Mapping the Dynamics of Project Management Field: Project Management in Action

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Introduction

Focusing on the role within and between organizations of the project management discipline to design and implement strategy, as source of competitive advantage, leads us to question the scientific field behind this discipline. This science should be the basis for the development and use of bodies of knowledge, standards, certification programs, education, and competencies, and beyond this as a source of value for people, organizations, and society. Thus the importance to characterize, define, and understand this field and its underlying strength, basis, and development is paramount. For this purpose we propose to give some insights on the current situation. This will lead us to clarify our epistemological position and demonstrate that both constructivism and positivist approaches are required to seize the full dimension and dynamics of the field. We will referee to sociology of actor-networks and qualitative scientometrics leading to the choice of the co-word analysis method in enabling us to capture the project management field and its dynamics. Results of a study based on the analysis of ABI Inform database will be presented and some future trends and scenarios proposed.

Project Management: A Knowledge Field …

First, hypothetically, it might be useful to assume that the project management knowledge field does exist. Consider Audet's definition (1986) "A knowledge field is the space occupied by the whole of the people who claim to produce knowledge in this field and this space is at the same time a system of relationships between these people. Those persons are competitors to gain the control of the definition of the conditions and the rules of production of knowledge" with respect to the behavior of professional bodies, authors, academics. The relationships between established professional bodies (Project Management Institute [PMI®], International Project Management Association [IPMA], and such) and their ways of development through individualism and collaboration (PMI through *A Guide to the Project Management Body of Knowledge [PMBOK® Guide];* IPMA through a shared competence baseline, IPMA Competence Baseline [ICB], is contextualized according the nationals needs of the national associations. For example PMI Headquarters draws from the Global Project Management Forum, (a kind of suprainstitutional body trying to promote a common basis in term of knowledge) the wish to create global standards, and in addition PMI is very active in supporting research in areas such as; establishing a theory of project management, demonstrating project management value for executives, and the achievement of corporate strategy through successful projects. The evolution of bodies of knowledge (*PMBOK® Guide*, APM BOK, and such) is evidenced further by themes in papers and books, citing techniques to psycho-sociology of temporary groups through to knowledge creation and organizational learning. In addition, the field, currently characterized by this abundance of initiatives, development of standards, increasing use of project management methods and techniques is in a preparadigmatic phase according to Kuhn's sense (1983). This phase is the place of revolution, inaugurated by a growing but still narrow subdivision within the project management community that the existing positivist paradigm has ceased to function adequately in the exploration of the nature. A second and more profound aspect upon which the significance of the first depends is that the success of revolution necessitates the full or partial relinquishment of one set of institutions in favor of another. Is this the intention of the creation, in the United States (US), of an alternative professional body (American Society for the Advancement of Project Management [ASAPM]) to PMI? It applies different rules and is more flexible about the legal aspects and copyright rules. Its aim being to make the knowledge produced by its members available and usable by the community in large; does the PMI initiative wish to establish regional headquarters?

… That Is Not Yet (That) Clear

In order to develop bodies of knowledge, standards, certification programs, education, and competencies, a knowledge

field is needed. Yet in both the academic and the business world, the field of project management is not clearly established and defined. In addition the field is still evolving in breadth and in depth. In breadth, it is embracing information systems, human resources management, change management, strategic management, economic value management, psychology, management of technology, quality, sociology, multicultural management, systems thinking, knowledge management, organizational learning, team management, temporary group, systems engineering, and so on. In depth, it is going further into cost engineering, finance, specific aspects of risk management, earned value management, scheduling methods, resources allocation, project life cycle, processes, studying phases, types of projects, projects portfolio management, and so on. Also, a number of books and papers explore issues that contribute both depth and breadth in several technical, methodological, and managerial dimensions. They aim to fill a long-standing need for a comprehensive, unified, and practical description of the field. Over the last twenty years the profession has been working on its recognition; both standards and certifications have been addressed by professionals associations, working both on the field definition and on the recognition of project management as a profession.

This demonstrates that the positivist perspective, if valid in a specific area, cannot produce answers to every type of problem. Furthermore, we argue that many applications of project management are done without questioning the deep nature of projects. What is a project? On which epistemological foundations can we build the project management field? Which hypotheses apply to the field? What are the consequences on the development and use of theories, concepts, methods, and techniques?

Epistemological Issues and Considerations

After Polanyi (1958), we propose an alternative epistemological perspective both to positivism and constructivism. We have no intention to separate personal judgement from scientific method. We argue that, especially in project management, knowledge creation and production has to integrate both classical scientific aspects and "fuzzy" or symbolic aspects. A "reality" can be explained according to a specific point of view and also can be considered as the symbol of higher order and a more general reality (for example a two-dimensional form can be seen as the projection on a plan of an n-dimensional figure). We argue that the "demiurgic" characteristic of project management involves seeing this field as an open space, without "having" (have) but rather with a *raison d'être* (be), because of the construction of real by the projects. It could be considered to be a fundamental explanation of the preparadigmatic nature of this field (see Kuhn 1983): the dominant paradigm, source of well established theory (ies) is *not* to find. The deep nature of project management implies this paradox of being built on moving paradigms reflects the diversity of the creation process by itself.

