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Scope:

The report is the result of a qualitative study of the innovative capability in Norwegian small- and medium-sized oil-contractors during the period 1993-1996. The study has focused on the implementation of technological strategies addressing the reorganisation process initiated by NORSOK.

Key-words: Technological development, Strategy, NORSOK

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Contents

Summary

The Norwegian oil-related suppliers experience deep structural changes changing the roles of oil companies, main suppliers and under suppliers.

Through a prospective of resource-based theory, the project "In the Norsok-land: innovation capability and competitiveness in small- and medium-sized companies" has tested, how the oil-related suppliers have developed and maintained their competitiveness in the market, during the period 1993-1996[1].

The project consisted of two complementary studies. The quantitative survey-study has focused on the different development strategies pursued by the suppliers. The qualitative study, to which this abstract refers, has focused mainly on the dynamic aspects of strategic adjustments.

In order to go beyond the limits present in the analytical capacity of resource-based theory, we proposed an integration with evolutionary theory. We have attempted to build a model of analysis able to connect the technology strategies of Norwegian oil-related companies to the specific firm resources, to the level of uncertainty characterising the external environments and the innovative search. Given the opportunity conditions within the Norwegian petro environment, we have assumed that the appropriability conditions, the degree of cumulativeness, of tacitness and of complexity present in the innovation are determined by the firm's organisational resources.

We conducted in depth interviews with top managers in 21 companies and organisations. We collected data on the specific resources of the firms, on the environmental conditions of the firms, on firms' technological strategies and on firms' innovative achievements. The qualitative study shows that:

1. Each area of activity inside the Norwegian oil industry is characterised by its own technological environment.
2. Each technological environment has generated different opportunities for the implementation of technological strategies addressing process and product development.
3. New contract designers have created different opportunities and threats for the main suppliers and the under suppliers

The new role of the oil companies in the Norwegian oil industry has influenced their attitude in financing technological development projects. They show a less interest in supporting projects aiming to the improvement of the general technological level within the sector. Instead, they focus on operative and tactical factors, rather than strategic when financing development projects.

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1 This report covers the period of 1993-1996. Therefore it doesn't examine time and cost overruns recorded in the deliveries of production ships and floating installations during the period of 1997 and 1998.

Preface

This report is part of the project "Effects of NORSOK on small and medium sized enterprises". The project is financed by the Research Council of Norway (the Petropol committee). It is part of a project package at RF - Rogaland Research (RF) and the Center for Technology and Human Values at the University of Oslo, aiming to analyse the transitions in the Norwegian petroleum industry since 1994.

The work has been conducted by a research group at RF. The following persons have participated: Senior researcher Odd Einar Olsen (project leader), researcher Jon M. Steinecke, researcher Emma Olivieri Askevold and researcher Ole Andreas Engen (project quality assurance).

Data was collected in 1997, by the use of key informant interviews and a questionnaire to small and medium sized suppliers to the Norwegian oil industry (400 respondents). We would like to thank all informants, who willingly have shared their experience and views, and also thank all the companies taking the trouble to answer our questionnaire.

A group consisting of practicians from the petroleum related industry has followed the work, and provided useful and important comments and information. The following persons have participated: Rune Espedal (OLF), Bernt Haave (Baroid AS), Elling Håmsø (Norsk Oljerevy), Ståle Kyllingstad (IKM), Øystein Kristiansen (Oljedirektoratet) og Øystein Søyland (Sørco AS).

The research group, however, is fully responsible for the report, including its shortcomings or errors.

Stavanger, May 1998

1 Background and research questions

In the last decade, extensive changes related to price, profitability, risk sharing structures and resource structure have characterised the Norwegian oil industry. As a result, the Norwegian Ministry of Industry and Energy initiated a "Building and Management Forum" for the petroleum sector in 1993. The Forum's report on the competitive position of the Norwegian oil industry ("Norsk Sokkel konkurranse-posisjon"), prepared the ground for seven task forces. Their work resulted in proposals on such diverse fields as[2]:

1. Cultural changes in leadership and work organisation.
2. Co-operation to increase the value added through: a) introduction of common standards in substitution of company specifications b) new forms of co-operation between operators and suppliers c) reduction of the administrative documentation.
3. Improving the general conditions for oil activities.

