

MANAGING ORGANIZATIONAL KNOWLEDGE INTEGRATION IN THE EMERGING MULTIMEDIA COMPLEX

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ABSTRACT

Due to technological convergence, complexes of interrelated industries are emerging. This paper presents a conceptual framework of the role different organizational forms and combinative capabilities play in the management of organizational knowledge integration in this context. The focus is on firms previously operating in one of the relatively stable constituting industries. We argue that a firm's organizational form has to be matched with appropriate combinative capabilities in order to integrate component knowledge into architectural knowledge that consequently serves as a platform for generating new product-market combinations. The framework is empirically illustrated using the example of two Dutch publishing firms moving into the multimedia complex, which is currently emerging around information and communication technologies. The empirical analysis shows that the framework offers strong potential for improving the understanding of the complex process of organizational knowledge integration, as the prerequisite for developing new business in an emerging industrial complex.

INTRODUCTION

The fundamental transitions that are currently taking place in a variety of industries are imposing new strains on businesses around the world (Bettis and Hitt, 1995). Consequently, both managers and researchers are searching for new management paradigms. This paper focuses on the emergence of a complex of interrelated industries, which is a highly relevant, but at the same time neglected subject in management research (Prahalad and Hamel, 1994). We examine the consequences an emerging industrial complex has for firms previously operating in one of the relatively stable constituting industries.

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An important characteristic of an emerging industrial complex (EIC) is the convergence of different technologies into hybrid forms. The implication of this phenomenon is that the boundaries of previously distinct and relatively independent industries are blurring (Astley, 1985; Van de Ven, 1993). A way to recognize this in quantitative terms is, for instance, the assessment of inter-industry flows of R&D spendings (Scherer, 1982). Prominent examples of industrial complexes are the ones emerging around micro-electronics and biotechnology (Lundgren, 1991; Van Tulder and Junne, 1988).

On the level of the individual firm, the emergence of an industrial complex implies that opportunities for new business development will grow. Moreover, already existing but previously alien assets and skills are likely to become necessary ingredients to exploit these opportunities successfully (Pennings and Harianto, 1992). Hence, the characteristics of this special case of economic and technological development ask for a renewed perspective on the managerial process that is considered to be appropriate for firms willing to survive. Still, the understanding of this challenge to renew is relatively underdeveloped and, accordingly, deserves more attention.

We take the position that the management of organizational renewal in the context of an emerging industrial complex should to a large extent be aimed at creating new architectural knowledge, which is a matter of reconfiguring existing component knowledge. This interpretation of organizational knowledge reconfiguration basically goes back to the seminal definition by Schumpeter (1934, p. 68) of innovation as 'the carrying out of new combinations', or in other words, 'the different employment of the economic system's existing supplies of productive means'. Furthermore, it builds on the distinction by Henderson and Clark (1990) between four types of innovations, namely incremental, modular, architectural and radical. As stated by the authors: 'The essence of an architectural innovation is the reconfiguration of an established system to link together existing components in a new way' (p. 12). This implies that architectural innovations have a more significant impact on the relationships between components than on the technologies of the components themselves. It is clear that this interpretation closely resembles Schumpeter's definition of innovation as a process of combining existing supplies of productive means in new ways. Moreover, it very well matches the context of an emerging industrial complex, in which for many firms the opportunities to combine the complex's existing technologies are more appealing than the opportunities to change the technology itself.

In this paper the term *component knowledge* is defined as knowledge already existing somewhere within the original industries constituting an industrial complex, but often unknown to firms stemming from other industries. The term *architectural knowledge* is defined as the innovation a firm creates by combining, or integrating different types of component knowledge into a new configuration. This architectural knowledge consequently serves as a platform for generating product-market combinations (PMCs) that need to provide a firm with a favourable return on its initial investments. The following assumption sums up the challenge of organizational renewal:

Assumption 1: Managing organizational renewal within an emerging industrial complex is a process of integrating existing component knowledge into new

architectural knowledge that serves as a platform for carrying out new product-market combinations.

ORGANIZATIONAL KNOWLEDGE INTEGRATION

The challenge to create new architectural knowledge as described above implies that the integration of different types of component knowledge becomes the key capability for a firm's management to master. The notion of the firm as a bundle of knowledge collections has recently attracted much interest. The emergence of this stream of literature to a large extent is the result of the popularity of the resource-based view of the firm (cf. Wernerfelt, 1984) and the related dynamic capability approach (cf. Teece et al., 1997). In addition, the growing literature on organizational knowledge also is an indication of the changes in the way organizations are being interpreted as economic units. This interpretation is moving away from a production-centred perspective, towards a learning-centred perspective. The latter implies that human capital in the form of knowledge, skills, and competences carried by employees and teams, rather than physical and financial capital, form a decisive basis for the interpretation of an organization's productivity and effectiveness (Nordhaug, 1993; Winch and Schneider, 1993).

In the literature on organizational knowledge a wide range of dimensions is used to characterize different types of knowledge (cf. Winter, 1987). The most widely used dimension is probably the one running from tacit to explicit (cf. Nonaka, 1994), which is based on the important work by Polanyi (1958, 1966). In this paper, however, the focus is on a related dimension of the knowledge concept that matches the concept of architectural knowledge as discussed above, namely its hierarchy of integration (Grant, 1996). Organizational knowledge is treated at different levels of integration, which can be seen as an elaboration of knowledge distinctions that simply focus on different levels of analysis (cf. Hedlund, 1994; Kogut and Zander, 1992). The crucial extension is the explicit recognition of the compound structure of the different levels. Another important aspect of this hierarchy of integration is that it is not necessarily the same as the hierarchy of authority in an organization, although there must be some degree of correspondence in order to operate effectively.