This field is thus composed of both quantitative aspects (have), dependent upon the positivist paradigm, where people have few degrees of freedom (operational research in network optimization, cost engineering, statistical methods, bodies of knowledge, application of standards, best practices, code of ethics, and so on … all these are seen as the truth), and qualitative aspects (be), dependent upon the constructivist paradigm where people have many degrees of freedom (organizational design, learning, knowledge management, change management, systemic approaches, contextualization of the life cycle, meta-rules, and so on). Some of these aspects are linked together; for example the creation and evolution of standards seen from the Theory of Convention (social construct) and their application (positivism). Thus, our vision for project management would be one of an integral function: the knowledge field is made up of differential elements, each of them being able to be defined (for example cost control, scheduling, communication, quality, information system, temporary group, and so on) yet seen as a whole? It is a transition to the limit, and in mathematics the result of an integral is quantitatively and qualitatively more than the sum of the parts. In other words, it can be called a system effect: parts A, B, and C forming a system S, keep some of their properties and potential performances, lose some others, but gain some entirely new performances (Legay 1996).

It seems to us from this point of view in the conceptual field of management of projects, that the knowledge and the representation understood in their distinctable activity is inseparable. The intended experience of knowing the subject and the grouping of the subject represents knowledge. Undoubtedly constituting the strong assumption on which we define teachable scientific and ordinary knowledge today (Lemoigne 1995).

These epistemological considerations lead us to define now, on meaningful foundations, the method we propose in mapping the dynamics of the project management field.

Co-Word Analysis

Theoretical Foundation

The analysis of the dynamics of science has attracted much interest. A qualitative concern with scientific change can be found in a range of disciplines like philosophy (Popper 1959), social science (MacKenzie 1978), history of science (Kuhn 1983), and science policy (Weingart 1982), and so on. Though these many writers have advocated a wide variety of theoretical perspectives they all have one thing in common; they do not make use of quantitative indicators in order to handle aggregated data. Quantitativists have worked in a quite different way, using large databases to count publications, citations, and patents (Garfeild et al 1978). And they share a common interest in the dynamics of science. However, it is necessary to build on this convergence. The reluctance of the qualitativists to use statistical analysis must

be overcome and, on the other hand, the materials collected and their application must contribute to a theoretically defensible concept of science (Callon, Law, and Rip 1986).

Built on the actor-network theory, and as a consequence of interaction between actor-networks, resulting structure of problems, and networks of problematization (Callon et al 1986), the co-word analysis technique was first proposed to map the dynamics of science. The most feasible way to understand the dynamics of science is to take the force of science in present-day societies into account. "Actor network" is the theoretical foundation for co-word analysis to map the dynamics of science. Laboratories and literatures are considered as two powerful tools for scientists to change the world. They build complex worlds in laboratories and enforce them on paper (Latour 1987). This implies that scientists attach particular importance to texts. They are not only using texts to publish their world built in the lab but also use texts as a way to build a world and enroll others. Even though science cannot be reduced to texts alone, texts are still a prime source for studies on how worlds are created and transformed in the laboratory. Therefore, instead of following the actors to see how they change the world, following the texts is another way to map the dynamics of science.

Based on the co-occurrence of pairs of words, co-word analysis seeks to extract the themes of science and detect the linkages among these themes directly from the texts' subject content. It does not rely on any a priori definition of themes in science. This enables us to follow actors objectively and detect the dynamics of science without reducing them to the extremes of either internalism or externalism (Callon et al 1986b). Overall, co-word analysis considers the dynamics of science as a result of actor strategies. Changes in the content of a subject area are the combined effect of a large number of individual strategies. This technique should allow us in principle to identify the actors and explain the global dynamics (Callon et al 1991).

Co-Word Analysis Method

Co-word analysis is a content analysis technique that uses patterns of co-occurrence of pairs of items (i.e., words or noun phrases) in a corpus of texts to identify the relationships between ideas within the subject areas as presented in these texts. Indexes based on the co-occurrence frequency of items, such as an inclusion index and a proximity index, are used to measure the strength of relationships between items. Based on these indexes, items are clustered into groups and displayed in network maps. For example, an inclusion map is used to highlight the central themes in a domain, and a proximity map is used to reveal the connections between minor areas hidden behind the central ones. Some other indexes, such as those based on density and centrality, are employed to evaluate the shape of each map, showing the degree to which each area is centrally structured and the extent to which each area is central to the others. By comparing the network maps for different time periods, the scientific dynamic can be detected. The co-word analysis technique was first developed in collaboration between the Centre de Sociologie de l'Innovation of the Ecole Nationale Superieure des Mines of Paris and the Centre National de la Recherche Scientifique (CNRS) of France during the 1980s, and their system was called "LEXIMAPPE." For about twenty years, this technique has been employed to map the dynamic development of several research fields.

Many examples (Turner and Callon 1986; Callon 1986; Courtial and Law 1989; Law and Whittaker 1992; Coulter et al 1998) reveal that co-word analysis is a promising method for discovering associations among research areas in science and for revealing significant linkages that may otherwise be difficult to detect. It is a powerful tool that makes it possible to trace the structure and evolution of a sociocognitive network (Bauin 1986). As such, it offers a significant approach to knowledge discovery.

In the following paragraphs we are introducing the main metrics we are using in this study. A more detailed presentation of the metrics used in co-word analysis can be found in He (1999).

Metric

The basis of a co-word analysis study is the calculation of the Equivalence or Link Coefficient:

1) [E.ij] = ([C.ij]/[C.i]) [multiplied by] ([C.i1]/([C.j]) = [([C.ij]).2]/([C.i] [multiplied by] [C.j]).

where,

[C.ij] is the co-occurrence frequency of the keyword pair ([M.i] and [M.j]) in the set of articles.

[C.i] is the occurrence frequency of keyword [M.i] in the set of articles.

[C.j] is the occurrence frequency of keyword [M.j] in the set of articles.

[E.ij] has a value between 0 and 1.

This coefficient is used to define the clusters and draw the Strategic Diagram.

