Making Sense of Learning Landscapes in Project-Based Organisations

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1. Introduction

This paper reports preliminary findings from a 3-year study[1] investigating the capture and transfer of organisational knowledge and learning practices in the production of what have been termed complex product systems (CoPS). CoPS have been defined as capital-, engineering-, and IT-intensive, business-to-business products, networks, constructs and systems (Hobday, 1998). They tend to be high in value and produced on a project basis, often in multi-firm alliances, as one-offs or in small and customised batches for specific customers and markets (Hobday, 1998). Examples of these types of products and systems include flight simulators, global business telecommunications networks, aircraft and avionics systems, power stations, offshore oil and gas platforms, process plants, mobile telephone systems, intelligent buildings, and large civil engineering projects. These kinds of activity, which involve high levels of customisation and a strong emphasis on project styles of organising, provide particularly interesting insights because of the severe challenges they present for effective learning between projects, especially compared with more routine organisational activities. The customised nature of CoPS products, the discontinuous nature of, and the level of complexity, interdependence, and uncertainty inherent in CoPS projects reduces both the repeatability of projects and the potential for project-to-project learning. These are examined in more detail in section 3 of the paper.

Despite these difficulties there are opportunities for learning between projects. Previous case study work had shown that CoPS firms used a number of different learning mechanisms to help them address the problems. The main objectives of the study included the identification of current practices and gaps in inter-project knowledge capture and transfer (IPKCT) and the identification of enablers and inhibitors to IPKCT. To this end an interview-based survey in forty-five organisations producing CoPS in Europe, North America and Japan was carried out.

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Approaches to knowledge management in both theory and practice have suffered from a tendency to focus narrowly on certain dimensions of knowledge practices in organisations at the expense of others. For many, knowledge management has become almost synonymous with the use of information and communication technologies (ICTs). More than that, it has become associated more with the capacity of ICTs to capture and store information than with their role in mediating communications. However, a sole focus on the information capturing capabilities of ICTs often leads to a static view of knowledge in organisations and it is easy to forget important considerations such as how information is used and to what ends. Our approach, therefore, was to search for not only ICT based solutions to knowledge management but also social solutions. This search enabled us to document the mechanisms and practices undertaken by the survey (listed later in section 4 of the paper). What we were not prepared for was the sheer range and diversity of these mechanisms and practices. This empirical diversity presented (and still presents) a major challenge for interpreting inter-project learning approaches since the different practices tend to come together in a variety of ways. In thinking about this variety we have experimented with a number of organising frameworks, none of which have we been unanimously satisfied with. One of these, the concept of 'learning landscapes' is reported in section 5. We show that the practices associated with inter-project learning are widely arrayed across a landscape characterised by variations in knowledge activities, levels of formality, technologies, social relations, and communicative interactions. While it is one thing to begin to map out the nature of these variations, it is quite a different matter to offer plausible explanations for these patterns. We recognise the difficulty in this, but the survey did indicate a number of conditions which broadly help to define the zones of manoeuvre within which the evolution of inter-project learning practices takes place. These are presented in section 6. In a further attempt to help understanding section 7 examines the survey findings in the context of meta-models, frames and scripts. A brief conclusion is provided in section 8 of the paper, but we begin with a broad overview of some of the current debates on organisational knowledge.

2. Polarisation in the organisational knowledge debate

Considerably energy has been expended in the debate on knowledge management discussing the relative importance of codified and tacit knowledge for organisational activity. According to Ancori *et al.* (2000), this debate has tended to polarise into two extreme positions, what they term the absolutist positions on codification and tacit knowledge. At its most simplistic, the absolutist position on codification suggests that, in principle, all forms of knowledge can be codified, although the effort and, by implication, cost of doing so may vary. This position is most closely associated with those approaches which consider knowledge management to be primarily about extracting and disseminating knowledge held by individual employees so that it becomes available to the organisation as a whole. The following statement from Gore and Gore (1999, 556) typifies this argument: "If tacit knowledge can be captured, mobilized, and turned into explicit knowledge it would then be accessible to others in the organization and enable the organization to progress rather than have its members having to relearn from the same stage all the time". This is based on an understanding of tacit and codified knowledge as straightforward substitutes. It owes more than a

little to the schema presented by Nonaka and Takeuchi (1995) depicting a series of conversions between tacit and explicit knowledge, comprising socialisation (tacit-tacit), externalisation (tacit-explicit), internalisation (explicit-tacit), and combination (explicit-explicit). Unfortunately, many accounts have borrowed from this framework in an incomplete and rather narrow manner. Consequently, any consideration of socialisation, internalisation, or combination tends to recede into the background as the emphasis is placed squarely on externalisation (e.g. Gore and Gore, 1999; Gupta *et al.,* 2000; O'Dell and Grayson, 1998). Not surprisingly, those who argue that practically all individual knowledge can be externalised and codified tend to attribute a central role to information and communications technologies (ICTs) in managing organisational knowledge. Knowledge management becomes a largely technical issue of capturing, storing, and circulating information using data warehouses, knowledge repositories, and the like.

The absolutist position on codification has not been without its detractors. At times, however, this critique is in danger of an equal if opposite one-sidedness by reducing all knowledge to the tacit dimension. Critics of the strong codification position have been correct in questioning the direct substitutability of codified and tacit knowledge. As Cook and Brown (1996, 14) have argued, it is important "not to confuse using one type of knowledge as an aid to acquiring the other with one being *converted* into the other. Tacit knowledge is not changed or 'surfaced' when used as a tool in learning something explicit, nor is explicit knowledge changed or 'submerged' when used as a tool for learning something tacit". For some, following Polanyi's (1958, 1966) characterisation of tacit knowing in the maxim: "We can know more than we can tell" (Polanyi, 1966, 4), it is meaningless to speak of articulating what by its nature is inarticulable (c.f. Teece, 1998; Winter, 1987). Gherardi (1999) has also criticised the tacit-explicit knowledge conversion thesis for abstracting from the ever-present practical dimension of any knowing act where tacit knowledge is a precondition for all knowledge (see also, Cowan and Foray, 1997). This is perhaps closer to the spirit of Polanyi's argument when he speaks of tacit knowing as an act of *indwelling* (Polanyi and Prosch, 1975).