The proposed efforts had the aim to achieve two primary goals:

1. Reduction of cost and delivery time of 40-50% in relation to the 1993 level.
2. Maintain the high level of work security in the Norwegian oil activities.

Since the goals are related to vital strategic areas, they have the potential to change the industrial organisation of the Norwegian oil industry. The main objective of this report is to explore how particular firms in the Norwegian oil industry relate themselves to the opportunities and the threats that the changes have created. The focus will be on how the innovation ability of the single firm is influenced by the changes in labour division and in the industrial organisation. Assuming that the innovative process is driven by competitive processes (Dosi, 1986), we shall discuss how the Norsok process has influenced the firm's innovative ability and thereby its competitiveness. Furthermore the object is to analyse how these structural changes have altered and impelled the process of technological innovation in the firm. More precisely we intend to explain:

1. How the absence of direct contact between small and medium firms and their final clients has influenced the strategic importance of the sources of innovative ability.
2. To what extent the innovative ability is a source of a firm's competitive advantage in the Norwegian petroleum cluster.
3. How the interaction between the previous phenomena has influenced the process of technological innovation.

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2 Norsok Hovedrapport, 1995.

2 Theoretical perspectives

Through this discussion we aim to demonstrate that the fundaments of the resource-based theory are compatible with the recent ontogenic orientation in evolutionary studies. We will argue that these two schools in business and organisational theories have compatible explanatory variables towards questions about strategic adjustment, innovative capabilities and technological development. However, we will emphasise those characteristics in evolutionary theory which need particular assumptions in order to make them compatible with resource-based theory.

Internal focus

Both approaches focus on the internal characteristics of the firms as an explanatory variable of the differences in firms' strategies and performances. The resource based theories assume that the performance of the firm is affected by the resources controlled and employed by the firm. The evolutionary theory assumes that the firm's behaviour is depending upon the firm's specific competence, embodied in its routines, and evolving over time, partly as the outcome of their internal learning and partly as a response to environmental changes.

External environment

The external environment of the firm has different functions in the two theoretical models. The resource-based theory considers the external environments in order to identify the opportunities and the threats that the firm's resources exploit or neutralise. Changes in the external environment influence the potential of resources to generate rents[3]. When this happens it becomes necessary to create new resources and to upgrade those already controlled by the firm (Schulze, 1992). Otherwise the evolutionary theory suggests that firms are embedded in the institutional context they live in (Dosi and Malerba, 1996). The political, financial, scientific and technological contexts define the opportunity-set of the firm in choosing among different strategic alternatives. In order to maintain the consistence with resource based theory we will assume that the management chooses among different strategic alternatives on the basis of the specific assets accumulated in the firm. The pre-existing system of resources in the firm constitutes the premises and the basis for resource-generating, competence-building, organisational evolution and technological innovation.

Technology

While resource-based studies have paid little attention to aspects of the technological innovation, the evolutionary approach has produced detailed accounts on this issue. These studies have often focused on the industry level. Even though concepts as technological paradigms, trajectories and regimes are mainly referred on the industry level, their implications on the firm level has been an increasingly subject of study (Foss, Knudsen & Montgomery, 1995).

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3 This important issue will be further discussed in the next paragraph.

"A technological paradigm defines contextually the needs that are meant to be fulfilled , the scientific principles utilised for the task , the material technology to be used." (Dosi 1988). The solution of the technological problems (the needs that are meant to be met) involves the use of formal knowledge and of uncodified capabilities-"tacit knowledge". In order to maintain the consistence with resource based theory we will assume that the firm's technological performance derives from the firm's tacit knowledge, the uncodified and cumulative capabilities that the firm has build over time.