At the very bottom of the knowledge hierarchy lies personal knowledge, while at the very top lies architectural knowledge. The purpose of the multi-level integration process is to create architectural knowledge that is firm-specific. This resembles the ideas developed under labels such as distinctive capabilities, core competences, strategic assets, etc. (cf. Amit and Schoemaker, 1993; Prahalad and Hamel, 1990; Rumelt, 1984). More and more it is recognized that the resource characteristic that really can provide a firm with a unique position is its interrelatedness to other resources. Nordhaug (1993) in this respect talks about competence networks and competence configurations, while Leonard-Barton (1995) defines a core capability as an interrelated, interdependent knowledge system.

For reasons of analytical simplicity, the multilevel integration process is reduced to two levels. At the bottom of the knowledge hierarchy lie three types of component knowledge, namely knowledge related to products (or services), production processes and markets. At the top lies architectural knowledge. In line

with Grant (1996), the knowledge integration process is characterized using three dimensions. These three dimensions are efficiency, scope and flexibility. Efficiency of knowledge integration refers to the way in which the architectural knowledge accesses and utilizes component knowledge. Scope of knowledge integration refers to the breadth of component knowledge the architectural knowledge draws upon. Flexibility of knowledge integration, finally, refers to the extent to which the architectural knowledge can access additional component knowledge and integrate existing component knowledge.

Using the idea of the knowledge hierarchy, a conceptual framework can now be constructed of the organizational knowledge integration process. This framework is outlined in figure 1. Borrowing the concepts of capacity, requirement, and fit from the information processing perspective as presented by Galbraith (1973, 1977) and Tushman and Nadler (1978), the framework should be interpreted as follows. The industrial context in which a firm operates determines the type of integration process which is required. This implies that it is a firm's challenge to match this requirement. In order to do so, a firm has two important design variables at its disposal, namely its *organizational form* and its *combinative capabilities*. Together, the organizational form and the combination capabilities generate a firm's knowledge integration capacity. Preferably, this capacity matches the knowledge integration requirement generated by the stage of industrial development the firm is faced with (i.e. the emergence of an industrial complex). Below, the different aspects of the integration process are further elaborated on.

Organizational Forms

The conceptual framework distinguishes various organizational forms as design variables of knowledge integration. In this connection, an organizational form is viewed as the infrastructure which in a specific way enables the process of integrating knowledge. Since each organizational form is different, each form is expected to offer potential for different aspects of the knowledge integration process. In other words, the choice of organizational form has important implications for a firm's ability to generate the type of knowledge integration process required by the context. To illustrate this we limit ourselves to four basic organizational forms, which primarily describe the firm's internal state. These are the

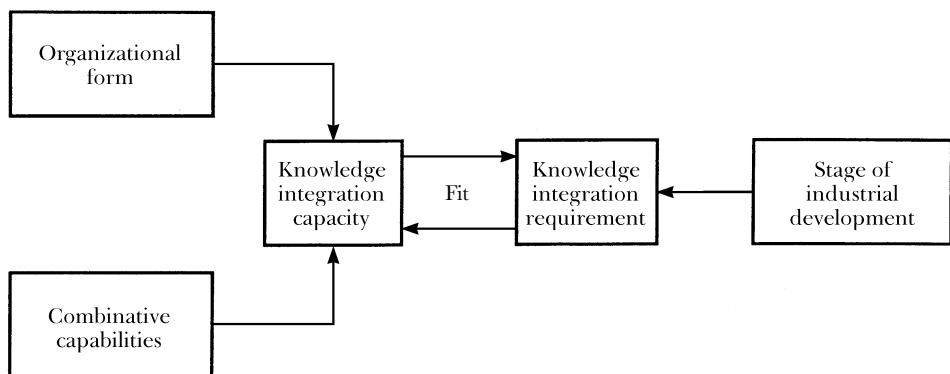


Figure 1. The conceptual framework of organizational knowledge integration

functional, division, matrix and innovative forms (Ansoff and Brandenburg, 1971).

Recently, a number of attempts have been made to come up with new types of organizational forms. Examples are the internal network form (Miles and Snow, 1986), the spherical form (Miles and Snow, 1994), the N-form (Hedlund, 1994), and the hypertext form (Nonaka, 1994). Most of these new types of organizational form have, however, not yet been explored in sufficient detail to assess their properties regarding the above mentioned three dimensions of knowledge integration. Still, the conceptual framework is in principle suited to incorporate these new organizational forms as well.

The four selected organizational forms can be roughly determined by analysing the way of grouping of activities, the number of hierarchical levels (not to be confused with the knowledge hierarchy), and the extent to which management is divided into various functional areas, which is commonly depicted by the organization chart (Volberda, 1998). In line with the three dimensions of knowledge integration mentioned above, we compare these basic organizational forms in terms of their potential for the efficiency, scope, and flexibility of the knowledge integration process.