To some extent, the critique of codification has highlighted the individual, cognitive limits on articulating and assimilating knowledge (c.f. Shariq, 1999; Steinmueller, 2000). However, the main argument against the strong codification position concerns the need to understand knowledge practices as mediated, situated, provisional, pragmatic, context-dependent, distributed, and contested (c.f. Blackler, 1995). As Yanow (2000, 262) has suggested, "organizational learning is as much about act and artifact and their meanings as it is about cognition". Drawing on activity theory (e.g. Engeström, 1987, 1990, 1993; Kuutti, 1994) and situated learning (e.g. Lave and Wenger, 1991; Wenger, 1998), knowledge (or more accurately, *knowing*) is depicted as a crucially practice-based activity which is inseparable from the social and historical context within which it takes place and which, in turn, it helps to constitute. As Gherardi *et al.* (1998, 274) have argued, "[k]nowledge is not what resides in a person's head or in books or data banks. To know is to be capable of participating with the requisite competence in the complex web of relationships among people and activities". Similarly, Wenger (2000, 226) has defined "knowing as an act of participation in complex 'social learning systems'".

This has quite different implications for how far it is possible or desirable actively to manage knowledge when compared with the strong codification position. For the latter, knowledge is a commodity which can be captured, moved around, and accumulated through conscious manipulation. In such approaches it is considered not only possible but essential for competitive success to disembed knowledge from the original context of its creation and disembody it so that the organisation is not over-dependent on what any single individual knows (c.f. Marshall and Sapsed, 2000). For practice-based approaches, in contrast, there are important limits to how far knowledge can be decontextualised. In the welter of enthusiasm surrounding new technological capabilities for capturing, storing, and distributing information, it appears for some that it is easy to forget the crucial issue of interpreting and making sense of this information. As Bannon and Kuutti (1996) have commented, "while records can be stored, on each occasion of 're-use', actors must develop a common information space in which meanings are developed". For practice-based approaches to organisational knowledge, the negotiation of meaning is intimately tied to participation in shared collective practices. While this an important insight, consistent with Wittgenstein's assertion that "the *speaking* of language is part of an activity, or a form of life" (Wittgenstein, 1953, 11), it is easy to assume that understanding is so closely tied to involvement in a localised context that meaning is impossible with any degree of separation from this context. In short, at its most extreme, the strong position on tacit knowledge tends to over-emphasise the 'stickiness' of knowledge (Von Hippel, 1994).

Taken in isolation, neither those approaches which prioritise codification nor those which privilege tacit knowing are adequate. It is for this reason that Cook and Brown (1999) have argued that explicit knowledge and tacit knowing are not straightforward substitutes, but are complementary and mutually supporting, brought together in a *generative dance.* There is also an emerging body of work which argues that approaches to codification are miscast because they focus on outcomes rather than processes (e.g. Ancori *et al.,* 2000; Prencipe and Tell, 2001; Zollo and Winter, 2001). The suggestion is that too much attention is directed towards the outputs of codification, in the form of books, documents, databases, and so on, without sufficient appreciation that the process of producing and interpreting codified knowledge itself involves cognitive effort. This helps to emphasise the active and dynamic character of knowing. It also serves as a reminder that encoded knowledge, in the form of symbolic representations (whether spoken or written language, drawings, or artefacts), is not a passive and static entity. Contrary to the knowledge-action dualism, knowledge practices such as reasoning, interpreting, and understanding are themselves activities. It is easy to lose sight of this within much of the practice-based literature because it tends to illustrate its arguments primarily with examples of physical activity (using hammers, riding bicycles, making flutes, repairing photocopiers). For complex product system projects, a large proportion of activities, such as design, involve producing and working with symbolic representations as well as material artefacts.

The recognition that codification processes and tacit knowing are intertwined is an important conceptual contribution. However, it is difficult to get from this insight to understanding the diversity of detailed interactions that occur within different contexts of action. Although a plethora of forms and practices of knowledge have been identified (e.g. Blackler, 1995; Fleck, 1997; Millar *et al.,* 1997; Winter, 1987), it is

problematic to make sense of these in any coherent way. At the other end of the scale there are integrative frameworks, such as the knowledge-creating cycle (Nonaka and Takeuchi, 1995), which run the risk of imposing a unitarist perspective which underplays the heterogeneity of knowledge practices within and between organisations. Thus far it appears that there have been few attempts to come to grips with the empirical diversity of organisational knowledge practices. Those that have been made have been somewhat limited. Hansen *et al.* (1999), for example, have suggested that knowledge management tends to follow two alternative strategies: codification or personalisation. While they recognise that both strategies may coexist, they argue that organisations should focus primarily on one or the other, or risk failing at both. As well as offering a rather sparse and dichotomous account of alternative knowledge practices, this argument also tends to reinforce the error of treating codification and tacit knowing as substitutable equivalents. Ahmed *et al.* (2002) have recognised rather more diversity in knowledge management approaches, identifying reactive, mechanistic, organic, and adaptive approaches. However, by tying these in to an evolutionary stage model, the argument becomes teleological and eventualist. While not all organisations exhibit such traits, these authors have a clear idea of what an ideal knowledge management system would look like. Despite the diversity, there is still 'one best way'. In contrast to these approaches, we believe it is important to acknowledge and attempt to make sense of the variety of knowledge practices. This is the main focus of the subsequent sections of this paper as we examine the range of practices relevant to inter-project learning in the production of complex product systems. First, however, it is necessary to understand something of the context within which this diversity of knowledge practices is located.

3. Obstacles on the road to inter-project learning

There is a commonsense association between repetition and learning. This is exemplified by the long-established way of thinking about organisational learning through the notion of the *learning curve.* Research carried out by the Rand Corporation in the 1960s on maintenance activities in the US Airforce observed that the number of hours it took to perform a given activity declined by a constant percentage each time total repetitions of that activity doubled (Ascher, 1965). In this view learning and repetition are intimately related. The experience of doing something makes future attempts at doing the same thing easier. For Nelson and Winter (1982) the idea of repetition is implicit to their understanding of organisational routines as the building blocks of firm-level capabilities. However, they also recognised that routinisation is more likely to be appropriate for organisations "engaged in the provision of goods and services that are visibly 'the same' over extended periods", while "organizations that are involved in the production or management of change as their *principal* function - organizations such as R&D laboratories and consulting firms - do not fit neatly into the routine operation mold" (Nelson and Winter, 1982, 97, emphasis original).