2.1 The resource based view

In all resource based studies the term resource is broadly defined as the set of assets and skills which are employed to create and support a competitive advantage (Schulze, 1992). According to Barney (1991) the firm's resources, assumed as idiosyncratic, immobile and heterogeneous are: *"all assets, capabilities, firms attributes, information, organisational process, knowledge controlled by a firm that enable the firm to conceive and implement strategies that improve its efficiency and effectiveness (...) and to exploit opportunities or to neutralise threats in a firm's environment".*

"A sustained competitive advantage refers to the implementation of a value creating strategy that is not susceptible of implementation by any current or potential competitors and not susceptible of duplication of its benefits by those competitors" (Barney, 1991). In order to be the source of sustained competitive advantage firm's resources have to consist of four attributes: value, rarity, inimitability, no-substitutability. Barney's model, defined by Schulze (1992) as "resource based strong model", assumes that markets are efficient and that the resources, above mentioned, are scarce relatively to their demand.

The capacity of these resources to generate rents remains constant under equilibrium conditions, thus possession of them is a vital strategic issue (Connor, 1991). Firms that for luck or brilliance manage to acquire resources before their competitors, earns Ricardian rents. Hence luck and brilliance rather than inputs specificity are resource of rents (Barney, 1986). The assumption of equilibrium condition facilitates an analysis that is more concerned with the sustainability of rents than with the creation of rents thus neglecting strategies which address the creation or replacement of rent-generating resources (Schulze, 1992)[4].

Other resource-based approaches defined, by Schulze as "resource-based weak models", indicate "resource complementarity" and "resource specificity" as factors that produce resource heterogeneity among the firms. An asset is complementary if it creates an higher economic value when employed in association with others (Teece, 1986). As Teece argues, marketing or "after sales service" are complementary assets to technological innovation because they are necessary to the firm in order to acquire the rents from innovation.

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4 The consequence of the assumption of equilibrium condition on the analysis of the innovative process will be discussed in the paragraph : "The basis for integration".

An asset is specific to a firm if it increases its value more than its price when associated to other assets of the firm. *"If the value of the asset A increases in the presence of the asset B, but the value of C is independent of either A or B, then A grows in value when it is teamed with B, but C does not. This growth in value is inextricably linked to rent earning; that is, to creation within the firm, through its resource-combining function, of true productive value that would not exist were A kept separate from B. (...) The greater the degree of the asset's specificity to a firm, the greater is the asset's rent potential to that firm"* (Connor, 1991).

Firm-specific resources have the potential to produce quasi-rents if they can be productively employed within the firm instead of being sold or leased (Dierickx and Cool, 1989). In the "weak version of the resource-based model" rents originate in the organisational capabilities of the firm and not in factor market failure. Invisible assets are considered to be more firm-specific than purchasable inputs and have the potential to be more significant generators of rents. Consequently, learning by doing, organisational culture, tacit knowledge, core competence, the collective learning in the organisation, in short the mechanisms by which firms generate knowledge, learn and accumulate multiple streams of technology, have been the subject of particular attention in many studies of assets specificity (Prahalad & Hamel,1990; Teece /Pisano & Shuen, 1990).

Different from the strong model, the weak model emphasises dynamic aspects and facilitates an analysis that is more concerned with the creation of rents and with strategies addressing the creation or replacement of rent-generating resources. Hence the weak model regards strategic management practices as important sources of sustainable competitive advantage (Dierickx and Cool, 1989).

Table 2.1 identifies the attributes of the two resource-based models.

	WEAK-FORM	**STRONG-FORM**
Efficiency of System	Weak	Strong
Analytical Condition	Dynamic	Equilibrium
Type of rents	Efficiency	Ricardian & Monopoly
Persistence of Rents	Temporary	Sustainable
Managerial Role	Creation & Protect	Discover & Exploit
Isolating Mechanisms	Human Resource Practices, Asset Specialisation, Learning, Culture, Team-Embodied skills and routines, Alliances for Learning.	Rare & Non-substitutable input factors, Tacit Knowledge, Size, Economies of scale/scope, Market power, Secrets, Patents.

Source: Freely inspired by W. Schulze (1992)

Table 2.1: Attributes of the two Resource-Based Models.