Functional form. The functional form is based on a functional grouping of similar activities under major functional managers, a hierarchy of authority consisting of many hierarchical levels with small spans of control, and a degree of functionalization of management which may be limited (no staff functions) or high (staff functions with formal authority). The principal advantage of the functional form is its efficiency attained from economies of scale, overheads and skills. The scope and flexibility of knowledge integration of the functional form is rather limited. Only in stable and homogeneous environments where there are few PMCs with a relatively long life cycle, might this form be appropriate (Krijnen, 1979). In more unstable conditions, conflicts of priorities occur, decisions and products begin to queue up, communication lines get longer, and time responsiveness to external conditions is degraded (Ansoff and Brandenburg, 1971).

Assumption 2: The functional form has a high potential for efficiency, but a low potential for both scope and flexibility of knowledge integration.

Division form. The division form is based on grouping by product–market combinations, a limited hierarchy of authority consisting of few hierarchical levels with large spans of control, and a limited functionalization of management in the form of some central staff functions. Because of the autonomy of divisions in terms of operational decisions and their direct contacts with the environment, the flexibility of knowledge integration is higher than the functional form. None the less, to this increase of flexibility of knowledge integration, economies of scale have to be sacrificed. Furthermore, the scope of knowledge integration is limited to a single division. The loose coupling among divisions facilitates divisional knowledge integration, but suppresses integration of knowledge between multiple divisions. Therefore, a division form is most appropriate in a dynamic environment with a large number of different groups of PMCs that have few characteristics in common and of which the life cycle is relatively long.

Assumption 3: The division form has a low potential for both scope and efficiency, but a high potential for flexibility of knowledge integration.

Matrix form. The matrix form is based on a dual grouping of activities, a dual hierarchy of authority consisting of few hierarchical levels, and a high degree of functionalization of management tasks. The matrix is a combination of the principle of specialized functional departments with the principle of self-sufficient, more or less autonomous units or divisions, in situations where a number of (temporary) divisions or autonomous units need to be created. The ability of each unit to seek the organizational form most appropriate to the project it is handling facilitates the variety and flexibility of knowledge integration. The fact that available means and persons can be allocated to various projects enables a high scope and flexibility of knowledge integration. However, as Child (1984, p. 103) pointed out with regard to the matrix form: 'A purely structural design will not of itself guarantee any desired pattern of behaviour'. Still, on account of its high scope and flexibility of knowledge integration, the matrix form is deemed appropriate for organizations that function in environments with many new PMCs with relatively short life cycles. None the less, the scope and flexibility of knowledge integration of the matrix form is detrimental to its efficiency. Economies of scale will be rather small because different functions, experts and tools will be needed in different simultaneously executed projects, which results in only partly occupied resources.

Assumption 4: The matrix form has a low potential for efficiency, but a high potential for both scope and flexibility of knowledge integration.

Innovative form. Ansoff and Brandenburg (1971) suggest this as a fourth basic organizational form which negates some of the disadvantages of the matrix. The matrix is not applicable in a large majority of manufacturing firms in which economies of scale are important, assets and competences are relatively inflexible, and products have long lives. The underlying principle of the innovative form is, therefore, to gather currently profitable, established product markets into a current business group and to place development of new product-market positions into a team-based innovation group. Thus, the innovation group focuses on increasing the scope and flexibility of knowledge integration, while the current business exploits its efficiency of knowledge integration. The innovative organizational form possesses a high potential for scope and flexibility of knowledge integration and has a satisfactory level of efficiency of knowledge integration. The degree of efficiency depends on the scale on which operations take place and on whether the new PMCs are transferred to a new or an existing division.

Assumption 5: The innovative form has a high potential for efficiency, scope and flexibility of knowledge integration.

In each of the four basic organizational forms, knowledge is divided and integrated in a certain way (Lawrence and Lorsch, 1967). In the functional form, component knowledge is specialized according to functional areas, while in the division form

component knowledge is integrated in semi-autonomous divisions. The matrix form tries to specialize knowledge in functional areas, but also to integrate knowledge in project teams. Finally, the innovative form separates component knowledge from the standard operating core.

The assumptions regarding the potential for knowledge integration of the four basic organizational forms are summarized in table I. None the less, we have to look at our classification in perspective. For instance, the potential scope of the knowledge integration process offered by a certain organizational form can be exploited by the use of temporary task forces, standing committees, project teams, or various other liaison devices that overlay the basic organizational structure (Galbraith, 1973; Mintzberg, 1979). Of course, there are many other intermediate forms. Therefore, we consider various combinative capabilities to actively exploit the potential of the organizational knowledge integration process offered by the various organizational forms.

Combinative Capabilities

As indicated, the idea behind the concept of combinative capabilities is that it is the integration of knowledge, rather than the knowledge itself that forms the basis of a firm's competitive advantage. The particular configuration of knowledge functions as a portfolio of options, or platforms (Kogut, 1991), on future developments such as new product-market combinations. These platforms are built through a firm's combinative capability to synthesize and apply current and acquired knowledge (Kogut and Zander, 1992).