The production of CoPS is equally problematic for the generation of routines. The strong focus on projects displayed by firms developing CoPS suggests that there might be problems associated with organisation-wide learning (Lindkvist, Söderlund and Tell, 1998). While in a functionally based firm, departments act as knowledge silos, the pure project-based firms lack the organisational mechanisms for the

knowledge acquired in one project to be transferred and used by other projects. Two further issues impair organisation-wide learning in project-based firms: the unique and the temporary nature of projects (Brusoni, Prencipe, and Salter, 1998). With regard to the former, projects differ from each other in several, critical aspects. They entail heterogeneous activities that may well not be repeated in successive projects. If projects exhibit one-off characteristics, the project-based firm confronts the difficult task of "learning from samples of one or fewer" (March, Sproull and Tamuz, 1991). In addition, projects may be characterised by relatively long life cycles, requiring similar project activities to be retrieved and repeated after long time intervals. With regard to the temporary nature of projects, projects can be characterised by the temporary constellation of people they entail (DeFillippi and Arthur, 1998; Tell and Söderlund, 2001). This feature implies that new human encounters and relationships take place whenever a new project is started, which may increase the barriers to learning from the previous experience of others.

However, while extensive customisation limits the degree of direct repetition, this does not mean that any form of learning is impossible. As Nelson and Winter (1982, 136) have also commented, "even the sophisticated problem-solving efforts of an organization fall into quasi-routine patterns, whose general outlines can be anticipated on the basis of experience with previous problem-solving efforts of that organization". They focus in particular on the role of generic problem-solving techniques and heuristics in providing a means for addressing novel situations. We shall return to this issue in the next section. First, however, it is important to give more detailed consideration of the learning challenges faced by project organisations. There are a number of characteristics of complex projects which make them a hostile environment for effective learning. These include customisation, discontinuity, complexity, interdependence, and uncertainty.

Customisation

All CoPS companies are involved in the production of complex products and systems where each project for their delivery presents, to a greater or lesser extent, novel requirements and demands customised solutions. Sometimes project novelty can reflect the pace of technological change. In the aerospace industry, for example, the relatively long duration of development projects means that key technologies can change between and even within projects. This means that existing design solutions, skills, and technical knowledge may become obsolete. Even where core technologies remain more stable, as is arguably the case in building and civil engineering, high levels of customisation can still be found. This is often driven by customer demands for distinctive designs which place limits on how far previous design solutions can be re-used. Projects may also differ according to how far customers require adherence to non-standard or proprietary specifications and standards. Whatever the cause, project novelty makes it difficult to apply lessons learned from previous projects directly to new projects.

Discontinuity

Projects by their very nature are temporary and discontinuous (Cherns and Bryant, 1984). They involve activities which are directed to achieving s specific outcome within a given time-scale. Not only are there temporal discontinuities between

projects, there may also be organisational discontinuities reflected in different attitudes, orientations, perceptions, and behaviours between different project teams and between projects and other parts of the organisation. Project teams often exhibit a strong task orientation towards 'getting the job done', focusing on specific project activities, sometimes at the expense of wider, more strategic issues. Given resource constraints, there is a tendency to focus on activities which are regarded as essential to project completion, while other activities, such as taking the time to reflect on project performance and communicating any lessons to others who may benefit, are typically accorded a lower priority. People and resources are often switched between projects as quickly as possible, leaving little time to take a step back from the detail of project tasks. The irony, of course, is that such a narrow focus on the project's immediate concerns may actually exacerbate resource pressures by failing to prevent avoidable mistakes. This creates a vicious circle whereby under such conditions cross-project learning is even less likely to occur.

Complexity

All CoPS projects exhibit high degrees of complexity. They are complex in the threefold sense of technical complexity, system complexity, and organisational complexity (c.f. Bonaccorsi *et al.,* 1996). In technical terms, the products and systems which are the output of these projects are complex, comprising multiple components and sub-systems which are functionally diverse and involve high levels of design input. System complexity refers to the difficulties in integrating these specialised components and sub-systems into a single functioning system. Although there is room for considerable variety in the precise formations, technical and system complexity tend to be mirrored by organisational complexity. Projects are made up of multiple technical and functional disciplines and demand a range of specialised knowledge inputs. There has been a long recognition of the tension between differentiation and integration (Lawrence and Lorsch, 1967). The technical, functional, and system complexity of activities promotes organisational differentiation which, in turn, creates the problem of how to integrate and co-ordinate these different areas. In part, the project form emerged as one attempt to address this challenge. However, this does not mean that the relationship between differentiation and integration has been (or ever can be) decisively resolved. This is evident in the continuing play-off between encouraging internal project co-ordination and promoting the development of expertise within functional groups.

Interdependence

Project outputs are not only complex, their systemic nature also means that they are strongly interdependent. This is why systems integration activities are typically recognised as extremely important within these organisations. Specialisation means there is a temptation to pursue the development of individual functional elements to gain efficiencies. However, since these elements need to be combined into a complete system, there are risks of incompatibility. Small changes in one part of the system can have major knock-on effects for other parts. The result is that it is not unusual for projects to experience quite unique and largely unanticipated problems which emerge from the complicated interrelationships between different parts of the system. As system complexity increases, the potential for problems which have never

previously been encountered also increases. The implication is that it may not always be possible to rely directly on past experience to solve current problems.

Uncertainty

The effects of interdependency are one source of project uncertainty. The customised and often one-off nature of the sorts of projects studied is also important. For this reason they are unable to rely on re-using largely standardised solutions and instead have to evolve novel solutions for each project. Consequently, at project inception there tends to be significant uncertainty both about customer requirements and the possible ways of meeting these. Considerable effort needs to be directed at understanding project requirements and developing appropriate design solutions. Since the project is often both prototype and finished product rolled into one, there are few guarantees that the final output will be identical in all respects to the design concept. It is also difficult for customers to specify at the outset precisely what their requirements are. It is not uncommon for customers to change their minds about what they want as the project progresses. Where the customer is highly informed, which is not unusual in these types of projects, they may be able to elaborate their requirements more precisely. However, informed customers also have a tendency to want to get involved in project details, which may also result in late design changes. Taken together, these sources of uncertainty further reduce the repeatability of projects and the potential for one-to-one project learning.