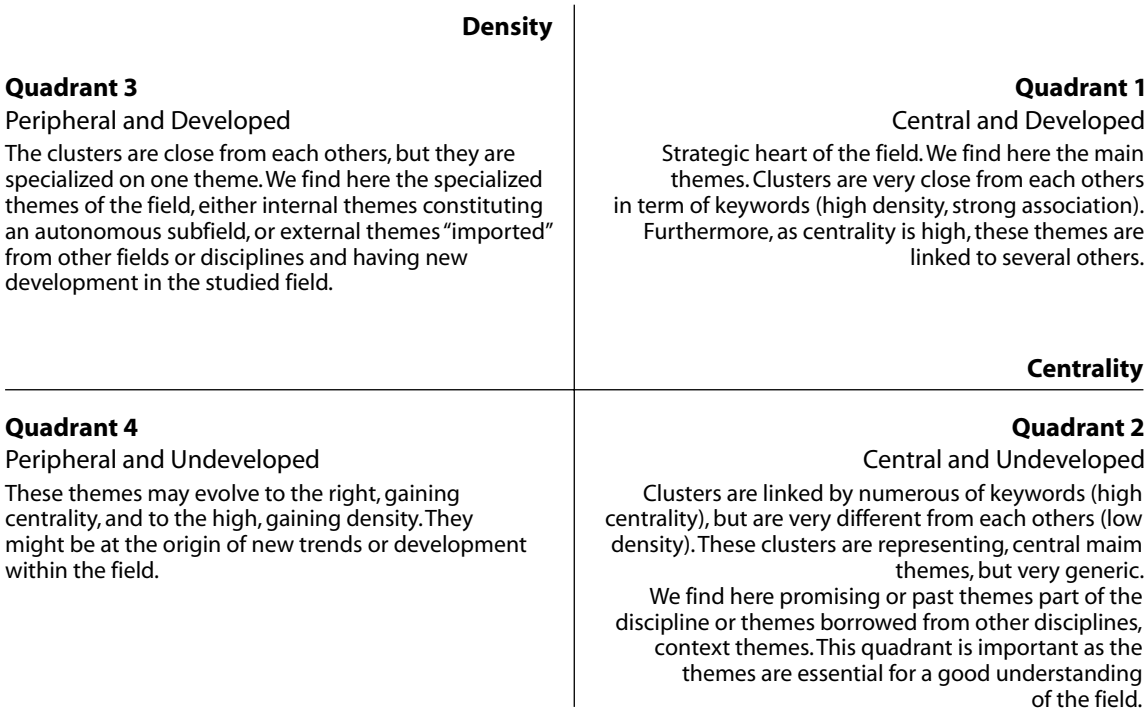
A cluster is a lexical structured set built from a co-occurrence analysis. It is constituted by a set of words strongly associated or in strong co-occurrence in the documents. The co-occurrence analysis is conducted through the index (list of words to take into consideration) associated to the corpus of documents.

Density, Centrality, and Strategic Diagram

A strategic diagram is used to illustrate the "local" and "global" contexts of themes. This diagram is created by putting the strength of global context on the x-axis (called centrality) and putting the strength of local context on the y-axis (called density). This diagram is used in many co-word studies. Two kinds of indexes (i.e., density and centrality) are used to measure the strength of local context and global context respectively.

Density: Density is used to measure the strength of the links (Equivalence or Link Coefficient) that tie together the words making up the cluster; This is the internal strength of

Exhibit 1. Strategic Diagram



a cluster and provides a good representation of the cluster's capacity to maintain itself and to develop over the course of time in the field under consideration (Callon et al 1991). Ranking subject areas (clusters) in terms of their internal coherence (density) is designed to provide information for systematic discussion of a major policy alternative. Further, sorting the keywords by decreasing order of density can provide a precise description of the areas (Bauin et al 1991). The value of the density of a given cluster can be measured in several ways. Generally, the index value for links between each word pair is calculated first. Then, the density value can be the average value (mean) of internal links (e.g., Turner et al 1988; Coulter et al 1998), the median value of internal links (e.g., Courtial et al 1993), or the sum of the squares of the value of internal links (e.g., Bauin et al 1991). An internal link means both of the words linked by it are within the cluster. Here we consider the average value (mean) of internal links.

Centrality: Centrality is used to measure the strength of a subject area's interaction with other subject areas. Ranking subject areas (clusters) with respect to their centrality shows the extent to which each area is central within a global network. The greater the number and strength of a subject area's connections with other subject areas, the more central this subject area will be in the network (Bauin et al 1991). For a given cluster (area), its centrality can be the sum of all external link values (e.g., Turner et al 1988; Courtial et al 1993) or the square root of the sum of the squares of all external link values (e.g., Coulter et al 1998). More simply, it can be the mean of the values of the first six external links (e.g., Callon et al 1991). An external link is one that goes from a word belonging to a cluster to a word external to the cluster. Here, we consider the mean of the values of the first six external links.

Strategic Diagram: A strategic diagram that offers a global representation of the structure of any field or subfield can be created by plotting centrality and density into a two-dimensional diagram (Law et al 1988). Typically, the horizontal axis represents centrality, the vertical axis represents density, and the origin of the graph is at the median of the respective axis values. This map locates each subject area within a two-dimensional space divided into four quadrants. The strategic diagram is used in many co-word analysis studies (e.g., Turner et al 1988; Courtial and Law 1989; Turner and Rojouan 1991; Callon et al 1991; Coulter et al 1998) and the analysis based on it is similar among these studies. Generally, the subject areas in quadrant 1 are both internally coherent and central to the network in question. However, those areas in quadrant 4 seem to be of only marginal interest to work in the global network. Coherent subject-specific areas always appear in quadrant 3 of the diagram. These areas are internally well structured and indicate that a constituted social group is active inside them. However, they appear to be rather peripheral to the work being carried out in the global network. Weakly structured areas are found in quadrant 2. These subjects, individually, are linked strongly to specific interests throughout the network but are only weakly linked together. In other words, work in these areas appears to be underdeveloped, but it could potentially be of considerable significance to the entire network. All these characteristics of a strategic diagram can be summarized in Exhibit 1.