Clearly, the use of the term combination of Kogut and Zander runs parallel to the term integration used by Grant (1996), and the term configuration used by Henderson and Clark (1990). What is neglected in most publications, however, is a specification of the different combination or integration mechanisms a firm has at its disposal and the impact these are likely to have on the outcome of the knowledge integration process. Therefore, in our framework we suggest three types of combinative capabilities, which can be both of an intra and interorganizational nature. In other words, a firm developing new architectural knowledge can use these three capabilities to integrate component knowledge located within its own organization, or component knowledge located within actors operating in its environment. Systems capabilities enable the creation of new architectural knowledge through formal systems such as codes, plans and procedures. Co-

Table I. Basic organizational forms and their impact on the dimensions of knowledge integration

	<i>Functional form</i>	<i>Division form</i>	<i>Matrix form</i>	<i>Innovative form</i>
Efficiency of integration	H	L	L	H
Scope of integration	L	L	H	H
Flexibility of integration	L	H	H	H

Note:

H = high; L = low

ordination capabilities enable the creation of new architectural knowledge through managerial instruments such as training, liaison devices and participation. Socialization capabilities, finally, enable the creation of new architectural knowledge through cultural institutions such as values and norms.

Systems capabilities. Often systems capabilities, in terms of directions, policies, procedures and manuals, are used to integrate explicit knowledge bases. Nonaka (1994) calls this *combination*. Individuals exchange and combine explicit knowledge through formal exchange mechanisms such as *a priori* procedures, formal language, codes, working manuals, information systems, etc. The reconfiguration of existing information through these *ex ante* designed information processing systems can lead to new architectural knowledge. Grant (1996) argues that the more complex an activity, the greater the number of locations in which that activity must be replicated, and the more stringent the performance specifications for the outcome of that activity, then the greater is the reliance on knowledge integration by systems capabilities.

While the efficiency of knowledge integration by systems capabilities is very high, the scope and especially flexibility of knowledge integration are less satisfactory. Systems capabilities describe the degree to which behaviours are programmed in advance of their execution (Galbraith, 1973; Khandwalla, 1977). It reflects the degree to which rules, procedures, instructions, and communications are laid down in written documents or formal systems. The primary virtue of systems capabilities is that they eliminate the need for further communication and co-ordination among subunits and positions. Consequently, they provide a memory for handling routine situations. In such routine situations, the behaviour of participants is predictable, that is, they know what to do, and they can react very quickly.

Assumption 6: Systems capabilities have a high potential for efficiency, but a low potential for both scope and flexibility of knowledge integration.

Co-ordination capabilities. While systems capabilities integrate knowledge by *ex ante* rules and procedures, co-ordination capabilities enhance knowledge integration by relations between members of a group. It refers to lateral ways of co-ordination which might be explicitly designed, but may also emerge out of a process of interaction (De Leeuw and Volberda, 1996). In this situation there is not a separate information processing system, but knowledge integration is produced by a specific bundle of relations between members of a group. Co-ordination capabilities accumulate in a firm as a result of training and job-rotation, natural liaison devices and participation.

An organization can achieve indirect knowledge integration by hiring educated professionals who can be further trained in the organization. Education and training achieve indirectly what rules and procedures as a part of systems capabilities do directly. They control and co-ordinate knowledge in the firm. On the job, professional or craft workers appear to be acting autonomously, but in fact they are guided by trained skills and acquired knowledge. In addition, in a very turbulent environment, mutual adjustment becomes the favoured means of knowledge co-ordination. This brings us to liaison devices for regulating mutual

adjustments between individuals or units. Such liaison devices result in lateral forms of communications and joint decision-making processes that cut across lines of authority. Consequently, liaison devices decentralize knowledge integration without creating self-contained units. The effect is that the capacity to process information and to co-ordinate knowledge is increased (Galbraith, 1973).

Finally, in situations in which delegation is a necessity, participation in decision making can supply the knowledge integration to offset the differentiation that delegation causes (Khandwalla, 1977). Participation describes the extent to which subordinates take part in the decision making of superiors. Low levels of participation therefore result in poor knowledge integration, because there is little sharing of information. A high degree of participation results in a more global and rich knowledge architecture, based on various contributions of lower levels. To conclude, while co-ordination capabilities are less efficient and more costly than systems capabilities, the scope and the flexibility of knowledge integration is much higher.

Assumption 7: Co-ordination capabilities have a low potential for efficiency, but a high potential for both scope and flexibility of knowledge integration.

Socialization capabilities. In addition to the direct integration of knowledge by rules and procedures and the indirect integration of knowledge by training, liaison devices and participation, we distinguish a third type of combinative capabilities. Socialization capabilities may integrate knowledge components by specifying broad, tacitly understood rules for appropriate action under unspecified contingencies (Camerer and Vepsalainen, 1988). These capabilities refer to the ability of the firm to produce a shared ideology that offers members an attractive identity as well as convincing interpretations of reality. In this perspective, socialization capabilities result from the firm's culture in terms of a system of ideas, or 'inferred ideational codes lying behind the realm of observable events' (Keesing, 1974, quoted in Allaire and Firsirotu, 1984, p. 197). The infusion of beliefs and values into an organization takes place over time, and produces a distinct identity for its participants, colouring as it does all aspects of organizational life, and giving it a social integration that goes far beyond the systems and co-ordination capabilities discussed above.

Camerer and Vepsalainen (1988) argue that the efficiency of knowledge integration of socialization capabilities is very high. However, they have serious doubts about the scope and flexibility of knowledge integration. Socialization capabilities can create mental prisons that hamper seeing important changes, for instance in the market (De Leeuw and Volberda, 1996). Moreover, strong cultures usually suffer from xenophobia (Ouchi, 1981) – that is, they resist deviance, retard attempts at change, and tend to foster inbreeding. Socialization capabilities rest in firms with a strong identity, in which one can find a coherent set of beliefs, highly shared values, a common language, and a strongly agreed-upon kind of appropriate behaviour. In addition, every member identifies strongly with, and professes loyalty to, the goal of preserving, extending, or perfecting the organization's mission, and so can be trusted to make decisions in the organization's interests. Such a situation leaves little room for integrating knowledge in ways which contradict shared beliefs.