4. Inter-project learning in complex product systems: background to the survey

A major component of the study involved an international interview-based survey of inter-project learning practices among complex product systems firms in Europe, North America, and Japan. This element of the research was specifically designed to explore the breadth of alternative practices and approaches to project learning, involving a total of 43 companies representing a range of complex product systems activities (see table 1). However, the intention was not to do this entirely at the expense of the depth of investigation, particularly given the intricacy of such practices and the importance of understanding at least something of the context within which they are enacted. For this reason, the survey was based on face-to-face, in-depth, and semi-structured interviews with at least one informant drawn from each of three organisational levels: a senior manager, a project manager, and a project practitioner. However, where possible, opportunities to conduct more interviews were taken. The aim here was to get some insight into the perceptions of project learning practices at different points of the organisation. Each interview lasted approximately 90 minutes. Relevant company documentation was also collected and those interviewed were subsequently asked to complete a short written questionnaire. Depending on the practicality of making a return visit, the results of the interviews and questionnaires were reported back to the companies, providing an opportunity for the findings to be validated. Table 1 provides outline information on the companies that took part in the survey. While they all share common features in terms of being involved in large, complex projects, there are nevertheless important variations according to size, turnover, and industrial sector.

Table 1: Characteristics of the Survey Companies

Company	Location	Activities	Company	Location	Activities
1	UK	Rail systems and services	**23**	UK	Building & civil engineering
2	UK	Airport management	**24**	Sweden	Defence products
3	UK	Civil & military aircraft & avionics, defence-related systems	**25**	Sweden	Power systems
4	UK	Training & simulation systems	**26**	Sweden	Enterprise software & consultancy
5	UK	Defence-related research & development	**27**	Italy	Aerospace
6	UK	Communication systems for broadcasting, air traffic control & defence	**28**	Italy	Aerospace
7	UK	Telecommunications systems & services	**29**	Italy	Financial services software
8	UK	Telecommunications systems & services	**30**	Italy	Management consultancy/IT projects
9	USA	Civil & military aircraft systems and avionics	**31**	Italy	Power systems
10	Japan	Shipbuilding, power & process plants, civil engineering, industrial machinery, aircraft engines	**32**	Italy	Building and civil engineering
11	Japan	Building & civil engineering	**33**	USA	Aerospace
12	UK	Management consulting	**34**	USA	Aerospace
13	UK	Environmental engineering	**35**	USA	Defence products
14	UK	Building & civil engineering	**36**	UK	Aerospace
15	UK	Transport & infrastructure, industrial plant, maritime structures	**37**	UK	Aerospace
16	USA	Enterprise software & consulting	**38**	UK	Building and civil engineering
17	USA	Aircraft engines, power generation & marine	**39**	UK	Building and civil engineering
18	UK	Simulation display screens & structures	**40**	UK	Defence products
19	Germany	Information systems, services & consulting	**41**	Canada	Aerospace
20	Germany	Information & communication systems, control systems, power, transportation, medical systems	**42**	UK	Telecommunications systems & services
21	Germany	Rail systems & services	**43**	UK	Telecommunications systems & services
22	UK	Water utility			

Table 2 provides a list of the various mechanisms that were reported during the survey, and an assessment of the prime knowledge process they involve.

Table 2

A list of learning mechanisms and practices and the associated knowledge process

Learning Mechanism/Practice	**Prime Knowledge Process**			
	Acquire	Create	Capture	Transfer
Post-project appraisals		X	X	
Mid-project reviews			X	
End of Phase reviews			X	
Mid-phase reviews			X	
Phase handover meetings				X
Project summaries and bulletins			X	X
Incorporation of previous learning points at start-up meetings/design reviews				
Brainstorming sessions		X		
Team-building events		X		
Cross-project meetings, e.g. project manager or functional department meetings		X		X
Specialist input from outside the project, e.g. experts invited to project meetings				
Milestone/tollgate meetings and reviews			X	X
Internal conferences and seminars	X			X
External conferences and seminars	X			X
Participation in industry groups and institutions	X			X
Learning from suppliers	X			X
Learning from customers	X			X
Document management systems			X	
Product data management systems			X	
Change control systems				
Risk management systems				
Risk registers				
Project management systems			X	X
Quality management systems			X	X
Maintenance records			X	
Customer feedback		X		
Corrective action documentation				
Performance improvement methodologies			X	
Benchmarking initiatives	X		X	
Technology watching/tracking and roadmaps	X		X	
Root cause analysis	X		X	
Standard design objects and templates			X	
Standard proposal documents and templates			X	
Records of successful/failed bids			X	X
Checklists			X	
Meeting minutes and documentation			X	
Project review documents			X	
Lessons learned database			X	X
Feedback and suggestions database			X	X
Standard processes, procedures, and guidelines			X	X
Process maps and mapping			X	

Knowledge mapping			X	
Reference projects		X		X
Technical and organisational audits	X		X	X
Standard work breakdown structure			X	
Document and design archives – electronic and hard copy			X	X
Company white pages				
Expertise/skills database			X	
Newsletters and company magazines				X
Information videos				X
Centres of competence/excellence		X	X	X
Best practice teams		X	X	X
Company intranets			X	X
Groupware			X	X
Inter-organisational extranets	X			X
Electronic/virtual universities	X			X
Hyperlinked documents				X
Discussion forums		X		X
Electronic chat rooms				X
Email communication				X
Global email distribution lists				X
Video/audio conferencing		X		X
Collocation of team				X
Shared interaction spaces, e.g. coffee areas				X
Social networks				X
Informal/ad hoc communication				X
Formal/informal social events				X
Boundary spanning individuals				X
'Travelling' experts who move around the organisation transferring knowledge				X
Mentoring and 'buddy' systems				X

Notes: For the purposes of this table the range of knowledge processes has been cut down to acquisition, creation, capture and transfer.

5. Alternative landscapes of inter-project learning

Table 2 indicates something of the diversity of practices and mechanisms which have a bearing on inter-project learning. These practices, identified through the survey, vary according to the project phases within which they typically occur, as well as according to the types of knowledge process they represent. This empirical diversity presents a major challenge for interpreting inter-project learning approaches since the different practices tend to come together in a variety of ways. In thinking about this variety we have experimented with a number of organising frameworks, none of which have we been unanimously satisfied with.

