the process of organizational formation and dissolution that characterizes this project industry is actually underpinned by patterns of enduring collaborations among interdependent participants. We build on these findings to speculate on processes of learning and

remembering that interpenetrate project firms' boundaries by being embedded within a texture of ongoing ties.

The paper is structured as follows: In the first two sections we extend principles of learning and memory in organizations to the realm of project firms. In particular, after having reviewed key ideas from the literature on organizational knowledge, we elaborate on the notion of latent organizations developed by Starkey et al. (2000) to postulate a mechanism of knowledge retention and transfer that builds on enduring collaborative relationships that span the boundaries of single project firms. We then describe the empirical setting and the method of data collection and analysis. After discussing the results, we conclude by drawing some implications about how our findings may help improve the understanding of transient organizations, and how they relate to other similar contexts.

2. Theory

Whether organizational memory is envisaged as set of artifacts, rules, practices or routines, the most common way of conceptualizing learning processes implies organizations lastingly engaged in the provision of goods or services (Nelson and Winter, 1982; Olivera, 2000). Permanency is obviously presumed in order for the encoding of inferences from history to take place. Things, however, get somewhat less clear cut when organizational permanency cannot be assumed a priori. *Project firms*¹ represent an interesting case in point.

Project firms are one-off ventures whereby practices of knowledge creation and sedimentation perforate and entangle organizational boundaries in multiple ways. In the course of the short term life-spans of project firms the locus of learning shifts continuously across boundaries, undercutting the reassuring coherence and integrity of the firm as the basic analytic building block (Grabher, 2001b). These and other related aspects are discussed in the following two sections.

2.1. LEARNING AND REMEMBERING IN ORGANIZATIONS

From a knowledge perspective, firms are “repositories of knowledge” that resides in assets, rules, routines and mental models (Levitt and March, 1988). This reserve of organizational knowledge allows the coordination of individual activities within organizations to produce organizational outcomes. Given the link between

organizational knowledge and organizational performance, researchers have gone on to argue that acquiring new knowledge, or learning, is critical to an organization's ability to do new things (de Holan and Phillips, 2004). Without learning organizations are unable to solve new problems or solve old problems in new ways (Argote, 1999; Miner and Mezias, 1996).

Although the notion of organizational learning has been defined in a variety of ways (Easterby-Smith et al., 2000), ranging from behavioral to cognitive views on learning (Miner and Anderson, 1999), a shared key idea among organizational scholars is that learning involves modifications in the knowledge base of an organization induced by experience (Huber, 1991). Thus, learning can be seen as an addition to an organization's stock of knowledge growing out of its history. As observed by Levitt and March (1988), organizations learn by capturing the experiential lessons of history and by making such lessons accessible to their members.

These lessons, stored in the form of organizational knowledge, allow organizations to perform collective actions. Since it is an attribute of the organization, such knowledge is not simply in the head of its members. Instead, organizational knowledge resides in a memory system that does not disappear as individuals move. In fact, "unless the implications of experience can be transferred from those who experienced it to those who did not, the lessons of history are likely to be lost through turnover of personnel" (Leavitt and March, 1988, p. 328). The ways organizations allow this transfer to occur are manifold. Inferences drawn from experience are recorded in documents, operating procedures, culture, and in the shared perceptions of "the way things are done around here". These retention devices are part of a system of socialization and control that allow organizations to remember (Olivera, 2000; Paoli and Prencipe, 2003; de Holan and Phillips, 2004).

2.2. LEARNING AND REMEMBERING IN PROJECT FIRMS

While permanent organizational structures allow for conservation of organizational experience even in the presence of considerable loss of individual actors (Leavitt and March, 1988), project firms epitomize a model where no structure persists, as the firm is dissolved once the task is completed. In these ephemeral contexts firms are but transient 'shells' allowing mobile professionals to coalesce around continuously renewing

problems (opportunities) to be solved (exploited) quickly and effectively (Faulkner and Anderson, 1987). Because project firms are organizations with neither past nor future, the usual accent on organizational continuity and history as the steppingstones of learning is misleading.

Recently, some studies have proposed novel conceptual perspectives to cast light on project-like firms. In particular, two fruitful approaches seem to have emerged: One emphasizes the embeddedness of project industries in ‘ecologies’ of normative structures (Grabher, 2001; 2002; 2004), that provide the very basis for coordinating complex tasks and the emergence of swift trust (Meyerson et al., 1996). This strand of research suggests that project industries emerge most often in thick institutional contexts where norms, conventions and rules of practice facilitate and accelerate the formation of interpersonal, as well as interorganizational, perceptions and expectations. This perspective, in other words, focuses on the external context as a source of learning that helps transient organizations to counterbalance their lack of prior organizational history at the firm level. The second perspective is somehow less investigated and emphasizes the role of enduring interpersonal ties, as opposed to the ephemeral institutional shell represented by the project (Starkey et al., 2000; Tempest and Starkey, 2004). Along this line, a distinctive feature of project industries would be the emergence of *latent organizations* (or latent networks), that is “forms of organization that bind together configurations of key actors in ongoing relationships that become active/manifest as and when new projects demand” (Starkey et al., 2000: 299).

According to Starkey and colleagues (2000), who derive their insights from research interviews in the UK television industry, issues of continuity of the project team are particularly relevant where collaboration and mutual understanding of a complex concept are the keys to realizing the creative potential for the product idea. Repeated ties provide a context within which to develop the individual cognitive schemata required to integrate each others’ capabilities and adjust individual contributions accordingly. The shared experience so gleaned is highly valuable as it results in the accumulation of a stock of collective knowledge, much of it tacit, which improves the tasks’ performance. The knowledge required for - and acquired through - the performance of the tasks is diffused among many single individuals and stored in something akin to a “collective mind” (Weick and Roberts, 1993), which is *experientially constructed* and expressed through an heedful interrelating of the collective’s members when faced with complex tasks that must be performed in

the context of challenging environments. Without the experience of working with each other, the individuals would not have the chance to construct the interpretive cognitive patterns required for effective mutual adjustment (Thompson 1967; Berman et al., 2002). Because latent organizations are the actual realization of a potential that is generated and reproduced by the practice of drawing on members of previous projects to serve on subsequent ones, Starkey et al. (2000) argue, they provide a source of continuity that counteracts the conditions of impermanence and change under which project firms operate (see also, on this point, DeFillippi and Arthur, 1998, page 126; Jones, 1996). The latent organization is the context for learning while its re-enactment over time provides the basis for remembering.