Assumption 8: Socialization capabilities have a high potential for efficiency, but a low potential for both scope and flexibility of knowledge integration.

The assumptions regarding the potential for knowledge integration of the different types of combinative capabilities are summarized in table II.

Stages of Industrial Development

In order to compare the knowledge integration capacity generated by the organizational form and combinative capabilities with the knowledge integration requirement generated by the industrial context, the implications of the change firms undergo when moving from the relatively stable context of a single mature industry towards the turbulent context of an emerging industrial complex need to be further specified. As indicated in the introduction, an important characteristic of an emerging industrial complex is technological convergence, which causes the blurring of industry boundaries and the rise of opportunities to combine existing component knowledge into new architectural knowledge. These notions can be combined with the literature on product, industry and technological life cycles (cf. Dosi, 1982; Tushman and Anderson, 1986; Utterback and Abernathy, 1975). In the early development phases standardization is low, uncertainty is high, and competition is on differentiation, rather than on costs (cf. Porter, 1980; Van den Bosch and De Man, 1997). This leads us to conclude that the type of architectural knowledge that is required in an emerging industrial complex should score high on both scope and flexibility of knowledge integration. At the same time, efficiency of knowledge integration, which is dominant in the context of a mature single industry (MSI), becomes of minor importance.

Assumption 9: In a mature single industry the dominant requirement of the knowledge integration process is efficiency.

Assumption 10: In an emerging industrial complex the dominant requirements of the knowledge integration process are scope and flexibility.

The assumptions regarding the knowledge integration requirement of the different stages of industrial development focused on in this paper are summarized in table

Table II. Basic combinative capabilities and their impact on the dimensions of knowledge integration

	<i>Systems capabilities</i>	<i>Co-ordination capabilities</i>	<i>Socialization capabilities</i>
Efficiency of integration	H	L	H
Scope of integration	L	H	L
Flexibility of integration	L	H	L

Note:

H = high; L = low

Table III. Stages of industrial development and their impact on the dimensions of knowledge integration

	<i>Mature single industry</i>	<i>Emerging industrial complex</i>
Efficiency of integration	H	L
Scope of integration	L	H
Flexibility of integration	L	H

Note:

H = high; L = low

III. It should be clear that assumptions regarding other types of (changes in) contexts can be formulated in a similar manner.

PROPOSITIONS

Now that theoretical assumptions regarding the knowledge integration capacity and requirement have been discussed, the next step is to combine these two in the form of a number of tentative propositions that can be used to illustrate the empirical appropriateness of the conceptual framework. So, propositions are to be formulated regarding the knowledge integration capacity of a firm's organizational form and combinative capabilities on the one hand, and the type of knowledge integration requirement of the industrial context on the other hand. In other words, the propositions regarding a firm moving from a context requiring efficiency (stage 1) to a context requiring scope and flexibility (stage 2) of the knowledge integration process can be logically deduced when combining tables I, II and III.

Proposition 1: Firms operating in a mature single industry generally need to employ a functional form, and either systems or socialization capabilities in order to generate the required knowledge integration capacity.

Proposition 2: Firms operating in an emerging industrial complex generally need to employ either a matrix or innovative form, and co-ordination capabilities in order to generate the required knowledge integration capacity.

THE EMERGING MULTIMEDIA COMPLEX

The example of publishing firms moving into the currently emerging multimedia complex is used as an illustration of the appropriateness of the conceptual framework presented above. The multimedia complex is chosen as an empirical example because it is right at the heart of the evolutionary process in which technologies stemming from various industries are converging into hybrid forms.

Among these industries are telecommunications, computers, software, consumer-electronics and publishing. An early overview of this new competitive landscape is provided by McLaughlin and Biriny (1984). More recent contributions include Aksoy (1992) and Hagel and Eisenmann (1994). In this context, traditional publishers are typical examples of firms having to reconsider their new business development strategies. Besides existing and still flourishing media such as books, newspapers and journals, information delivery can now also occur through a range of new electronic and optical media such as on-line databases, Internet, CD-ROM, CD-i, and audiotex. A remarkable characteristic of these new media types is that their initial development took place 'beyond the bounds of the traditional publisher's strategic heartland' (Kist, 1987, p. 4). Hence, publishers provide a prototype of firms moving from a mature single industry, to an emerging industrial complex in which existing but alien component knowledge merges with native component knowledge.

To illustrate our conceptual framework, we examined a number of Dutch publishing firms with a strong background in folio publishing. Our examination took place in the midst of the change from a mature single industry to an emerging industrial complex; 1996 is chosen as the year in which this change took place. The case studies of two of these firms are presented below. Within these two firms semi-structured interviews were held and internal documents were studied to create a longitudinal picture of their organizational knowledge integration process from the early 1980s to mid 1997. The reason for choosing this period is that it covers the transformation of both firms from a predominantly folio business to a hybrid business of both folio and new media. With some witticism, this transformation can be labelled with the wordplay *mediamorphosis*. The specific type of new architectural knowledge focused on by the firms was medium-neutral database management, which is a prerequisite for so-called publishing on demand. This means that the firms were developing the ability to deliver information to its customers exactly in the amount, format, medium, moment, etc. they desire. The types of component knowledge that needed to be integrated in this respect are a specification of the basic types of component knowledge previously described. Knowledge related to the enrichment of information content (i.e. product knowledge), knowledge related to the process of information gathering, processing, refining, updating, storing, and distributing (i.e. production process knowledge), and knowledge related to the anticipation, interpretation, understanding, and stimulation of customers' need for information (i.e. market knowledge).