Based on a sub-sample of six of the studied firms, the notion of learning landscapes was introduced in an earlier paper (Prencipe and Tell, 2001). This was originally an attempt to discern alternative patterns of inter-project learning according to their location within a matrix of learning processes and organisational levels (see Figure 1), resulting in three main ideal types. The analysis of the horizontal and vertical dimensions combined enabled the identification of what we termed a firm's learning landscape in relation to project-to-project learning. A firm's learning landscape was defined as the mix of project-to-project learning mechanisms adopted and

implemented.[2] This concept of learning landscape reflects the multidimensional nature of a firm's approach to project-to-project learning.

However, it quickly became evident that there are many different ways to map learning landscapes, with differing implications for how they are viewed, just as maps come in a variety of projections and focus on certain features at the expense of others. Not only are the landscapes of inter-project learning differentiated, the possibilities of representing them are also varied. In this spirit, the concept of learning landscapes provides a useful metaphor through which to think about different knowledge practices rather than being thought of as a fixed representation. While we offer one reading of the landscape, we recognise its limitations and would welcome other maps of the territory.

Figure 1. Inter-project learning mechanisms

	Learning processes		
Level of analysis	*Experience accumulation*	*Knowledge articulation*	*Knowledge codification*
Individual	• On-the-job training • Job rotation • Specialisation • Re-use of experts	• Figurative thinking • "Thinking aloud" • Scribbling notes	• Diary • Reporting system • Individual systems design
Group/Project	• Developed groupthink • Person-to-person communication • Informal encounters • Imitation	• Brainstorming sessions • Formal project reviews • De-briefing meetings • Ad-hoc meetings • Lessons learnt and/or post-mortem meetings • Intra-project correspondence	• Project plan/audit • Milestones/deadlines • Meeting minutes • Case writing • Project history files • Intra-project lessons learnt database
Organisational	• Informal organisational routines, rules and selection processes • Departmentalisation and specialisation • Communities of practice	• Project manager camps • Knowledge retreats • Professional networks • Knowledge facilitators and managers • Inter-project correspondence • Inter-project meetings	• Drawings • Process maps • Project management process • Lessons learnt database

The initial notion of learning landscapes generated three ideal types (see Figures 2, 3, and 4). It is based on Zollo and Winter's (2001) typology of experience

[2] Learning mechanisms are empirical instances such as e.g. lessons learnt meetings, databases or informal encounters. The *learning landscape* then refers to the collection, or portfolio, of such mechanisms, here clustered into three distinct patterns.

accumulation, articulation, and codification processes, augmented to consider their operation at individual, group, and organisational levels.

The L-shaped landscape (figure 2), which might also be characterised as a socially-driven approach, comprises firms that rely to a great extent on people-embedded knowledge. Here the emphasis is on creating and sharing implicit and experience-based knowledge through joint participation in work activities. Face-to-face communication and interactions across social networks tend to be important. Inter-project learning has a more informal character and involves the sedimentation of new practices in the form of routines.

Figure 2. The L-shaped learning landscape

	Learning processes		
Level of analysis	*Experience accumulation*	*Knowledge articulation*	*Knowledge codification*
Individual	• On-the-job training • Job rotation • Specialisation • Re-use of experts	• Figurative thinking • "Thinking aloud" • Scribbling notes	• Diary • Reporting system • Individual systems design
Group/Project	• Developed groupthink • Person-to-person communication • Informal encounters • Imitation	• Brainstorming sessions • Formal project reviews • De-briefing meetings • Ad-hoc meetings • Lessons learnt and/or post-mortem meetings • Intra-project correspondence	• Project plan/audit • Milestones/deadlines • Meeting minutes • Case writing • Project history files • Intra-project lessons learnt database
Organisational	• Informal organisational routines, rules and selection processes • Departmentalisation and specialisation • Communities of practice	• Project manager camps • Knowledge retreats • Professional networks • Knowledge facilitators and managers • Inter-project correspondence • Inter-project meetings	• Drawings • Process maps • Project management process • Lessons learnt database

The T-shaped landscape (figure 3) characterises firms with a broadly socio-technical approach, although with a greater emphasis on articulation processes at all organisational levels. Meetings and other arenas for enhanced communication were pursued as means for transferring knowledge gained in one project to another.

Figure 3. The T-shaped learning landscape

Level of analysis	Learning processes: *Experience accumulation*	*Knowledge articulation*	*Knowledge codification*
Individual	• On-the-job training • Job rotation • Specialisation • Re-use of experts	• Figurative thinking • "Thinking aloud" • Scribbling notes	• Diary • Reporting system • Individual systems design
Group/Project	• Developed groupthink • Person-to-person communication • Informal encounters • Imitation	• Brainstorming sessions • Formal project reviews • De-briefing meetings • Ad-hoc meetings • Lessons learnt and/or post-mortem meetings • Intra-project correspondence	• Project plan/audit • Milestones/deadlines • Meeting minutes • Case writing • Project history files • Intra-project lessons learnt database
Organisational	• Informal organisational routines, rules and selection processes • Departmentalisation and specialisation • Communities of practice	• Project manager camps • Knowledge retreats • Professional networks • Knowledge facilitators and managers • Inter-project correspondence • Inter-project meetings	• Drawings • Process maps • Project management process • Lessons learnt database

The staircase learning landscape (figure 4) includes firms involved in the advanced development of ICT-based tools to support inter-project learning. Their emphasis is on deliberate attempts to codify and store knowledge developed during the execution of a project and document it so it can be disseminated and re-used by other projects. These are technically-driven approaches where learning is primarily directed at creating and updating formal procedures.

Figure 4. The staircase learning landscape

Level of analysis	Learning processes: *Experience accumulation*	*Knowledge articulation*	*Knowledge codification*
Individual	• On-the-job training • Job rotation • Specialisation • Re-use of experts	• Figurative thinking • "Thinking aloud" • Scribbling notes	• Diary • Reporting system • Individual systems design
Group/Project	• Developed groupthink • Person-to-person communication • Informal encounters • Imitation	• Brainstorming sessions • Formal project reviews • De-briefing meetings • Ad-hoc meetings • Lessons learnt and/or post-mortem meetings • Intra-project correspondence	• Project plan/audit • Milestones/deadlines • Meeting minutes • Case writing • Project history files • Intra-project lessons learnt database
Organisational	• Informal organisational routines, rules and selection processes • Departmentalisation and specialisation • Communities of practice	• Project manager camps • Knowledge retreats • Professional networks • Knowledge facilitators and managers • Inter-project correspondence • Inter-project meetings	• Drawings • Process maps • Project management process • Lessons learnt database

The practices within this matrix of learning approaches can also be considered along the following complementary dimensions:

1. The degree of formality/informality of inter-project learning processes, ranging from more formal activities such as post-project appraisals specified in formal project procedures, to less formal practices such as exchanging project-related news by the coffee machine.