If this interpretation holds true, the observed level of reiteration of the collaborations among firm project participants should exceed what would be expected through random chance. More in detail, we expect the reiteration of pair-wise collaborations to be particularly frequent for those collaborations involving highly interdependent tasks and skills that require complex and specific forms of information exchange and coordination. In the context of such collaborations and of the mutual adjustments they imply, reciprocal learning takes place at the individual level that is highly idiosyncratic and specific to the identity of the persons involved. While this learning is potentially of great individual and organizational importance, its value can only be captured in the reiteration of the collaboration among two specific persons, and tends to get lost in the occasional collaboration of a professional with different partners across different projects. Accordingly, we submit the following proposition:

Proposition: Project professionals with interdependent skills will reiterate their collaboration over subsequent projects

3. Research setting

3.1. THE U.S. FEATURE FILM INDUSTRY

The object of our empirical inquiry is the idea that the organizational learning processes of project firms are rooted in a dense texture of ongoing collaborations and interpersonal ties. Although we recognize the crucial role played by the local context in shaping such processes, we also believe that because this source of learning is part of a shared institutional heritage that can be tapped by any member of the community simply by being

socialized into the system, it hardly can translate into idiosyncratic knowledge. In contrast, the existence of patterns of reiterated collaboration would suggest the possibility for project firms of leveraging learning and talent synergies that are highly distinctive, in that they are specific to the group of project members involved in the ongoing if episodic relationships. To the best of our knowledge, no prior research has tested this idea within the framework of a large sample study. In fact, most of the existing empirical research on latent organizations and, more generally, on issues of learning in project firms rests on single case studies and/or anecdotal evidence. We seek to fill this gap by focusing on project firms in the U.S. feature film industry.

The U.S. feature film industry is a good setting for elucidating the organizational phenomena described above. First, in the course of several decades the U.S. film industry underwent a transition from the firm-based studio system to the market-based “package unit” system (Staiger, 1985). Before this transition firms (known as “The Majors” - 20th Century Fox, Metro Goldwyn Mayer, Paramount, RKO and Warner Brothers), integrated across all the stages of the value chain. Antitrust action led to a 1948 consent decree where they agreed to divest their theater holdings (Conant, 1960). During the same time period, competition forced them to end exclusive contracting with talents, greatly reducing the extent of in-house production (Balio, 1985). Downsizing, deverticalization, increasingly unpredictable demand, and the subsequent tendency to turn to outsourcing practices were some critical consequences of this process. As a result, by the end of the 70s the film industry has been organized around projects and personal and informal networks rather than traditional hierarchies and in-house human resource departments (Baker and Faulkner, 1991; Lampel and Shamsie, 2003: 2190). In this system: “Firms and subcontractors combine for a specific project, disband when the project is finished, and then combine for new projects [...] Self-employed subcontractors move from project to project, while the role of the company is to finance and distribute the finished product” (Jones, 1996, p.58).

Second, the film industry provides extremely detailed and updated data collections, including the composition and characteristics of the professional community from which team members are drawn. In particular, team membership is easily tracked since credits for key roles on each film are available. These features make the modern U.S. film industry an appropriate ground for analyzing project-based dynamics. In addition, as Faulkner and Anderson (1987) pointed out, it is a well observable industry because it is constantly in movement and draws attention to its movement.

Third, this choice of the empirical testing ground follows the lead of several researchers who brought strategic and organizational lenses into the realm of filmmaking, in order to draw useful implications for a broad range of organizations (Robins, 1993; Miller and Shamsie, 1996; Boschetti, 1998; Zuckerman and Kim, 2003). While the use of film industry data offers many advantages for testing organizational theories and much can be learned from this setting, the empirical validity of our proposition is investigated within the acknowledged limits of a single industry study. All our evidence comes from a setting with a highly specific set of characteristics (high rate of social reconstruction, co-existence of esthetic and commercial imperatives, uneven source of investments, etc.) hence we cannot test the proposition decisively. If the proposition holds we have gained some support through partial confirmation. If not however, the disconfirmation is fairly strong.

3.2. PROJECT PARTICIPANTS AND TASK INTERDEPENDENCIES IN THE MAKING OF FEATURE FILMS

As is apparent from the most cursory examination of “film credits,” motion pictures are the collective creation of a large number of separate individuals, each contributing their creative input, unique talents, and technical expertise to the project. These individuals are typically organized in multidisciplinary teams or sub groups where they occupy specific roles and contribute their interdependent skills, at different times, in the accomplishment of various tasks such as principal photography, set decoration, sound recording, stage lighting, etc. (Chion, 1999). Teamwork helps establishing feedback coordination and encouraging leeway, while coordination through the formal structure of rules and performance audit is relaxed (Faulkner and Anderson, 1987).

Nowadays film crews encompass literally hundreds of professionals distributed across many roles and teams. In the present study we focused on two such groups, which we distinguish based on the differences in the contexts and time frames of their team work:

- 1) Director, cinematographer, editor, production designer, composer
- 2) Sound mixer, sound recordist, boom operator, music mixer, music editor, composer²

The first group - sometimes referred to as the “*core team*” (Goldman, 1983) - represents the organizational heart of the film-project during its shooting phase, as it includes all the key representatives from each of the “departments” in which the production crew is divided³ (Ascher and Pincus, p. 210). This group is centered on the director whose work consists of orchestrating the activity of the core members roles is to orchestrate and The second group encompasses the key members of the so-called “*sound crew*” (IMDB’s internal classification), that is the group of crewmembers whose task is the creation of a movie's soundtrack.

Not all these skill holders are actively involved during the entire lifespan of the project. Instead, as we already mentioned, the activity of a film project goes through phases and is typically structured around interrelated sub-tasks, each of which requires the coordinated action and mutual adjustment of a subset of highly specialized skill-holders who provide their expertise at a critical time or in a critical combination. The degree of reciprocal interdependence among these individuals (and hence the extent to which they will reinforce their collaboration over subsequent projects) varies depending to the nature and complexity of the task to which they are jointly committed within the project.

The core team is engaged with tasks that are at the same time technical and highly creative. Being each project outcome unique and non repeatable, “innovation in the design and execution of ideas is uppermost in members’ minds, search procedures are complex and choices among alternative lines of actions must involve a high degree of [...] feel” (Faulkner and Anderson, 1987, p. 880). The need of experimentation and search in judgments and decisions requires both technical and experiential information to be continuously exchanged by the core members. As we illustrate below, the combination of technical and cognitive interdependencies that stem from these exchanges is made especially manifest in the relationships that the director needs to establish with each of its key collaborators in order to reify his vision.