Exhibit 2. Research Process

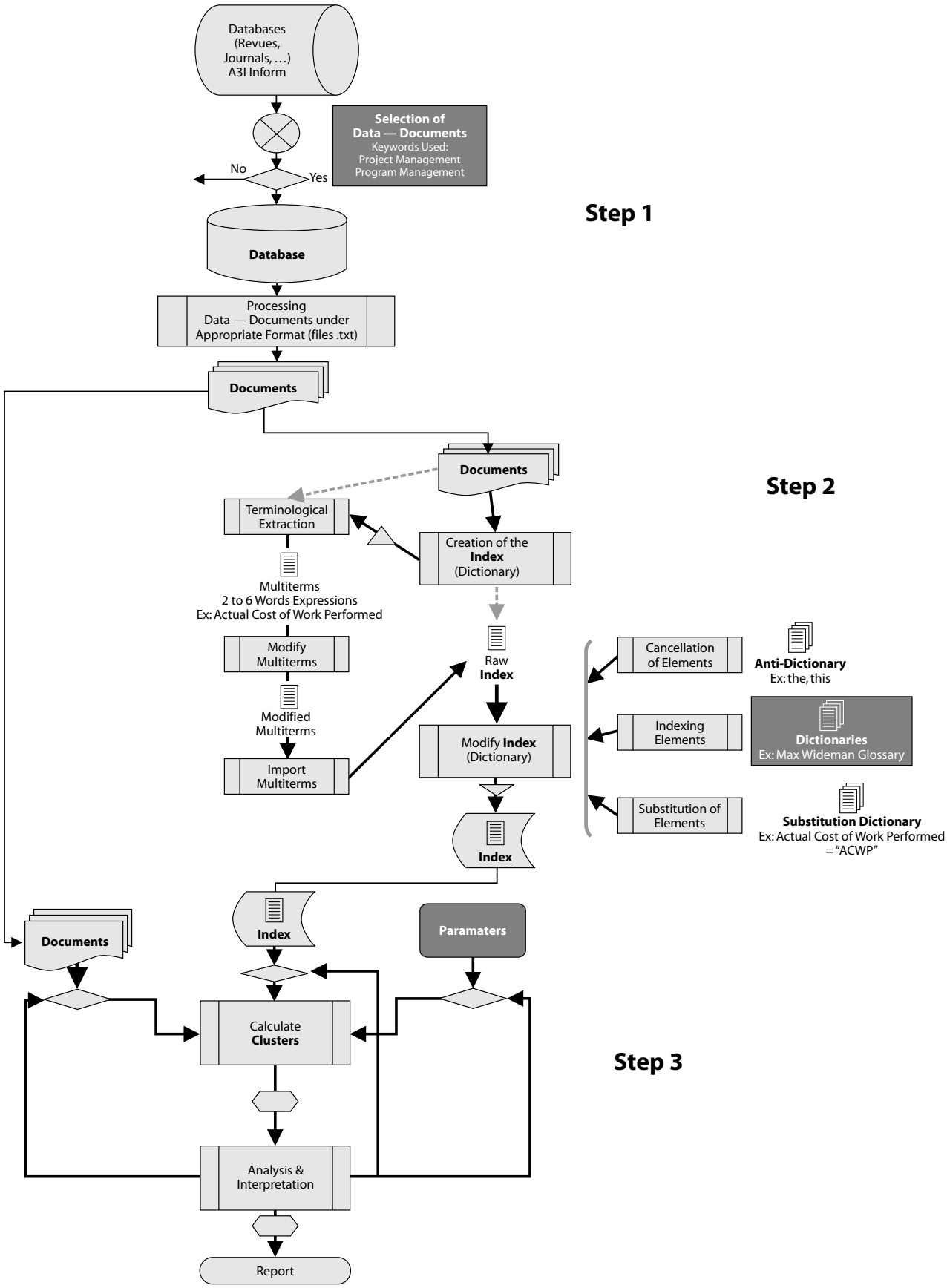


Exhibit 3. Parameters

Minimum number of letter by extract	30
Maximum number of letter by extract	3000
Minimum number of co-occurrences	5
Maximum number of words by clusters	25
Maximum number of internal links	50
Maximum number of external links	50
Minimum number of words by clusters	5
Minimum frequency	1
Maximum number of words by expression	6

Dynamics of Networks: A striking feature of some strategic diagrams is the radical change in the configuration of the network at two periods. This reflects the dynamics of science. Based on the strategic diagram, we can analyze the stability of the networks and foresee their changes in the future. This issue is addressed in many studies, and the methods used in these studies fall into two categories: The study of strategic diagrams and the ratio of centrality to density. Here we use the former one. This method is used to study the stability of networks and is directly based on the strategic diagrams (e.g., Callon et al 1991; Turner and Rojouan 1991). The findings can be summarized as showing that the probability for the content of themes situated in quadrants 2 and 3 to change over time is significantly higher than it is for themes which are situated in quadrant 1. With a low density, the unstructured themes in quadrant 2 tend to undergo an internal restructuring to improve their cohesiveness. With a low centrality, the scope of themes in quadrant 3 is likely to be extended in order to better articulate what is being done in the rest of the network. The reason, as well as the goal, for all these changes is to place their work at the heart of their field (quadrant 1). This can be done either by enlarging its scope or by improving its visibility through conceptual developments in the definition of the field.