2. The extent to which inter-project learning relies on making project knowledge explicit through codification and documentation. This is contrasted with situations where such knowledge remains largely implicit, localised, and experience-based and where its transfer occurs mainly through learning-by-observation and learning-by-doing.

3. The degree to which information technologies are used to support inter-project learning. A further distinction is made here between the use of IT as an effectively passive and unidirectional information tool for storing and retrieving data, on the one hand, and its more dynamic role as a medium for communication and interaction, on the other.

4. How far communication takes place through face-to-face interaction compared with more distanced styles of communication. It is also useful to distinguish between interactions which take place in 'real-time' (e.g. face-to-face or telephone conversations) and those in which there is a time interval of varying magnitude between message and response (e.g. e-mail, reading a document).

The concept of learning landscapes provides an interesting starting point for attempting to unravel the similarities and differences in learning styles between these organisations. However, a few caveats and words of warning are in order. Firstly, these ideal types tend to downplay internal variations within the survey organisations. Different divisions, departments, and projects may exhibit different learning approaches. Moreover, at the level of detailed project activities, it is typically the case that different knowledge practices come to the fore during particular types of activity. For example, the emphasis on intense, face-to-face interaction is generally higher during creative, problem-solving activities, such as can be found at the beginning and often end of projects, while more distanced, process-based practices and routines tend to be more in evidence during the middle phases of the project once requirements and project plans have been established. Secondly, as Engeström (2000) has argued, there are problems in attempting to represent dynamic processes in the form of a static matrix. Not only are organisation likely to shift between different approaches over time, there is also a sense in which, as we have already suggested, it is difficult to understand such processes as experience accumulation, articulation, and codification in isolation. However, despite their limitations, attempts at mapping learning practices are important because they at least go some way in acknowledging and trying to understand their diversity.

6. Understanding the diversity of learning practices

We have seen that the practices associated with inter-project learning are widely arrayed across a landscape characterised by variations in knowledge activities, levels of formality, technologies, social relations, and communicative interactions. While it is one thing to begin to map out the nature of these variations, it is quite a different matter to offer plausible explanations for these patterns. It is appealing, but almost certainly misleading, to offer a standard contingency explanation which sets out to relate the nature of learning practices to key differences in project and organisational characteristics. The all too familiar danger here is of positing a one-to-one correspondence between organisational contingencies and learning practices which suggests a transparent and unidirectional causality where organisational actors design rational strategies in response to clearly recognised internal and external environmental stimuli. Having said that, it is equally tempting to throw one's hands up in despair at the complexity of it all and refuse to explore *any* of the inter-relationships between different organisational phenomena. It is beyond the scope of this paper to offer anything more than a few initial pointers regarding such relationships and there is considerable room for further efforts on this issue. However, the survey did indicate that there are a number of conditions which broadly help to define the zones of manoeuvre within which the evolution of inter-project learning practices takes place. There is not enough space to consider all of these in detail, but a few of the more relevant are outlined briefly under the following

headings: technical complexity; technical novelty; project timing; organisational size; style of project organisation; and project staffing.

Technical complexity

Variation in the technical complexity of projects is largely related to the different sectors in which the survey companies operate (see Table 1). Companies in the aerospace and defence sectors are typically involved in highly complex, technologically intensive projects. Projects in telecommunications, information systems, and rail systems are also technically complex, although marginally less so. The remaining companies, which largely fall within the building and engineering sectors, tend to be involved in projects which have a rather lower technical content. While it is dangerous to draw straightforward conclusions from these variations, there is a tentative inverse relationship between technical complexity and project repeatability. As system complexity increases it is more likely that knock-on effects and feedback loops will generate unanticipated outcomes. However, even given the generally lower technical content of building and civil engineering projects, there is still sufficient variety in components and technological interfaces to make many outcomes difficult to predict.

Technical novelty

The technical novelty of projects refers to the extent to which each project requires a customised technical solution different from previous solutions. One indication of this is the design effort that is needed. Again there appears to be a tentative relationship between industry sector and technical novelty. However, this belies important differences in project activities often carried out within the same company. Company 9, for example, which operates in the aerospace sector, is simultaneously involved in aircraft development projects incorporating radical technological innovations, as well as projects where incremental changes are made to established technologies. Similarly, Company 2, an airport operator, is involved in a wide range of building, infrastructure, and civil engineering projects, some of which are relatively straightforward and recur regularly in a similar form (e.g. runway repairs and resurfacing), while others are highly customised and complex packages of work (e.g. baggage handling facilities, terminal buildings). Not surprisingly, the potential for continuous improvements is generally higher for the more repetitive projects than for those which involve higher levels of customisation.

Project timing

The duration of projects and the degree to which they overlap with other similar projects also have a crucial effect on how far inter-project learning is possible and relevant. Development projects in aerospace and defence not only tend to be of several years duration, there are also usually major gaps between them. Notwithstanding the dramatic technological changes that can occur during and between such projects, it is difficult to maintain continuity in experience and expertise over such extended time-scales. Even where the turnover of projects is more rapid, there may be considerable time-lags between projects of a similar scope. Company 15, for example, was involved in two industrial plant projects for the same client, separated by a gap of several years. Many of the same mistakes made on the first

project were repeated on the second. While people who participated in the original project were still employed by the company, they were not available for the later project. The project team assembled for the second project had no previous experience of this type of industrial plant and were unaware of what had happened on the preceding project. At the opposite extreme, there are projects which are very similar but which occur in parallel or with significant overlaps. These can be just as challenging for inter-project learning because an intense focus on internal project activities often means that potentially useful lessons are not communicated to other projects.

Organisational size

The companies involved in the survey vary widely in size. At one extreme there are companies with only 50 to 60 employees, while at the other there are huge multinational conglomerates employing several thousand people. The smaller companies in the survey are more likely to be based at a single location and tend to be less differentiated in terms of the number and diversity of functions and activities. The larger organisations are almost invariably multi-locational and made up of highly variegated functions. These characteristics have an important influence on knowledge practices and learning styles. Company 6, a manufacturer of high quality communications systems, is at the smaller end of the scale. All staff are based at the same location and the company is small enough that most people know each other on a first name basis. The majority of interactions occur face-to-face and the style of management is fairly informal. Formal procedures for carrying out projects do exist, but they are not slavishly adhered to and, indeed, there appeared to be rather low levels of awareness about what they actually are. This was not considered too much of a handicap because a large proportion of staff are long-serving employees who have effectively internalised the way things are done at the company. Given these characteristics, the style of inter-project learning is strongly personalised, reliant on individually accumulated experience, and spread through well established social networks.