Core team task interdependencies

Filmmaking is a collaborative affair however, if a film is to be a coherent work of art rather than a scramble of individual gestures, a single coordinating sensibility must dominate. “The director - explains the movie director Philip Kaufman - is the centre, the person who coagulates the ideas and determines the final result” (quoted in Paul, 1979, p.107). Not surprisingly it is the director who often chooses the main

components of the troupe: "...the wise director chooses his key crew members as carefully as he selects his cast... (because) they can contribute to the over-all look and feel of the picture" (Tylor, 1967, p. 76). On the other hand, in order to pursue his vision, the director is mutually dependent on each of his collaborators' skills. With them he needs to exchange both technical and experiential information:

Director – Editor: The editor, in consultation with the director, articulates film's tempo and pauses, defining its most appropriate cinematographic rhythm (Ascher and Pincus, 1999). Editors know the technique and have an excellent perception of film timing and visual pace, yet only the director has an all-round-vision of the work and a clear sense of the rhythm that would serve it best. Free and open communication is necessary, as well as a personal relationship that is fine-tuned on the same wavelength (Alvarez and Svejenova, 2002b, p. 22).

Director – Cinematographer: Because the best films have a consistent visual style that is carefully worked out in advance, the cinematographer, like the production designer, is normally involved since the earliest stages of pre-production. His task is to provide the movie with a visual nuance suitable to the director's sensitivity and visual aspirations. For example the director Jerry Schatzberg emphasizes the need to communicate often and reach a common point of view with the cinematographer (Paul, 1979). "The fact that the director is using the camera to tell his story – writes Tylor (1967, p. 37) – demands absolute team work between the cinematographer and the director if anything worthwhile is to be accomplished".

Director – Production Designer: The production designer is the head of a film's art department, which usually consists of an art director, costume designer, prop master, and a set decorator. He is responsible for providing 'shape and soul' to the physical setting where the characters are to move in. Thus, he is generally one of the first key collaborators hired by the director (Chion, 1999). Together with the director and the cinematographer he works out the creative vision of the film " Because the production designer – notes Chiarini (1965) – helps conferring the film its own style, it is necessary that he penetrates the spirit of the work from the very beginning, and that he fully understands the intentions of the director".

Director – Composer: The composer discusses and defines with the director themes and narration passages to be underscored in order to translate the film musically. As the composer Roman Vlad explains: "...The real creator of a film...is the director; I always try to compose the music which he would were he a composer...I therefore try to compose the music for that particular film, and not to impose my own film on it...I feel that

collaboration with the director is indispensable...the work with the director, discussions regarding the style of the music and the development of ideas proceed step by step with the shooting of the film” (quoted in Manvell and Huntley, 1969, p. 1999-2001); and similarly the composer Dag Wiren who notes: “... the director says when he wants music and what he wants it to express. Then the director and the composer discuss things each from their point of view. The worst sort of collaboration is when the director leaves everything to the composer...” (quoted in Manvell and Huntley, 1969, p. 200).

Figure 1 provides a schematic representation of these dyadic interdependences.

Figure 1 about here

As to the sound crew, the reason for focusing on this group (we might as well have selected other sub-teams such as the camera-crew, lighting-crew, or art department) is that it includes a particularly rich and diverse array of professionals, featuring both skill-holders engaged in the production phase (or “principal photography”) - the phase in which, explains Clevè (1994, p.11), “the film is actually shot” that is, professionals working on set, during the actual shooting - and specialists working in the post-production phase that is, off-set, when the shooting is over. This characteristic provides an interesting cue for ascertaining the variation of sound members’ collaborative patterns across production phases (see table 1). The detailed description of sound members’ tasks interdependencies and information exchanges in such two phases is provided below.

Table 1 about here

Sound members task interdependencies

Sound is traditionally divided into three elements: dialog, music, and effects (any auditory information that isn't speech or music). Much of the dialog is usually recorded during principal photography (although it will need fine tuning later), while almost all other sound and sound effects is added during postproduction, together with music. The sound members included in this analysis represent two of these three elements: the

first group of roles (sound team 1), composed of sound-mixer, boom operator and sound recordist, operates during the production phase and it is charged with recording the live dialogue, whereas the second group, formed by composer, music mixer, music editor (sound team 2), takes care of music mixing and editing in post-production (Weis, 1995).

Sound team 1 (production): The sound mixer (or production sound mixer) represents the primary member of this team, he is typically an expert of acoustics and he is responsible for capturing sound as cleanly and crisply as possible as it plays out live (Tylor, 1967). The sound mixer is sided by the sound recordist (also known as tape recorder operator) and the boom operator. The former is the operator of the device in which the magnetic tape flows. He is in charge of recording the sound carved-out by the sound mixer who, through a console, “can determine the acoustics of the area in which he works and dial out, as far as possible, unwanted sounds” (Tylor, 1967, p. 43). In such activity these two professionals are assisted by the boom operator, whose task is to “maintain the microphone at the correct distance from the sound source”, so that the recording comes out clear and coherent with the scene’s perspective. The triangulation of technical information necessary to accurately perform this task makes these professionals reciprocally interdependent, implying concerted action and mutual adjustment.

Sound team 2 (post-production): Composer, music mixer (also called re-recording music mixer or scoring mixer) and music editor deal with the processing and editing of the music score. The music personnel are a discrete department as much as the previous group (Weis, 1995). The music editor is the person who spends the longest time on the scoring. It is the job of the music editor to spot every cue, that is, to make a precise list of timings--to the split second-- for each appearance and "hit" (point of musical emphasis) of the music. The composer then has about six weeks to come up with a score (Weis, 1995) that will proceed to the recording session, where sound mixer’s task gets crucial. Tylor (1967) describes the music mixer as the one who deals with the regulation and balancing of volumes. Music mixer and music editor appear strongly interrelated, in their functions, to the activity of the composer⁹. “A music editor is assigned simultaneously with the composer. He acts as a sort of technical 'secretary' to the composer, and sits with him for all runnings of the picture. Throughout the composing and scoring periods he is the composer’s chief aide, providing exact timings and all the intricate technical information needed” (p. 125). It shall indeed rest upon the music editor,

by selecting the best entry, to make music and shot scenes “coincide”. The competencies of the music mixer become crucial during the recording sessions: in this phase, as explained by Manvell and Huntley, (1969, p. 183): “Regular consultation with the music mixer is necessary to ensure that the complete intention of the composer is in fact being registered on the sound-track”. The triadic interdependence among these roles is illustrated in figure 2.