Network Comparison: In co-word analysis studies, several subnetworks (clusters) can be constructed concurrently even though each network changes over time. To detect the difference among subnetworks simultaneously or subnetworks at different times has been a long-standing research issue. The transformation of networks and their intersections with other networks across time periods provides insights into theme emergence. The similarity of networks in different time periods has also been studied by Coulter et al (1998). In this study, the authors employ the similarity index (SI), which comes from Callon's dissimilarity (or transformation) index (Callon et al 1991).

Exhibit 4. Distribution of Documents by Year

Year	Number of Documents
1985	212
1986	264
1987	255
1988	330
1989	316
1990	381
1991	336
1992	409
1993	663
1994	658
1995	709
1996	884
1997	882
1998	968
1999	756
2000	692
2001 (July)	706 (284)
Total	**8999**

A transformation index (T), also called a dissimilarity index, is defined to measure the degree of dissimilarity between two given clusters. This index is defined as:

2) T = ([W.i] + [W.j]) / [W.ij]

where,

[W.i] is the number of words in cluster [C.i].
[W.j] is the number of words in cluster [C.j].
[W.ij] is the number of words common to [C.i] and [C.j].

The similarity index is defined as follows:

3) SI= 2 [multiplied by] ([Wij] / ([W.i] + [W.j]))

where,

[W.i] is the number of keywords (descriptors) in network [N.i].
[W.j] is the number of descriptors in network [N.j].
[W.ij] is the number of descriptors common to [N.i] and [N.j].

A constant 2 is multiplied to make the maximum value of SI to 1, which occurs when [N.i] and [N.j] have identical nodes (keywords or descriptors). SI is used to measure the point of descriptor intersection in two networks and to examine the emergence of a network during a particular period.

Some Key Issues in Co-Word Analysis

The maps obtained by co-word analysis are generally considered very difficult to understand in isolation. They have

Exhibit 5. Documents and Descriptors per Period

Time Period	N of Documents	N of Descriptors (Index)	Descriptor/ Document Ratio	N of Words	% Coverage = Descriptors/ Words	Median Centrality/ Median Density
1985–1991	2094	89037	42.52	425174	20.94%	c.m = 0.030857 d.m = 0.094559
1992–1996	3323	110973	33.40	581638	19.08%	c.m = 0.023117 d.m = 0.084113
1997–2001	3582	85554	23.88	461037	18.56%	c.m = 0.028788 d.m = 0.086738

to be interpreted with caution. It is suggested that the interpretation must be active and based on the comparison of maps (Callon et al 1986). Given that the goal of co-word analysis is not just to photograph a field of knowledge but also to reveal the strategies by which actors mutually define one another. Callon et al (1991) suggest that the maps cannot be considered in statistical isolation; they must be interpreted dynamically.

The choice of the words (keywords, descriptors) is another issue to be carefully considered and has led to many discussions (Leydesdorff 1997; Whittaker 1989). A literature review shows that the words used in co-word analysis are expanding from keywords in a lexicon to words in the full-text (Bauin 1986; Callon et al 1991; Rotto and Morgan 1997; Kostoff et al 1997). The "normalization" of words must be considered as well (for example many words for which British and American spellings differ have been standardized to the American spelling by the Institute for Scientific Information when they are put into the citation index databases). This has been addressed in several studies (Turner et al 1988; Courtial et al 1993; Nederhof and van Wijk 1997).

Questions of meaning or change of word meaning at different level (during a period of time, from one author to another, and such) is also addressed (Leydesdorff 1997, 1998). Words are not used as linguistic items to mean something in co-word analysis, but are used as indicators of links between texts, whatever they mean. They are chain indexes, allowing one to compute translation networks. What is important for co-word analysis is not the exact meaning or definition of a word, but the fact that this word is linked to word X in one case and word Y in another case (Courtial 1998).

Project Management in Action

Research Process

The following Exhibit 2 describes the research process. Three key aspects of this process are: 1) the use of the keywords "project management" and "program management" to extract from the ABI Inform database the articles we wish to analyze as reflecting the project management scientific field; 2) the combination of different glossaries (Max Wideman, *PMBOK® Guide*, NASA 7120.5A, DoD standards, IPMA Competence Baseline, and so on) to define the descriptors (index) and constitute the dictionary we are using for this research; 3) the choice pf the parameters for the analysis (use of SAMPLER™, developed by Cisi, Groupe COMPAGNIE DES SIGNAUX).

Here are the parameters (algorithm constraints) we use to run the analyses. Link and Node limitations mostly determine how networks will be generated in concert with the corresponding co-occurrence minimum. If the co-occurrence minimum is too high, few links may be formed; if it is too low, an excessive number of links may result. In the former case, subthemes or concepts in the field may not emerge; in the latter case, the field may look disproportionately cluttered. The choice of parameters aims to avoid both the too detailed and the too general perspective where both would lead to problems of misinterpretation.

When a cluster already has twenty-five words in it, the next link will be refused. The value of this link that is first refused is called the saturation threshold. After a cluster saturates, a new cluster is started. The e-coefficient value of the first link of this new cluster is called the "ceiling threshold." Based on the association value of the intercluster link and external links and the value of the ceiling threshold and saturation threshold, three distinct categories of clusters can be identified. Exhibit 3 shows the parameters.

Resulting Data: Overview and First Findings

The research is based on the study of the ABI Inform database abstracts, from 1985 to 2001. The distribution of the documents by year is given in Exhibit 4.

We can note the development of the numbers or articles from 1985 to a peak in 1998, and then a decrease with a level around 700 papers a year. This may give an indication that the field has reached a more mature development.