Company 20 represents the opposite extreme. It is a diversified industrial conglomerate involve in a wide range of business activities including information and communication systems, transport systems, and control and manufacturing systems. Even within business divisions, activities tend to be spread globally over several sites. In contrast to smaller organisations, there is a much greater emphasis on formal processes to ensure harmonisation between the geographically- and functionally dispersed parts of the organisation. There is also a greater reliance on the use of ICTs, both for capturing and archiving information and for supporting interactions between distantly located groups where face-to-face communication is not always possible. However, even with formal processes it is difficult within an organisation of this size to enforce totally centralised control. In line with other similarly massive organisations, Company 20 devolves considerable autonomy to its individual operating units. This is reflected in its approach to knowledge management which is based on a number of parallel initiatives developed within the different divisions. There is a small corporate-level group responsible for tracking these different knowledge management programmes and attempting to transfer good practices between divisions.

Style of project organisation

One of the key influences on inter-project learning is the style of project organisation and the way that projects relate to each other and to the wider organisation. Table 1 indicates something of the range of project organisational styles. They vary between those which involve a greater functional orientation and those based on dedicated and integrated project teams, with some companies exhibiting a mixture of approaches in between. Whether activities are orientated around functions or products/projects is a long-standing organisational dilemma and one for which there is no definitive solution because both orientations have something to recommend them. The benefits of a strong project orientation are related to the potential for greater integration and co-ordination of project functions. Given the complexity and open-ended nature of the types of project carried out by the survey companies, such co-ordination is by no means straightforward. Design and implementation activities tend to unfold in an emergent fashion and it is important for there to be intense dialogue between different functions to ensure that the various system elements are not incompatible.

The same characteristics of a strong project orientation which are its strengths are also a source of weakness. Heavyweight project organisations tend to be strongly focused on internal project activities. The density of interactions within the project is much greater than that between the project and other parts of the organisation. Project members move from project to project, taking their experience with them, but they often have few opportunities to exchange ideas and information with those carrying out similar roles on other projects. Organisations which are more functionally orientated, in which different disciplines are grouped together, tend to be better able to manage the accumulation of specialist expertise. Engineers in the same discipline are able to share their experience of working on different projects. Functions effectively take the form of knowledge silos, but this means that there is typically a lower level of interaction with other functions, encouraging problems with project integration.

Many of the companies that participated in the survey have experimented with different styles of project organisation but they seem to experience some difficulty in arriving at a conclusive position on this. This is well illustrated by Company 3, an aerospace and defence company, which has fluctuated between functional- and project-orientated approaches several times over the past ten years. As an unintended consequence of this see-sawing of approaches, one of this company's project managers suggested that even though new arrangements were put in place the previous style of organisation would persist for a time because people would continue to keep in touch with colleagues they had previously worked closely with. He described this as a kind of 'shadow organisation' existing behind the formal organisational structure. Without conscious design there are intense interactions both within projects and functions. A rather similar pattern was observed at Company 4, which manufactures training and simulation systems.

Other companies have made more purposeful attempts to mix the benefits of project- and functionally-orientated structures, with varying success. Company 1, which produces rail systems, has attempted to promote both project integration and the development of functional expertise by moving staff between projects and functions on a periodic basis. Ideally, people work within a dedicated project team for the

duration of the project and they are then reassigned to work within functional areas so they can communicate their experiences and gain insights into developments within their discipline. However, this rarely happens in practice because time pressures and resource constraints mean that there is a strong impetus to move people onto new projects as quickly as possible. Several of the survey companies are interested in encouraging communities of practice as a way of overcoming the problems with dedicated project teams. These are informal groups of people, such as project managers or electrical engineers, who participate in the same activity but who do not normally get the opportunity to communicate their experiences to others who have similar interests. Company 13, an engineering design consultancy, has been particularly active in promoting such communities.

Important influences on the style of project organisation are the size of projects and the demands for specialist expertise. Where companies are simultaneously involved in a series of small projects it does not make sense to tie staff to a particular project. Instead, employees will typically work across a range of projects. This does, of course, create issues around how resources are allocated between projects and the priority given to different streams of work. For some employees with highly specialised skills for which there is a strong demand it may be necessary to share their input across several projects or have them work only for a limited phase of a project. Acoustics engineers at Company 17, an aircraft engine manufacturer, occupy such a role. What is interesting is that these 'travelling experts' can act as channels for communicating between projects. By moving between projects they are able to keep less mobile project team members apprised of what is happening on other projects. Company 9 has attempted to formalise this process by having specialists whose role it is to travel between projects offering advice.

Project staffing

Approaches to project staffing both influence and are influenced by the relative priority assigned to codification processes vis-à-vis more socially embedded and context-dependent knowledge practices. Where it is considered possible to codify and decontextualise knowledge away from specific project contexts there is less emphasis on ensuring continuity in staffing between projects. However, if the experience built up by project teams is viewed as distributed, collective, and context-sensitive, then it will be seen as important to keep at least a core of project members together through different projects. Opinions on this issue differed quite widely among interview respondents. For many project managers, continuity in staffing is an ideal which it is not always practical to achieve. Depending on project timing, people with the relevant experience may not be available. There were nevertheless some cases where moving core teams between similar projects had actually been achieved. A senior manager at Company 13, for example, commented as follows:

> Well, we do face the age old problem of availability and also it's not a perfect world and we can't achieve it 100% of the time. But what we've started to do is look at the development of frameworks, for instance, working for particular clients, we try and roll teams forward, so if we've had a team of five people working on a design of a plant for _____, when that job comes to an end, the first thing we will be looking to do is keep those as a _____ team and roll them on.