Figure 2 about here

If our theoretical conjectures hold true, the observed level of reiteration of collaborations along the director and each of his project collaborators should exceed what would be expected through random chance.

4. Data and Methods

We coded the identity of the individuals who occupied the selected professional roles in the making of movies across a five years period. We then coded the collaborative ties between any two individuals as implied by their joint participation in the making of one or more movies, and analyzed their pattern of collaborations across time.

For each pair of roles, we analyzed the collaborations of each observed occupant of the first role with the occupants of the second, over the 5 year period. If a given role’s occupant collaborated constantly with the same occupants of the second role across multiple projects, we would say that his collaborations are concentrated over few individuals, as opposed of being scattered among many. In line with our theoretical arguments, within pairs of roles that correspond to highly interdependent tasks, we expect each individual’s collaborations in one role to be concentrated over few individuals in the second (i.e. the same individuals reiterate their collaborations across multiple projects).

4.1 DATA DESCRIPTION

Our dataset includes the movies produced and distributed in the United States by the 7 Majors⁵ and by the two largest independent subsidiaries (Miramax and New Line) in the five-year-period 1995-1999. The seven

historical Majors overwhelmingly dominate the industry, either directly, through their financial might, or indirectly, through distribution control. Miramax and New Line were included in the light of the significantly growing market share gained by these two subsidiaries (constantly beyond 6.7% and 6.2% respectively in the last 7 years). Over the entire period these nine companies consistently captured a market share of approximately 95% of the entire US box-office⁶.

We then coded the identity of the individuals occupying the 10 selected roles. Our source was the Internet Movie Database (imdb.com), which is an online database owned by Amazon.com and largely supported through advertising. Most of the data provided by the Internet Movie Database is submitted on a voluntary basis and validated by an in-house staff of 70 members. Whenever possible, we crosschecked the reliability of the data with the Alan Goble Film Index (Goble, 2003).

The sources listed occupants of the selected roles for 762 movies produced in the period 1995-1999. This sample roughly corresponds to the 80% of the total amount of feature films distributed by the nine observed companies over the five-year period of this study. Table 2 shows the number of observed movies for each production company and year.

Table 2 about here

Overall, 3104 individuals were involved in the making of the movies in one of the selected roles. In some cases the same person occupied more than one role in the making of the same movie, and/or occupied different roles across different movies in the observed period. Since we want to analyze the pattern of collaborations across unique roles, we coded separately the same person as occupant of different roles. This resulted in 3174 person-role codes. Given that we were interested in the recurrence of collaboration ties across different movies in the observed period, we excluded from the analyses those person-role codes that were observed in only one movie. This left 1375 person-role codes generated by 1361 individuals, who participated to the making of 738 movies produced by the nine observed companies in the observed period. Table 3 shows the distribution by role of the person-role codes.

Table 3 about here

4.2. MEASURES

We measured the dispersion/concentration of project participants' collaborations across each pair of observed roles, by building on Blau's (1977) index of heterogeneity; we did this separately for the collaborations among the core roles (director, cinematographer, composer, editor, production designer) and among the sound crew roles (boom operator, composer, music editor, music mixer, sound mixer, sound recordist). For instance, for each director we measured the dispersion of his/her collaborations with cinematographers, with composers and so on; the lower the index of dispersion with cinematographers, the more often the director worked with the same persons in the cinematographer roles. A detailed description of the measures is presented in the appendix.

We first computed the average dispersion of collaborations for each pair of roles (i.e., in terms of the example above, we averaged the director-cinematographers indexes across all directors), and organized them in two matrices (core roles and sound crew roles), which we compared with those implied by our expectations. We then computed and tested the average difference of the individual dispersion/concentration indexes across two sets of values: those computed for pairs of interdependent positions (where we expect higher concentration that is, lower heterogeneity values) and those computed for pairs of less interdependent positions (where we expect lower concentration that is, higher heterogeneity values).

5. Results

Shaded cells on the left side of figures 3 and 4 translate in matrix form the interdependencies that we summarized in figure 1 and 2, based on the qualitative evidences presented in section 3.2. These cells indicate the pairs of roles where we expect higher concentration of collaborations between individuals, i.e. lower values of heterogeneity indexes. We discuss our results for core and sound roles by first comparing the hypothetical and actual matrices, then by showing the t-tests of the average difference between the two sets of matrix values, those included in the shaded cells and those that are not.

Core roles: As illustrated in figure 3, results are fully consistent with our expectations. Collaborations among core members tend to concentrate along specific relational trajectories. As expected, the higher concentration measures correspond to the relation between the director and each of the other core members.

Figure 3 and Table 4 about here

T-test is significant at the .01 (table 4), suggesting that interactions tend to be more recurrent between project-participants with critically interdependent skills.

Sound roles: Figure 4 provides a general overview of the expected relations and results concerning the sound team. Overall, the comparison of darkened cells on the left, and the matrix of results on the right suggest a substantial correspondence between the postulated pattern of collaborations and the empirical evidence.

Figure 4 and Table 5 about here

Based on the same idea as above, by comparing the single β 's and the overall average of the matrix, figure 4 provides a quick illustration of the collaborative pattern established by the sound members across projects. The collaborations of *music mixers* are less dispersed/more concentrated than average with the occupants of any other role. While this is not entirely consistent with our expectations, note however that the average concentration of the *music mixers*' collaborations with *sound mixers*, *sound recordists* and *boom operators* is lower and closer to the general average (0.87), than their collaborations with *composers* and *music editors*, as we expected. The goodness of our predictions is supported by a highly significant t-test ($p < 0,01$).

6. Discussion and conclusions

While nurturing a continuous process of organizational formation and dissolution, projects firm operate in a milieu of reiterated collaborations that translates into latent networks and continued association of interdependent resources that counterbalance the absence of a permanent organizational structure. This

process, we have argued, may act as a bridge between the transient nature of the firm and the accumulation of organizational knowledge over time. The ongoing processes of firm formation and dissolution are thus only part of the story. A richer story stems from appreciating project firms as the organizational reification of knowledge and collective skills that are generated, retained and reproduced by the practice of drawing on core members of previous project firms to serve on subsequent ones. In a context constantly in flux, due to the free-lance market-based organization of labor and the short term nature of the production process, reiterated collaborations provide stability and continuity. These ties persist, even as project firms start up and disappear. Why does that happen?