For the purpose of the study we have grouped the data in three periods of time: 1985–1991; 1992–1996; and 1997–2001.

Exhibit 6. Strategic Diagrams

	1985–1991 c.m = 0.030857 d.m = 0.094559			1992–1996 c.m = 0.023117 d.m = 0.084113			1997–2001 c.m = 0.028788 d.m = 0.086738		
		Centrality	Density		Centrality	Density		Centrality	Density
Quadrant 1	Product	0.055752	0.125507	Application	0.026409	0.113176	Support	0.037657	0.087055
	Public	0.040427	0.100584	Program	0.042612	0.168154	Cost	0.038088	0.108532
	Construction	0.061488	0.199120	Technology	0.042812	0.190242	System	0.048892	0.145838
	Project	0.087718	0.575052	Project	0.075150	0.527071	Engineering	0.058226	0.172468
				Analysis	0.044764	0.140969	Water	0.032525	0.147432
				Success	0.033275	0.109829	Management	0.087979	0.524980
Quadrant 2	Budget	0.031785	0.071304	Building	0.027111	0.056148	Need	0.029634	0.062054
	Team	0.031016	0.072817	Team	0.029521	0.080561	Application	0.029117	0.063504
	Implementation	0.038829	0.094341	Performance	0.024057	0.063082			
Quadrant 3	Equipment	0.029034	0.159077	Professional	0.012740	0.113431	Professional	0.022831	0.112795
Quadrant 4	Impact	0.018850	0.022848	University	0.010564	0.060395	Maintenance	0.014292	0.037230
	Framework	0.018011	0.035551	Solving	0.015679	0.017064	Function	0.023473	0.027584
	Integrate	0.016052	0.080470	Employee	0.014233	0.084021	Implement	0.016127	0.049283
	Complete	0.021343	0.055912	Goal	0.013841	0.027713	Develop	0.018393	0.046080
	Expertise	0.029380	0.019661	Start	0.013874	0.024846	Framework	0.020698	0.040762
	Office	0.022891	0.088154	Improve	0.017374	0.043341	Section	0.023115	0.024202
	Division	0.017343	0.023972	Critical	0.013843	0.022748	Cycle	0.016864	0.044230
	Environment	0.028551	0.062446	Operating	0.013238	0.061802	Customer	0.016470	0.045794
	Professional	0.016319	0.038098	Manage	0.016427	0.027557	Tool	0.020803	0.047729
	Scope	0.020779	0.056474	Operation	0.014489	0.014769	National	0.012236	0.020633
	Language	0.019845	0.013775	Enterprise	0.012726	0.020914	Communication	0.022792	0.036399
	Ability	0.022223	0.074108	Budget	0.018950	0.047434	Major	0.023523	0.044706
	Managing	0.026152	0.063582	Level	0.014378	0.038544	Global	0.019596	0.018934
	Manager	0.025055	0.047445	Integration	0.019483	0.047350			
				Developing	0.019026	0.054990			
				Experience	0.014476	0.030789			

The first two periods of time where chosen in a previous study (Bredillet 1998, 1999). We wish to update the previous results by taking into consideration new developments and adding the new period of time.

This gives a first indication of the expanding nature of project management given that the ratio of Descriptors/Documents and coverage of the field Descriptors/Words is decreasing. That means that the field encompasses new concepts (i.e., new words). At the same time, the evolution of centrality and density show that from 1985–1991 to 1992–1996, the field is in development (from twenty-two clusters to twenty-six) and that themes are changing (lower density). It also shows that new themes are part of the field (lower centrality). From 1992–1996 to 1997–2001, the change and arrival of new themes occurring in the previous period became more integrated within the field (higher

Exhibit 7. Content of "Project" and "Professional" Clusters According to the Different Periods of Time

Project			Professional		
1985–1991	1992–1996	1997–2001	1985–1991	1992–1996	1997–2001
Project	Project	Management	Professional	Professional	Professional
Cost	Construction	Construction	Profession	Responsibility	Career
Information	Management	Development	Responsible	Institute	Training
Case	Document	Industry	Conversion	Profession	Education
System	Project Management	Software	Convert	Certification	Path
Project	Project	Company	Installation	Body of Knowledge	Management Development
Management	Actual Start Date	Document	Testing	Project Management Body of Knowledge	Employment
Document	Planning	Planning	Vendor	Project Management Institute	Job
Project Management	Company	Project	Request for Proposal	Knowledge	Labor
Actual Start Date	Information Technology	Management	Competition	Award	Staff
Software	Software	Project Management	Consultant	Excellence	Workforce
Planning	Development	Information Technology	Firm		Coaching
Development	Industry	Actual Start Date	Consulting		Recruitment
Information Technology	Information	Data	Reputation		Human
Company	Case	Processing	Client		Resource Planning
Research			Director		Resource Management
Science			Safety		Human Resource
Data			Occupational		Standard
			Prevention		Regulatory
			Administration		Safety
			Administrative		Occupational
			Purchase		OSHA
					Workplace

density and centrality), and the numbers of clusters declined from twenty-six to twenty-two. This demonstrated the recomposition of the field around new concepts, showed more focus and more maturity, with, perhaps a paradigm shift as correlated with the evolution of the number of papers (see Exhibit 5).

Strategic Diagram Analysis

After an overview on the first findings, it is appropriate to study the strategic diagrams generated and their evolution. A wealth of information emerges from these maps, sometimes difficult to translate. We are using a combination of qualitative and quantitative approaches in analyzing them. The three strategic diagrams are presented in Exhibit 6.