Het Financieele Dagblad

Het Financieele Dagblad (HFD) is a publisher of mainly Dutch financial and business information. HFD has a long history in publishing, going back to 1796. Today, HFD holds a special position in the Dutch publishing industry. The company is not listed at the stock exchange, and has managed to withstand the wave of mergers and acquisitions during the last couple of decades. Despite a wide range of take-over candidates, HFD's bicentennial anniversary in 1996 was still celebrated in independence. In 1997, HFD had about 160 employees, which makes it a relatively small player. Still, within the market for financial and business information, HFD holds a very strong position. Its newspaper is the only one of its kind and has a solid subscription base.

HFD's most important product has always been and still is the financial newspaper, which is comparable to the British *Financial Times* and the German *Handelsblatt*. It is the leading financial and business publication in the Netherlands. Besides the newspaper, HFD nowadays is involved in a wide range of other information and communication activities as well. An important element of HFD's strategy to develop a mixed media portfolio was its database with the electronic archives of a number of existing folio products, of which the newspaper is the most important part.

HFD started the exploration of the opportunities for database information in 1982. During the development of the database, HFD has clearly evoked changes to its organizational form and combinative capabilities. In stage 1, HFD showed the functional form. There was a division between the editorial, prepress, and marketing activities. This offered the appropriate structure to create the required efficiency capacity, as suggested by proposition 1.

In 1996 HFD introduced a new organizational structure, which resembled the innovative form. Part of the new structure was a separate and independent new business development unit which since then became responsible for electronic products such as the database, as well as other activities, such as organizing congresses. The major benefit of the new business development department was the bundled expertise and the focused attention. Because of this stronger internal position, the new business development department also became better equipped to deal with external partners. The change in stage 2 towards the innovative organizational form, which is suggested by proposition 2, had a positive effect on both the speed and the focus of the development process.

Regarding the combinative capabilities the following changes occurred. In stage 1, HFD employed few so-called hard mechanisms such as formal planning, budgeting, procedures, etc. Neither the hierarchical structure nor the promotion policy was very stringent, for example. The same applied to the new business development activities, which were fairly unstructured. Partly, this was due to the traditional routines that ruled the publishing industry in general. There simply was no inclination within HFD to do things differently. Besides, the company was so unfamiliar with new media that one simply did not know what and how to plan, budget, control, etc. Instead, the firm clearly showed a strong reliance on socialization capabilities. Because of its long history, HFD has had a long time to develop a strong corporate culture on which to rely its functionalized operations. This was especially the case with the editorial staff department (journalists and editors), which was considered to form the core of the firm's existence. Overall, the firm's use of combinative capabilities appeared to be in accordance with proposition 1.

A considerable and complex product, such as the database has become since then, now requires a much more formalized approach than it has seen so far. HFD is increasingly using systems capabilities to evaluate the new business development activities. Another implication of HFD's choice to bundle the new business development activities in a semi-independent unit is the need for extensive communication and knowledge exchange between the different departments. Project management is a suitable management instrument in this respect. A project team brings together people with different functional backgrounds, which encourages the integration of different knowledge components. During stage 1,

Table IV. HFD's deployment of combinative capabilities

	<i>Stage 1: 1982–1996</i>	<i>Stage 2: 1996–1997</i>
Systems capabilities	Except for editorial articles hardly present	Project management guidelines, marketing targets
Co-ordination capabilities	Hardly present	Editorial class system, project management
Socialization capabilities	Strong traditional folio publishing routines	Emergence of a new media mindset

however, project management was not used due to lack of clear external objectives. In stage 2, and especially with regard to the exploration of new business opportunities, HFD started using project teams consisting of people from new business development, marketing, and the editorial staff. Altogether, the use of co-ordination capabilities in stage 2 was suggested by proposition 2, while the use of systems capabilities was not. HFD's overall deployment of combinative capabilities is summarized in table IV.

Samson H D Tjeenk Willink

Samsom H D Tjeenk Willink (SHDTW) was one of the many business units of the Dutch publishing conglomerate Wolters Kluwer. (Early in 1998, SHDTW merged with one of Wolters Kluwer's other business units.) The roots of SHDTW lie in the production and trade of office products. In 1882, Nicolaas Samsom, municipal secretary and tax collector, handily took advantage of his experience and started a private business in municipal administrative systems and forms. Today, SHDTW still publishes information primarily for the government. Because of space restrictions, the description of the process of mediamorphosis at SHDTW is limited to a typical mixed media project, namely a reference guide containing educational information. In the past, the reference guide was solely published as a loose-leaf folio product. During the last couple of years, however, loose-leaf issues in general have been hit by a declining circulation, indicating this medium is reaching the end of its product life-cycle. Hence, there is a ubiquitous need for publishers to search for new ways to exploit their information. Electronic media offer strong potential in this respect.