Building on the notion of latent networks (Starkey et al., 2000), we have submitted that there is a relationship between shared experience, the emergence of a collective mind and the stock of collectively held tacit knowledge (Berman et al., 2002). This argument is based on deductive logic and is entirely consistent with prior theorizing by the likes of Nelson and Winter (1982) and Weick and Roberts (1993). In a context where no one individual is in a position to describe the full knowledge required to perform the task and where the knowledge has an important interpretative component, the practice of working repeatedly together allows to retain and accumulate know how and practices that are highly relationship specific. Also, because the output of project firms is unique and the innovation in the design and execution of ideas is uppermost in members' minds, search procedures are complex and choices among alternative lines of action must involve a high degree of *feel* (Faulkner and Anderson, 1987, p. 880). For this reason, as director Sydeny Pollack explains, the finding of other professionals on the same wavelength is perceived as 'an emotional pleasure' (quoted in Jones and DeFillippi, 1996, p. 97), to the point that 'when you find people you can work with you never want to give them up' (quoted in Jones et al., 1997, p.12).

Whilst the observed data patterns are consistent with our conjecture we are also aware that there may be alternative angles to interpret such patterns. Unfortunately, the nature of our data on the film industry is such that does not allow us to test the propositions in a more rigorous framework of multivariate control and estimation; for this reason results should be considered suggestive rather than decisive and exploratory in their nature rather than confirmatory. For instance, we cannot confidently rule out the possibility that the observed patterns be the result of cognitive biases stemming from satisfying heuristics that limit partners' search if

existing collaborators meet some threshold of satisfaction (March and Simon, 1958). Likewise, we cannot exclude that recurrent collaborations emerge as a result of friendship or affection rather than being the functional response to the learning challenges posed by a system in constant flux. On the other hand, it is important to emphasize that the primary reason for this study was more to explore the existence of patterns of organizational continuity in the absence of permanent formal organizational boundaries, rather than to explain the micro processes underpinning such patterns; this goal would have required a methodological approach much more oriented towards qualitative data and field evidence. Nor did we concern ourselves with ascertaining whether similar patterns should be considered an efficient response, an issue which would clearly imply an orientation towards performance measures and causal mechanisms. Whatever the driver or motive long term networks can be expected to exist because they perform a memory function that would otherwise be missing in a context where shifting coalitions are needed for innovation purposes.

While these shortcomings undoubtedly represent areas for fruitful inquiry, we also believe that they do not subtract to the originality and robustness of our study. On the contrary, our results are all the more surprising considering the nature of the empirical context we have focused on. It is important to emphasize that the feature film industry is a setting where the absence of long-term specific investments, and the discipline on malfeasance provided by industry gossip about reputation, suggest that industry personnel should *not* commit themselves to particular others (Caves, 2000: 96; Zuckerman, 2004: 4). In fact, in a recent study grounded on film industry data, Zuckerman (2004) provides a rich and insightful illustration of the reasons why, if we were to follow standard assumptions on market transaction efficiency, we should *not* expect such ongoing collaborations and enduring ties to occur. Despite this theoretical expectation, however, Zuckerman's analysis converges with our results in showing that repeated ties do represent a salient feature of this context, a finding this one that, according to the author's interpretation, would point to the need for a reconsideration of the conventional imagery that pictures firms and market as contrasting modes of economic organization. Albeit from a different angle, our study contributes a further tassel to this emerging frame of thinking by suggesting that in a 'projectified' (Lundin and Söderholm, 1998) setting characterized by high rates of organizational formation and dissolution such as the feature film industry, this texture of ongoing

relationships may serve as a surrogate of those processes for learning and remembering that characterize any durable organizational form.

Because we only focused on patterns of collaboration across firms no inference was drawn as to the possible impact of these dynamics on the performance of project firms. For instance, while the establishment of stable trajectories of interaction seems to be a widespread practice within the industry, it may well be the case that enduring too tight and close cliques of collaboration would translate into diminishing returns for the group of individuals strongly committed to each other and, hence, for the project performance. As Berman and colleagues (2002) have illustrated in the context of NBA basketball, although the stock of tacit knowledge is likely to accumulate as the members of a team learn to interact with each other, after a period of time the value of this stock of knowledge may begin to decay, owing to a process of knowledge ossification. Skills become routinized around a taken-for-granted way of interacting and internal variation is hindered. This idea is somewhat mirrored by director's Peter Weir observation⁷ that when you stick to the same people for a certain period you may run out of what he calls 'creative frictions', that is interactions that may trigger ideas and spark creativity. On the other hand, it takes just a while to track the career credits of such an acclaimed film director as Steven Spielberg, and discover that in the last ten years he has consistently and constantly collaborated with a stable nucleus of key members⁸. Likewise, the highly acclaimed and successful film director Pedro Almodovar appears to have developed a truly 'symbiotic relationship' with his key collaborators (Alvarez and Svejnova, 2002). It would then be interesting to understand what circumstances may lead to prefer one strategy to the other, and how the outcome of this choice might be affected by internal as well as external contingencies. For example, one important internal factor with clear impact on this choice is the level of team cohesion. Cohesion refers to the desire that individual members have to remain part of the team (Cartwright, 1968). One avenue for future inquiry would then be to assess the level of team cohesiveness and investigate how this may translate in terms of group capability and persistence over time. This and similar internal processes merit closer qualitative and longitudinal examination. On the external side, the degree of uncertainty that surrounds the project appears equally critical in affecting the viability of one strategy versus the other. For example, projects in which the desired level of experimentation is particularly high might be better off when a high degree of variation is allowed. In such an instance, having highly experienced teams

involved in the production process might result in myopia or mindlessness towards promising variations (Levinthal and March, 1993; Levinthal and Rerup, 2004), whereas a more loose system of interactions could lead to a greater openness to ideas and change (Katz, 1982). This and related areas deserve further attention.

As project firms are temporary creative systems, they have much in common with scientific projects, consulting teams, task forces, and other short-term groups. Thus, our findings should be of interests to managers of such groups. Clearly, generalizations from the film industry to the business world should be made with care. Replicating our analysis in other project-based settings will be crucial to fully explore the power of our arguments.