We can note the general dynamic of the field: from a 1985–1991 period focused (quadrant 1—"strategic heart" of the field) on construction, public, product, and project methods we then moved to a period (1992-1996) where the strategic issues of application, programs, technology, project methods and management, analysis (finance, risk, statistics, decision making, investment, and so on), success factors, and of quality. Finally we moved to a period (1997–2001) where the main problem area of support, cost, system integration, engineering, resources considerations, (water, oil, energy, environment, utility, reserves, and so on) and project, as a whole, are part of management.

If we have a look on quadrant 3 (the well-defined and developed themes), we can easily see that from a problem area of equipment (transportation, aerospace, transport, space, aircraft, aviation, defense, NASA, air force, electric, water, gas, power, nuclear, utility, regulatory, energy, and plant) in 1985–1991, we move to the theme of "professional" for the next two periods (1992–1996 and 1997–2001); this theme arising from peripheral themes (quadrant 4). "Equipment" is integrated in "team" issues (quadrant 2—central themes) in period 1992–1996 and in "application" (still in quadrant 2) for the period 1997–2001. This demonstrates a shift in the well-defined and accepted focus within the field. Analysis of

Exhibit 8. "Project" and "Professional" Clusters Summary Data

Cluster	Project (& Management 1997–2001)			Professional		
Period	1985–1991	1992–1996	1997–2001	1985–1991	1992–1996	1997–2001
N Words	17	14	14	22	11	23
L Internal Links	50	50	50	24	22	32
Complexity L/N	2.94	3.57	3.57	1.09	2.00	1.39
Percentage of Connectivity 2L/(N*(N - 1))	37%	55%	55%	10%	40%	13%
Transformation Index		2.06	1.15		8.25	17.00

quadrant 2 (central main themes, promising or past themes part of the discipline or themes borrowed from other disciplines, context themes) is important, as these themes are essential for a good understanding of the field. In 1985–1991, budget, team, and implementation (integrating organizational, success, change issues) are key themes. In 1992–1996, team is more linked to the concept of Integrated Product Team as developed by agencies like DoD, NASA, and to partnerships between stakeholders. Performance encompasses the notions of quality, continuous improvement, benchmarking, success criteria, and optimization. The building theme (contractor, bank, finance, credit, facilities, environment, and policies) is also very important in this period. Moving on to 1997–2001, we have a shift toward application (contextualization aspects to different industries), and need, theme-integrating subjects such as quality, value management, strategy, productivity, improvement, and progress, and so on. In fact we can see that the movement of the field from the 1985–1991 period to the 1997–2001 period was supported by borrowing from other disciplines according to period context. It is interesting to note that some of these themes are now considered as very close to, if not part of, the project management field (quality, value management, investment topics, facility management, and so on).

We may note that the quadrant 4 includes themes peripheral to the field, but that these themes may evolve to the right, gaining centrality, and upwards gaining density. They might be positioned for the origin of new trends or development within the field. As quoted above, this for example, is the case for the theme "professional."

Clusters Analysis

Once we have analyzed the general dynamic of the field we can focus on specific and interesting clusters. Here, we propose an analysis of the "professional" and of the "project" clusters.

The table in Exhibit 7 gives the content of the clusters according to the periods considered.

From this table it is possible to study the in-depth evolution of each cluster during the time period. The table in Exhibit 8 summarizes the main information to analyzing each cluster.

Firstly, let's consider the "project" cluster. This cluster is part of quadrant 1 at each period (see Exhibit 7); it is high on centrality and density. It appears to be a complex cluster (many links between the words comprising it) with a strong level of connectivity. Complexity and connectivity have increased from 19985–1991 to 1997–2001. Given that the transformation index has decreased at the same time, this cluster represents a well-defined strategic theme within the project management field and is the subject of many papers. It is also significant to note that the name of this cluster moved from "project" to "management" in 1997–2001. This may be interpreted as a sign in the development or recognition of project as a management issue. It may also be considered as an opportunity (recognition of the contribution of project management to the management of organizations), or a threat (integration of the project management field in the general management).

If we now consider the "professional" cluster, we can see that it is neither very complex, nor very connected. This theme moved from quadrant 4 (1985–1991) to quadrant 3 (1992–1996, 1997–2001). The transformation is high meaning that this theme is still moving in terms of content, and that the concept of "professional" within the project management field retains a plurality of meanings. This indicates the need for clarification, and for further research or studies. Thus the theme moved from a "task" focus concept (1985–1991) to a "knowledge" and "professional body" concept (1992–1996, to a "human resource management" concept (1997–2001). Confirmation is provided by the analysis in terms of similarity between the "professional" cluster (1997–2001) and the clusters from the previous period (1992–1996) that contributed to its emergence. See Exhibit 9.

We can note that the cluster "employee" (1992–1996) provided ten words to the cluster "professional" (1997–2001)

Exhibit 9. Emergence of "Professional" Cluster—Period 1997–2001

1997–2001	1992–1996			
Cluster "Professional"	Clusters (Origin)	Number of words Clusters (Origin)	Number of Common Words	Similarity Index
Professional	Start	25	1	0.042
Career	Experience	24	1	0.043
Training	Professional	12	1	0.057
Education	Solving	19	1	0.048
Path	Program	20	2	0.093
Management Development	Manage	17	1	0.050
Employment	Integration	24	1	0.043
Job	Improve	25	1	0.042
Labor	Employee	22	10	0.444
Staff				
Workforce				
Coaching				
Recruitment				
Human				
Resource Planning				
Resource Management				
Human Resource				
Standard				
Regulatory				
Safety				
Occupational				
OSHA				
Workplace				

and the similarity index between the two clusters is 44.4 percent, while the similarity with the previous cluster "professional" is only 5.7 percent. The figure below shows the transfer and reconfiguration between the cluster "employee" (1992–1996) and the cluster "professional" (1997–2001). It may be interpreted as an integration of project management career path as part of human resource development. See Exhibit 10.