The road towards an electronic guide was long and thorny. In 1985, a first attempt was made to computerize the data files of the guide. It was only in the summer of 1996, however, that the database became operational. The first supplement to the folio issue of the guide deducted from the database was produced by the end of 1996. The first electronic product finally was introduced on the market in the summer of 1997.

An important reason why it took so long for SHDTW to develop the database and new media product was the difficulty it had in changing its organizational knowledge configuration. In stage 1, SHDTW showed a strong division between semi-independent publishing groups focusing on a clear set of product–market combinations. This structure reflected the division form, which was not suggested

Table V. SHDTW's deployment of combinative capabilities

	<i>Stage 1: 1985–1995</i>	<i>Stage 2: 1995–1997</i>
Systems capabilities	Only aimed at the effectuation of specified profitability levels	Aimed at standardization of products and production processes, but still in its infancy
Co-ordination capabilities	Hardly present	Project groups at various levels
Socialization capabilities	Strong traditional folio publishing routines	Still largely aimed at folio publishing

by proposition 1. Still, SHDTW's division form in stage 1 can be explained in the light of the great number of PMCs compared to HFD. When the context changed, however, SHDTW did not change its organizational form. Hence, in stage 2 SHDTW managed to develop the required flexibility capacity, but did not develop the required scope capacity.

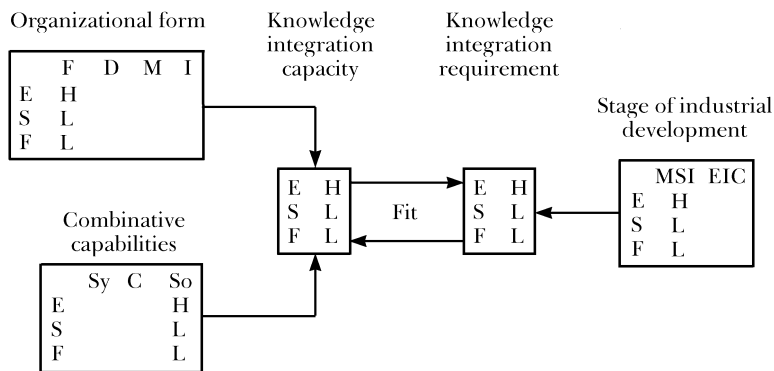
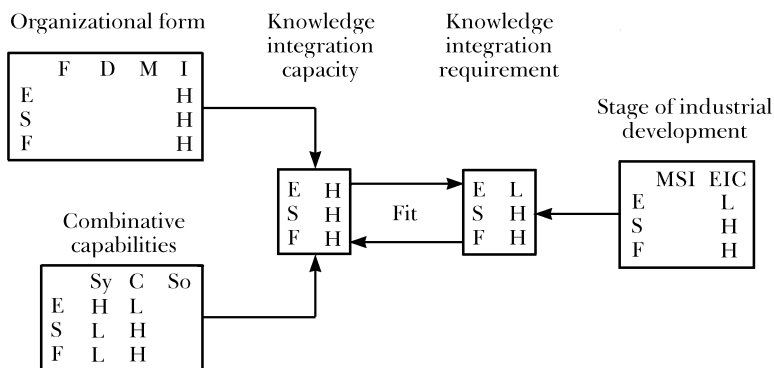
Regarding the combinative capabilities the following occurred. In stage 1, SHDTW clearly showed a strong reliance on socialization capabilities. The use of these strong routines aimed at traditional folio publishing is in accordance with proposition 1. Although in stage 2 SHDTW deployed co-ordination capabilities, such as project teams, to increase its scope and flexibility capacity, it proved to be problematic to overcome its old socialization capabilities. Hence, while the use of co-ordination capabilities is in line with proposition 2, the perseverance of the old socialization capabilities inhibited the development of the required knowledge integration capacity. SHDTW's overall deployment of combinative capabilities is summarised in table V.

DISCUSSION

The changes that HFD and SHDTW experienced in their organizational form and combinative capabilities can now be discussed in terms of the conceptual framework. Figure 2 shows the way in which HFD's knowledge integration capacity as well as the knowledge integration requirement of its environment have changed over time. Figure 3 shows the situation for SHDTW.

The first stages in figures 2 and 3 indicate that, prior to the emerging multimedia complex, especially HFD showed a strong fit with its environment. The second stage in figure 2 shows that the emergence of the multimedia complex, and the change in the knowledge integration requirement this has created, has largely been matched by HFD's internal changes. The company has learned how to deal with its changing environment by choosing an appropriate organizational reconfiguration. On the other hand, the second stage in figure 3 shows that SHDTW has not (yet) learned how to deal with its changing environment.