Appendix

Core team task interdependencies

MEASURES

In this study we observe collaboration ties among persons, as defined by their joint participation to the making of movies. Given that a same person may occupy different roles, and since we are interested in observing persons' collaborations across roles, we established an unambiguous correspondence between persons and roles by coding separately the same person as an occupant of different roles. Thus, when we refer to the observed collaboration between persons, we actually refer to the joint observation of two pairs person-role (a person in a given role) among the participants to the making of one or more movies.

MEASURING COLLABORATIONS

We coded as null the collaboration relation between two persons if they never participated together to the making of a movie. In all other cases, we measured the strength of their collaboration throughout the period of observation. The number of movies to which both the two individuals participated could be an indicator of their collaboration's intensity, but this is only a very raw measure. In any single movie, there is indeed a difference in the actual collaboration between a director and an editor if three editors and two directors were involved in the making of a movie, as compared to a movie that involved only one director and one editor. In the first case we can expect that the collaboration between the director and the editor is somewhat diluted, by consequence more weight should be given to the collaboration observed in the second situation. To account for this, we measured the strength of collaboration relations by keeping in account the total number of persons who occupied each type of role in the making of any single movie. The coding proceeded as follows

- 1) We measured the individual participation of a person to the making of a movie as the reciprocal of the number of individuals who occupied his/her same role. Thus for instance, in the first situation above the coding of each director's participation would have been $1/2$ and that of each editor $1/3$.

- 2) The collaboration between two individuals implied by their joint participation to the making of one single movie was measured as the product of their individual participations to that movie. Thus, the amount of collaboration within any pair director-editor in the example above would have been coded as

$$a_{ij}^k = \frac{1}{2} \cdot \frac{1}{3} = \frac{1}{6}$$

Where index k identifies the movie i the director and j the editor.

- 3) This is not yet the total collaboration between i and j in the observed period, but only the measure of their collaboration in movie k . The total collaboration between the persons i and j , across all the movies to which they jointly participated, was measured as the sum of their collaborations across all movies

$$b_{ij} = \sum_k a_{ij}^k$$

We summarized the b_{ij} 's in two square matrices (core roles - 897 x 897, and sound roles - 626 x 626) whose ij^{th} element represents the cumulative strength of the collaboration relation between persons i and j in the observed period; these matrices are symmetric since $b_{ij} = b_{ji}$. These matrices' rows/columns can be grouped by role, so that two partitioned matrices are obtained where the values of the collaborations between individuals across a given pair of roles are grouped in the same sector of the matrix.

MEASURING COLLABORATIONS' DISPERSION/CONCENTRATION

We measured how dispersed/concentrated were the collaboration of each person with persons in any other role. Along any row of the b_{ij} 's matrices, a separate dispersion index was computed across each set of b_{ij} values associated with each given role. For instance, along a director's row in the core members' matrix, we computed four dispersion indexes over his collaborations with production designers, cinematographers, editors and composers. As a measure of dispersion we adopted the Blau's index of heterogeneity (1977), adapted to the structure of our data as illustrated below. The lower the index of heterogeneity computed over a director's collaborations with editors, the more concentrated were his collaborations with them, i.e. the more intensely the director collaborated with a few editors as opposed to collaborating less intensely with many.

Blau's index of heterogeneity measures how evenly a certain quantity is distributed across a given number of categories. In our case:

- the quantity is the total amount of the collaborations of an individual with the people observed in another given role; for instance, the total collaboration of director i with editors is

$$\sum_{j \in \{\text{editors}\}} b_{ij} = \sum_{j \in \{\text{editors}\}} \sum_k a_{ij}^k$$

- the number of categories is the number of potential collaborators across whom the total collaboration of an individual might be distributed. This is the number (c) of roles of a given type observed across all movies to which the individual participated. In the example above, c is the total number of editor roles available across all movies to which director i participated (c_{editors}).

The expression of Blau's index of heterogeneity, B , is

$$B = 1 - \sum_j p_{ij}^2$$

where the sum on the right hand side spans all the individuals j observed in a given role, and p_{ij} is the proportion of i 's total collaborations (with people in that given role) represented by the collaboration with j . In the director-editor example p_{ij} and B can be written as

$$p_{ij} = \frac{b_{ij}}{\sum_{j \in \{\text{editors}\}} b_{ij}} = \frac{\sum_k a_{ij}^k}{\sum_{j \in \{\text{editors}\}} \sum_k a_{ij}^k}$$

$$B_{i,\text{editors}} = 1 - \sum_{j \in \{\text{editors}\}} p_{ij}^2$$

B is larger when i 's collaborations are evenly distributed across all the c potential collaborators (the j 's). The measure is bounded by zero and a maximum value which depends on c :

$$0 \leq B \leq \max(B) = 1 - \frac{1}{c}$$

Since we need to compare the heterogeneity indexes across individuals whose number of potential collaborators c varies, we normalized the B indices by dividing for their maximum values. The normalized version of the heterogeneity index, β , is

$$\beta = \frac{B}{\max(B)} = \frac{B}{1 - \frac{1}{c}}$$

and its range of variation is

$$0 \leq \beta \leq 1$$

In the director-editor example, β can be written as

$$\beta_{i,editors} = \frac{1 - \sum_{j \in \{editors\}} p_{ij}^2}{\max \left(1 - \sum_{j \in \{editors\}} p_{ij}^2 \right)} = \frac{1 - \sum_{j \in \{editors\}} \left(\frac{b_{ij}}{\sum_{j \in \{editors\}} b_{ij}} \right)^2}{1 - \frac{1}{c_{editors}}} = \frac{1 - \sum_{j \in \{editors\}} \left(\frac{\sum_k a_{ij}^k}{\sum_{j \in \{editors\}} \sum_k a_{ij}^k} \right)^2}{1 - \frac{1}{c_{editors}}}$$

We summarized the β 's in two matrices, one for the core members (897 x 5) and one for the sound crew (626 X 5). These matrices were partitioned in the same way illustrated for the b_{ij} matrices, the only difference being that any β matrix sector includes a single column, and as many β values as the number of the rows associated with a given kind of role, since for any of the persons along the rows, the values of his/her collaborations with persons in another role are summarized in one β heterogeneity value.

By averaging the β values reported along the rows associated with a given role and over the column that corresponds to another role, we obtained the values presented in the partitioned matrices shown in Figures 1 and 2. We then tested the mean difference between two sets of β values: those computed within pairs of interdependent roles (which we expected relatively low) and those computed within pairs of less interdependent roles (which we expected higher).