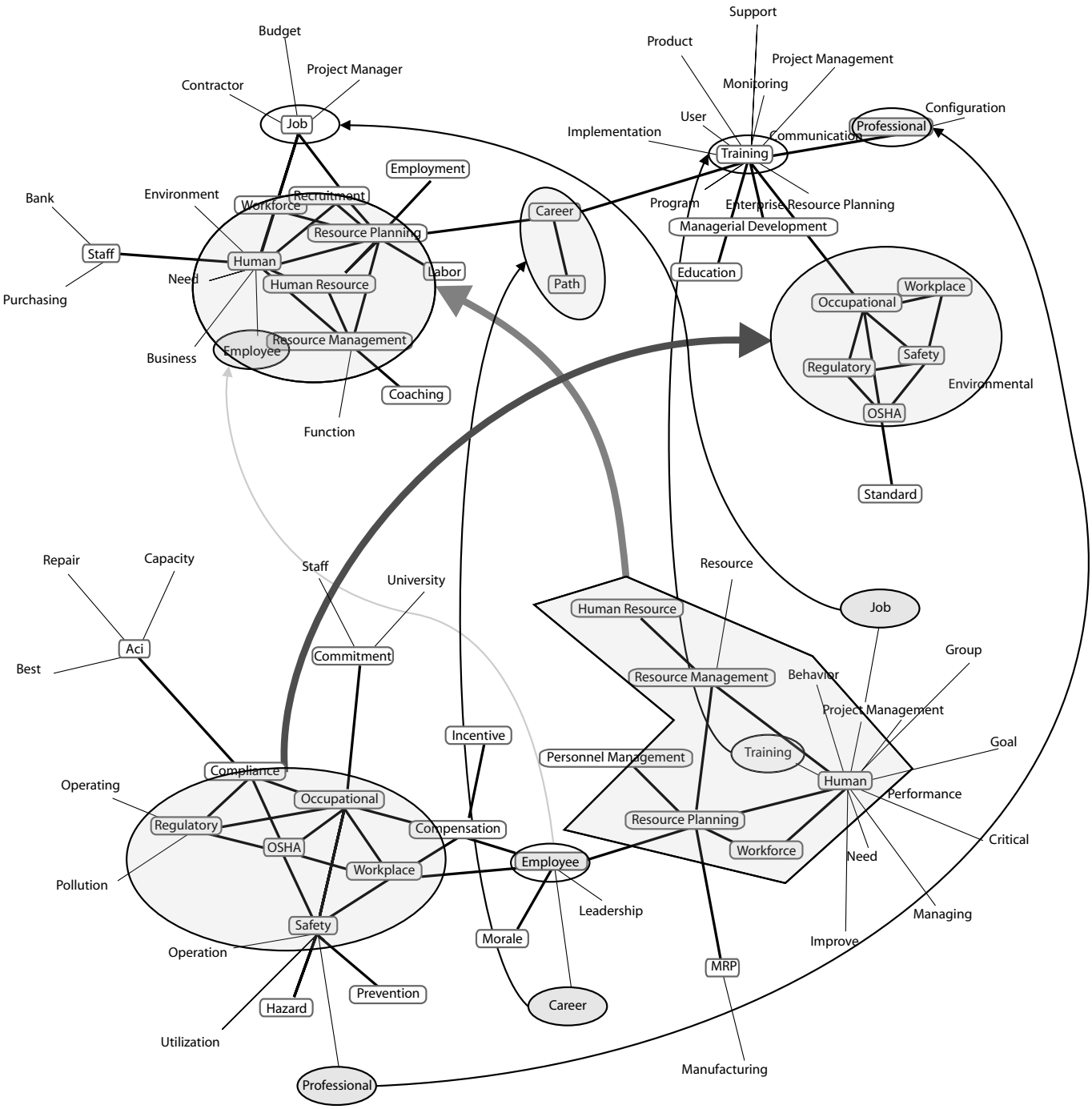
We cannot go any further within the scope of this paper. Many other theme transformations are suggested by the clusters and strategic diagrams and have been studied.

Conclusion

At this stage we may formulate few possible trends for the project management field. The field seems to become more mature, although very dynamic, and focused around the role of project in strategic issues as management, organizational issues, effective management, and/or use of resources and cost. The contextualization of the applications and the creation of value for the stakeholders seem to be another main trend. Furthermore, the clarification of the theme "professional" seems to be a major issue. As part of the weak signal detected, the threat of having project management becoming a part of general management may be considered. It reinforces the need to clarify the former theme. Another trend is that the more "technical" aspects of project management are appearing no more as strategic for the field. Project management is becoming more focused on implementation of organization strategy.

Methodological limitations are addressed previously (Some Key Issues in Co-Word Analysis). This study is based exclusively on the ABI Inform database. It is too far away to

Exhibit 10. Contribution of the Cluster "employee" (1992–1996) to the Cluster "Professional" (1997–2001)



reflect upon the entire project management field and it would be very interesting to add proceedings of congresses, in-companies publications, other publications, books, theses, and other non-published works.

However, this study demonstrates the interest of co-word analysis for extracting patterns form, structure, and dynamics of the field, and identifying trends within the discipline represented by a corpus of publications. It shows clearly that the analysis of a discipline must combine both quantitative and qualitative methods and integrate both synchronic and diachronic perspectives.

We hope that this brief study has shown an innovative way to gain in-depth knowledge and perception of the evolution of the project management field.

Further work is underway to integrate this approach as part of an International Observatory of Project Management Practices. This method is used as well to study the interactions between project management field and others

disciplines and to link concepts together in the design of educational programs and curricula.

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