Altogether, the investigation of the two publishing firms showed a moderate to strong plausibility of our assumptions and propositions. The empirical analysis,

Stage 1: 1982–1996**Stage 2: 1996–1997****Notes:**

E = efficiency; S = scope; F = flexibility; H = high; L = low

Organizational form: F = functional form; D = division form; M = matrix form; I = innovative form

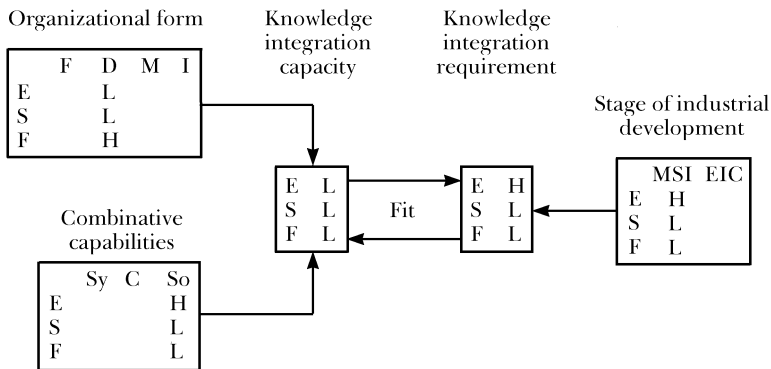
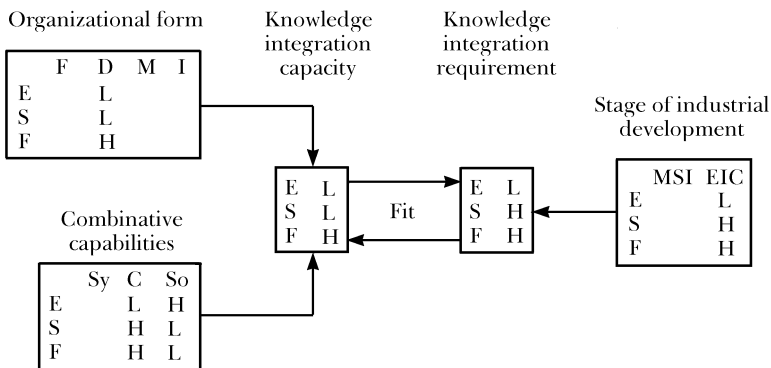
Combinative capabilities: Sy = systems capabilities; C = co-ordination capabilities; So = socialization capabilities

Stage of industrial development: MSI = mature single industry; EIC = emerging industrial complex

Figure 2. The conceptual framework applied to HFD

however, revealed additional information that was not covered by our conceptual framework. An interesting point not suggested by our framework is that HFD's use of systems capabilities in stage 2 did not seem to frustrate the knowledge integration process. On the contrary, in our analysis of HFD the use of systems capabilities indirectly enabled the required integration of HFD's product, production process, and market knowledge. The benefit of the use of clear and strict directions for knowledge integration, as revealed in the investigation of HFD, is that it can facilitate the process of breaking down the old socialization capabilities.

Having a relatively long and stable history in folio publishing, new media did not fit comfortably or closely into the established frameworks and concepts of the two publishing firms. Instead, HFD and SHDTW were entering uncharted terri-

Stage 1: 1985–1995**Stage 2: 1995–1997****Notes:**

E = efficiency; S = scope; F = flexibility; H = high; L = low

Organizational form: F = functional form; D = division form; M = matrix form; I = innovative form

Combinative capabilities: Sy = systems capabilities; C = co-ordination capabilities; So = socialization capabilities

Stage of industrial development: MSI = mature single industry; EIC = emerging industrial complex

Figure 3. The conceptual framework applied to SHDTW

tories. Fortunately, the stickiness of HFD's old socialization capabilities to a large extent was matched by their customers. Most markets were still far from ready to be penetrated with new media PMCs. None the less, especially SHDTW encountered difficulty to overcome its old socialization capabilities, which frustrated the attempts to generate its knowledge integration capacity.

The stickiness of these old socialization capabilities is related to the fact that publishing has always been a relatively profitable industry, especially regarding scientific and professional information. This has created a very strong and successful culture to please stockholders with ever increasing profits. At the moment, however, this culture for many firms clearly inhibits the making of the heavy and uncertain investments that are required to become a publisher on

demand. In fact, a firm which is not faced with the pressure of the stock exchange, such as HFD, seems to be in the lucky position to have less difficulty with this.

On the whole, our empirical analysis provided the opportunities to amend our initial propositions. Extended research in the emerging multimedia complex is needed to investigate the plausibility of, among other things, the following new proposition:

Proposition 3: Firms moving from a mature single industry to an emerging industrial complex generally need to overcome their previous socialization capabilities in order to not frustrate the generation of their integration capacity. Due to the stickiness of socialization capabilities, this is likely to be a tough and lengthy process.

CONCLUSION

Today, the emergence of industrial complexes is an important phenomenon that requires new understanding at various levels of analysis. This paper has addressed the implications this industry change has for the management of organizational knowledge integration at the level of the individual firm. A conceptual framework of organizational knowledge integration was presented and a number of tentative propositions were formulated accordingly. Although the propositions were not tested in any great detail, the investigation of two Dutch publishing firms moving into the emerging multimedia complex illustrated that the conceptual framework appears to have potential for explaining how different types of organizational forms can be matched with different types of combinative capabilities in order to create the knowledge integration capacity that is required by the industrial context. None the less, it is clear that the framework is not conclusive and needs to be further refined, both theoretically and empirically.

First of all, additional as well as more specific propositions have to be developed. Secondly, the propositions have to be investigated using other types of firms in other kinds of emerging industrial complexes. The complex emerging around biotechnology is a worthy suggestion in this respect. A third opportunity for further research is to extend the conceptual framework. This paper has only concentrated on the process of creating new architectural knowledge. The equally important process of using the architectural knowledge as a platform for the generation of new PMCs has been largely neglected, but deserves attention as well.

Hence, the initial step has been made, but much work still needs to be done so that enriched understanding of the management of organizational knowledge integration in an emerging industrial complex ultimately will be useful to various types of firms operating in such a context.

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