Notes

¹ It is important to clarify that with the expression project firms we do not mean subsequent projects governed by the same firm, whereby contributing skill holders are individuals employed by such common organization. These sorts of

organizational arrangements have been extensively covered by research on project management (Prencipe and Tell, 2001; Lampel and Jha, 2004). While features of project formation and dissolution are hinted at in a number of such empirical contributions, project management theory is not concerned with occasions in which the project *is* the firm rather than a temporary structure *within* the firm (Faulkner and Anderson, 1987). Differently from such approach, our focus here is on projects carried out in the *market*. In project firms skill holders are commonly free lancers that come together in temporary ventures to work on a complex task over a limited period of time; they are well typified by their interdependence of task accomplishments as well as the continuous interrelating of their members (Goodman and Goodman, 1976, p.474; Faulkner and Anderson, 1987; Grabher, 2001; Staber, 2004; Frederiksen and Lorenzen, 2004a). Because they are well suited to capitalize on economies of speed and provide flexibility by allowing for easier movement of specialized personnel (Faulkner and Anderson, 1987; Storper, 1989), project firms are increasingly common in industries characterized by intermittent contracting and high rates of project innovation.

² The composer is also a key member of the core team, even if he is not usually actively involved in the shooting phase while his contribution becomes salient during the postproduction. We decided however to include this role in both groups since many sources converged in depicting his relation with the director as a symbiotic one. There are many instances of composers involved by the director in the creative process since the very inception of the production schedule (Brown Royal, 1994).

³ In order to simplify the analysis we did not include in this set of roles the producer. Although producers are undoubtedly a critical component of the core group and may sometimes have a part on decisions and choices taken during the shooting phase, we decided to exclude them from the analysis as a great majority of the sampled films typically exhibited multiple producers, raising complex attributive problems. The problem is further compounded by the proliferation of seemingly undistinguishable roles (associate producer, co-producer, executive producer, etc.) that revolve around this multifaceted position.

⁴ It must be remarked that the problem relates only to credits other than the core members, for whom no missing data problems were encountered.

⁵ Universal, Paramount, Warner Bros., Columbia/Tri-Star, Disney, 20th Century Fox and Metro-Goldwyn-Mayer (MGM).

⁶ The sample roughly corresponds to the 85% of the total amount of feature films distributed by these nine companies over the five-year period. Figures are from Variety. See, in particular: January 5-11/2000; January 5-11/1998; January 12/1997; Compact Variety, 1997.

⁷ Personal communication with one of the authors.

⁸ As a further illustration of the concerted nature of these tasks, note that composer, music editor and re-recording music mixer are (collectively) the recipients of the annual Golden Reel Award for Best Music Editing, awarded by The Motion Picture Sound Editors Association (the most prestigious recognition in the field together with the Academy Award). For a quick reference, the last three years awards' listing can be seen on <http://www.mpse.org>.

⁹ The two groups of selected sound members do not exhaust the full set of roles generally enlisted under the sound crew 'umbrella'. In the last decade the numbers of professionals involved in this department has increased exponentially, mostly due to the massive recourse to sophisticated technologies for postproduction sound processing. To have a sense of this shift consider the evocative case of John Ford's 'My Darling Clementine'. The movie, which was realized in 1946, included Wyatt Earp as technical consultant and only one person responsible for all of postproduction sound (the composer). On the other hand, the credits for Lawrence Kasdan's Wyatt Earp (1994) list the names of thirty-nine people who just worked on postproduction sound (Weis, 1995). In particular the postproduction processes of sound effects editing, sound effects mixing and foley creation (named after Jack Foley, an early practitioner regarded as the 'Father' of the field, is the art of recreating incidental sound effects - such as footsteps - in synchronization with the visual component of a movie) imply dozen of technicians and artists whose tasks tend sometimes to be blurred and whose recruitment is very much dependent on the nature and genre of the film project (not to speak of the budget). To reduce the impact of these contingencies (which would have hampered the consistency of the data over different projects), we limited our analysis to sound tasks entailing a neatly discernible division of competencies and unaffected by genre-related or budget constrains. The seven selected roles are consistent with these criteria.

¹⁰ Namely: Janusz Kaminski (Cinematographer); John Williams (Composer), Michael Kahn (Editor).

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TABLES and FIGURES

Table 1. Sound members: production and post-production

| | <i>Production</i> | <i>Post- production</i> |
|--|-------------------|-----------------------------|
| <i>Sound mixer (or production mixer)</i> | * | |
| <i>Recordist</i> | * | |
| <i>Boom operator</i> | * | |
| <i>Music mixer</i> | | * |
| <i>Music editor</i> | | * |
| <i>Composer</i> | | * |

Table 2. Distribution of sampled movies by distributor (1995-1999)^(*)

| | 1995 | 1996 | 1997 | 1998 | 1999 | Total |
|--------------------------------------|------|------|------|------|------|-------|
| <i>20th Century Fox</i> | 15 | 16 | 17 | 13 | 4 | 65 |
| <i>Buena Vista Pictures</i> | 9 | 0 | 0 | 0 | 0 | 9 |
| <i>Columbia Pictures Corporation</i> | 24 | 21 | 18 | 5 | 13 | 81 |
| <i>Fine Line Features</i> | 1 | 3 | 8 | 0 | 0 | 12 |
| <i>Hollywood Pictures</i> | 14 | 9 | 6 | 6 | 5 | 40 |
| <i>MGM (Metro-Goldwyn-Mayer)</i> | 15 | 13 | 12 | 4 | 5 | 49 |
| <i>Miramax Films</i> | 20 | 25 | 14 | 14 | 10 | 83 |
| <i>New Line Cinema</i> | 20 | 15 | 14 | 11 | 8 | 68 |
| <i>Paramount Pictures</i> | 17 | 15 | 20 | 14 | 9 | 75 |
| <i>Touchstone Pictures</i> | 4 | 8 | 6 | 9 | 12 | 39 |
| <i>TriStar Pictures</i> | 7 | 7 | 6 | 14 | 4 | 38 |
| <i>Universal Pictures</i> | 18 | 17 | 13 | 9 | 14 | 71 |
| <i>Walt Disney Productions</i> | 3 | 4 | 10 | 8 | 9 | 34 |
| <i>Warner Bros.</i> | 25 | 22 | 26 | 15 | 10 | 98 |
| | 192 | 175 | 170 | 123 | 103 | 762 |

^(*) Under the ‘Buena Vista’ brand are distributed all films from Walt Disney Pictures, which, in turn, is divided into four “divisions”: Walt Disney Pictures; Touchstone Pictures; Hollywood Pictures e Buena Vista Pictures. The same holds for Sony and New Line: The Sony Group distributes movies via Columbia Pictures and Tri-Star Pictures. These two Majors, in fact, have been part of the Japanese giant since 1989. New Line is an Independent branch of the Time Warner Group. The ‘New Line’ brand includes New Line Cinema and Fine Line. The latter was established in 1991 as a division of New Line (Schatz, 1997).