However, there were also those who did not necessarily see continuity in staffing between projects as desirable. The business development manager at Company 1 suggested that "it is not necessarily the case that you need to have the same people working project after project, whether it is possible or not. Here we use the term 'positive regrouping' to describe our approach to setting up new teams. It means allocating people in an intelligent way focusing on a core of people". It is interesting that this same manager also offered the following comment referring to the need to capture, codify, and distribute project-related information: "It is the only way the company can survive - you have to take the knowledge out of the people". While keeping the same team of people working together may promote the transfer of experience between projects, there is the danger that they will become less creative and innovative because they lack an influx of new ideas (c.f. Janis, 1974). Company 8, for example, has an explicit policy of moving people around between activities to 'freshen up' project teams.

7. Meta-models, frames and scripts

Given the conditions associated with complex projects, it is easy to assume that any form of inter-project learning is virtually impossible. However, as we have seen, the survey indicated a range of practices, procedures, and mechanisms of varying formality and pervasiveness through which organisations were, both consciously and unintentionally, addressing the issue of learning between projects. One helpful way of understanding these learning practices is by considering the different types of knowledge that are involved in project activities, their differing range of applicability, and the implications for learning. Although there are any number of typologies of knowledge, we have found it useful to distinguish between technical-, process-, strategic-, and social knowledge practices. Technical knowledge is applied to the design and implementation of the product or system itself. This is the domain of specialist engineering disciplines and detailed problem-solving. It is the 'know-what' of projects (c.f. Millar *et al.,* 1997). Process knowledge is more about how project activities are actually performed. It is project 'know-how'. Strategic knowledge is concerned with the bigger picture of overarching project aims and how any individual project relates to other projects and streams of activity. It is the 'know-why' of projects. Finally, social knowledge is that needed to participate in various social networks. It includes, for example, knowledge about who to turn to for advice, who within projects knows about certain things, or the approach to take when dealing with a particular customer. This is project 'know-who'.

The point is that projects involve a range of knowledge practices and difficulties in learning along one dimension may not be experienced equally along others. The challenges of project customisation and complexity, for instance, tend to have a proportionally larger impact on technical learning. This is because the technical solutions required by each project are different and it is not possible to re-use previous approaches without modification. However, although the precise conditions of application may vary from project to project, the process knowledge of how project activities are organised and how problems can be tackled may be relatively generic. Indeed, many of the survey companies have developed general project tools and guidelines which can be tailored to suit specific situations. This is one form of, fairly formal, process learning in which generic practices are crystallised into organisational

routines. There are also less formal types of process learning, such as the accumulated experience of project managers or engineers who are able to judge what solutions have the potential for working successfully in a given situation. In addition, there is a sense in which technical knowledge itself can be divided into specific and generic elements. Projects encounter novel technical problems, but the fundamental engineering principles underlying their solution are often rather similar.

Thus, while complex projects involve crucial elements of context-dependent knowledge, Arora and Gambardella (1994) have suggested that it is nevertheless possible for project knowledge to be abstracted and generalised so that its range of application extends beyond the immediate project context. Similarly, Bartezzaghi *et al.* (1997, 123) have argued that "there are some meta-capabilities at higher levels, which are progressively refined, experience after experience, and remain valid even when dealing with radical changes". The concept of meta-capabilities or meta-models, which owes more than a little to the work of Bateson (1972), is also congruent with the notion of *frames* and *scripts* (e.g. Minsky, 1975; Schank and Childers, 1984). Frames can be thought of as stereotypical models of certain sorts of general situation, precise instances of which may vary widely in their actual detail. The idea is that there are few situations which are completely new. Scripts are general strategies for action guided by some understanding of the range of things that might be expected to happen under such situations and the responses that are appropriate. Thus, for example, a group of engineers coming together to discuss an engineering problem which none of them have encountered in this exact form before, depending on how experienced they are, will probably share some common understanding of what such problem-solving situations involve and the range of practices that they are likely to encounter. They are also likely to behave in ways which they know from previous experience have the potential to solve the problem, even though the solution may not be readily at hand. These background assumptions form the general framework out of which specific solutions can be improvised. It is because scripts, unlike totally rigid procedures, are flexible that such improvisation is possible.

However, there are instances where established meta-models, frames, or scripts are themselves inappropriate for the situation at hand. Problems will occur if the, often implicit, assumptions guiding action prove to be unfounded. For instance, it may be that not all the engineers in our previous example are equally familiar with such problem-solving situations or they may fail to appreciate that the problem they are trying to solve is so radical as to make it unsusceptible to established approaches. The problem, of course, is that existing frames or mental models can become so embedded that it is extremely difficult to identify how far they are consistent with previously unencountered situations. A number of researchers have suggested that the tendency to try to relate every new problem to past experience may limit the range of solutions that are thought to be feasible, or even that are recognised (e.g. Argyris and Schön, 1978; Bain, 1998; Levinthal and March, 1993; Snyder and Cummings, 1998). In addition, while it is tempting to associate learning with positive growth and change, this is not always the case. Previously learned approaches may become inappropriate and it is for this reason that some authors refer to the need for 'unlearning' as well as learning (e.g. Fiol and Lyles, 1985; Hedberg, 1981). As a consequence, it should not be taken for granted that inter-project learning is necessarily a good thing. This very much depends on the characteristics of learning and their influences on practice. The

dangers of unreflexively repeating previous patterns of action, which are often reinforced by a perceived association with successful outcomes, mean that it is important to direct interpretative efforts at the assumptions and mental models upon which detailed processes of identifying and solving problems are built (Hedberg and Wolff, 2001). Unfortunately, project time pressures and the cult of immediacy militate against such reflexive practices, with the result that existing practices are simply reproduced.

Conclusion

Project-based organisations constitute particularly interesting phenomena to be investigated by students of organisational knowledge and learning. So far, the extent to which larger samples of such organisations have been studied from an organisational learning perspective has been limited. This paper has reported on an international interview based survey of 43 project-based organisations. The studied organisations are operating in a multitude of sectors and differ substantially in size.

In the project-based organisations studied, both problems of organisational learning as well as approaches towards overcoming obstacles to learning are highlighted. Studying inter-project learning in CoPS firms, we have found an overwhelming variety of learning mechanisms and practices. This paper reported on some preliminary attempts of analysing and organising this empirical diversity. Using the concept of learning landscapes as one starting point for analysing inter-project learning, we offered further interpretations aiming at making sense of the heterogeneity exhibited in the organisations investigated. In particular, we have stressed dimensions such as: the technical complexity involved, technical novelty of projects, timing of projects, organisational size, project organisation and project staffing. The analysis of the empirical data is far from finished, and the findings reported here should be perceived as merely indicative of what further examination will reveal.

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