Table 3. Project-participants by role, 1995-1999^(*)

| | Position | Nr. |
|---|---|------|
| <i>Core members</i> | <i>Director</i> | 161 |
| | <i>Cinematographer</i> | 179 |
| | <i>Editor</i> | 225 |
| | <i>Production designer</i> | 184 |
| <i>Sound members (production & post-production)</i> | <i>Sound mixer (production mixer)</i> | 152 |
| | <i>Recordist (tape record operator)</i> | 74 |
| | <i>Boom-operator</i> | 91 |
| | <i>Music mixer</i> | 31 |
| | <i>Composer</i> | 148 |
| | <i>Music editor</i> | 130 |
| | <i>Total</i> | 1375 |

^(*) Project participants were 1361. The same person is counted separately for each of the roles he/she occupied in the making of the movies in the observed period. The table refers to participants observed in the making of at least two movies in a given role, i.e. only those person-role codes observed for more than one movie.

Figure 1 Core team's interdependencies

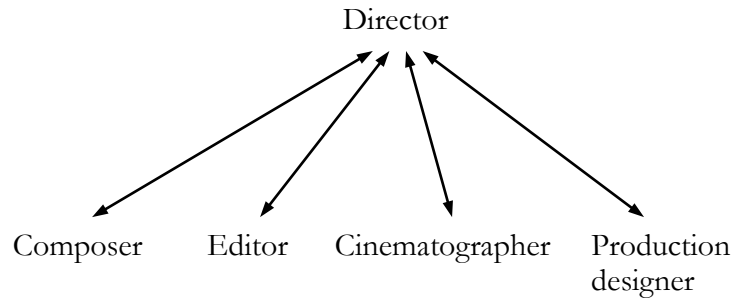


Figure 2 Sound crew interdependencies

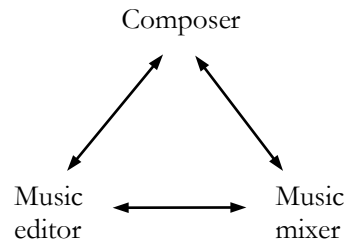
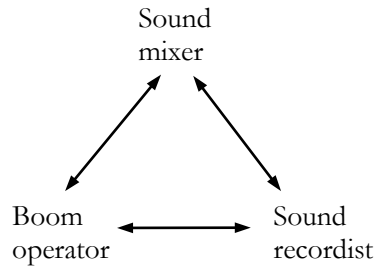


Figure 3. Expected and observed patterns of collaborations dispersion (Core roles)

| | Expected (*) | | | | | Observed (**) | | | | |
|-----------------------|--------------|------|------|------|------|---------------|------|------|------|------|
| | 2 | 4 | 6 | 7 | 8 | 2 | 4 | 6 | 7 | 8 |
| 2 Director | - | low | low | low | low | - | 0.62 | 0.51 | 0.45 | 0.69 |
| 4 Production designer | low | - | high | high | high | 0.65 | - | 0.89 | 0.84 | 0.87 |
| 6 Cinematographer | low | high | - | high | high | 0.55 | 0.88 | - | 0.83 | 0.86 |
| 7 Editor | low | high | high | - | high | 0.35 | 0.80 | 0.76 | - | 0.82 |
| 8 Composer | low | high | high | high | - | 0.66 | 0.90 | 0.80 | 0.84 | - |

(*) Darkened cells are hypothesized to correspond to higher average concentration of collaborations, i.e. lower dispersion/heterogeneity.

(**) Matrix average is 0,72. Darkened cells' are lower than the general average.

Table 4. Average differences of collaboration dispersion across pairs of roles (Core)

| | N | Mean | Std. Deviation | Difference (low - high) | |
|----------------------|------|--------|-------------------|-------------------------|------------|
| | | | | Mean | Std. Error |
| <i>expected low</i> | 946 | 0.5484 | 0.4469 | -0.2896* | 0.0160 |
| <i>expected high</i> | 1798 | 0.8380 | 0.2815 | | |

* $p < 0.01$; equal variances not assumed.

Figure 4. Expected and observed patterns of collaborations dispersion (Sound roles)

| | Expected (*) | | | | | | Observed (**) | | | | | |
|--------------------|--------------|------|------|------|------|------|---------------|------|------|------|------|------|
| | 8 | 10 | 12 | 15 | 16 | 19 | 8 | 10 | 12 | 15 | 16 | 19 |
| 8 Composer | - | high | high | low | low | high | - | 0.91 | 0.94 | 0.39 | 0.81 | 0.93 |
| 10 Sound mixer | high | - | low | high | high | low | 0.93 | - | 0.66 | 0.84 | 0.94 | 0.36 |
| 12 Sound recordist | high | low | - | high | high | low | 0.95 | 0.50 | - | 0.77 | 0.93 | 0.35 |
| 15 Music mixer | low | high | high | - | low | high | 0.55 | 0.95 | 0.94 | - | 0.81 | 0.93 |
| 16 Music editor | low | high | high | low | - | high | 0.68 | 0.91 | 0.92 | 0.41 | - | 0.91 |
| 19 Boom operator | high | low | low | high | high | - | 0.92 | 0.41 | 0.57 | 0.84 | 0.94 | - |

(*) Darkened cells are hypothesized to correspond to higher average concentration of collaborations, i.e. lower dispersion/heterogeneity.

(**) Matrix average is 0,87. Darkened cells' are lower than the general average.

Table 5. Average differences of collaboration dispersion across pairs of roles (Sound)

| | N | Mean | Std. Deviation | Difference (low - high) | |
|----------------------|------|--------|-------------------|-------------------------|------------|
| | | | | Mean | Std. Error |
| <i>expected low</i> | 804 | 0.5452 | 0.3807 | -0.3704* | 0.0141 |
| <i>expected high</i> | 1201 | 0.9156 | 0.1485 | | |

* p < 0.01; equal variances not assumed.