In an attempt to synthesise the two different approaches of resource-based theory, Miller and Shamsie (1996) have defined and tested the concept of resources through their performance implication in different competitive environments. "In the interest of testing and advancing the application of the resource-based view, (their study) develops the distinction between property-based and knowledge-based resources" (Miller and Shamsie, 1996). While the former are "appropriable" resources controlled by property rights, the latter are resources whose appropriability is protected by knowledge barriers.

"The benefits of property based resources are quite specific and fixed and thus, the resources are appropriate mostly for the environment for which they were developed" (Miller and Shamsie, 1996). Because of this specificity, property based resources are of most value in stable or predictable settings where the objects controlled by property rights, maintain their economical relevance.

On the other hand, *"knowledge-based resources allow the organisation to succeed not by market control or by precluding competition, but by giving firms the skills to adapt their products to market needs and to deal with competitive challenges"*. They typically are appropriate mostly for changing and uncertain environments (Miller and Shamsie, 1996).

Furthermore each of the two categories of resources are distinguished in two varieties: discrete and systemic resources (Miller and Shamsie, 1996). Discrete resources are independent of one another and have intrinsic value more or less independent of the organisational context they are put in. Systemic resources, on the other hand, have value essentially because their components are part of a network or system (Amit and Schomaker, 1993). The value of systemic resources relies in the synergy created by the role they play in to an integrated system (Barney, 1991; Black and Boal, 1994).

2.2 The evolutionary theory of the firm

When analysing strategic behaviour of the firm, some evolutionary theories apply biological metaphors as variation, heredity and selection. They attempt to analyse social and economic phenomena in terms of processes of change. The process of technological change, the most obvious analogy to the biological concept of mutation, has been analysed in terms of technological paradigms, trajectories and regimes. Emphasising the biological analogy, some evolutionary studies were predominantly phylogenetic, i.e. oriented to analyse the industrial evolution (Hannan and Freemann, 1977). However, firm behaviour has been taken into consideration, since it is on this level that analogies of heredity should be found. Concepts as technological paradigms, trajectories[5] and regimes refer mainly to a sector level, but applications at the firm level has been subject of many studies (Burgelman and Rosembloom, 1989); (Malerba & Orsenigo, 1996); (Dosi, Winter and Teece, 1992).

As mentioned above, the evolutionary theories consider the institutional context as determining the opportunity-set exploitable by the firm through different strategic alternatives. (Dosi and Malerba, 1996).

The firm is conceptualised as a knowledge-bearing entity. Firms possess path-dependent knowledge bases and are characterised by competence, routines and learning processes. Routines are a set of organisation rules allowing the communication and the implementation of individual knowledge within the firm (Malerba & Orsenigo, 1996). Competence stored and organised in routines, are the set of specific capability and complementary assets of a firm. Three dimensions of competence may be identified: tacitness, specificity and complexity (Dosi & Malerba, 1996).

The learning processes are the basis of competence accumulation in a firm (Malerba, 1992). "Learning is local, being highly affected by the cognitive frames and actual competence of firms, and is cumulative in that it builds on what has been already learned." (Dosi & Malerba, 1996).

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5 The concepts of technological trajectory and technological paradigm were developed for instance by Nelson and Winter (1977) and Dosi (1982) respectively. They are not entirely free from deterministic overtones. Both models, however, share a common heritage, which can be loosely called evolutionary thinking (Van den Belt & Rip, 1993).

2.3 The basis for the theoretical integration

The evolutionary and resource-based approaches both recognise the basic idea of fundamental diversity among firms. The notions of resources, routines and competence all have a fundamentally epistemic content: on the one hand the notion of resource incorporates knowledge-related resources, on the other the notions of routine and competence is based on path-dependent knowledge possessed by the firm. The evolutionary theory traditionally didn't consider physical assets and patents as resources, but have never given a priori reason to exclude them (Foss, Knudsen and Montgomery, 1995).

The resource-based perspectives have not yet attempted to study the characteristics of firm's organisation with specific reference to its innovative ability. As far as we are aware, it has only provided studies on the casual relation between firms resources and firms competitiveness. The lack of attention on the firm organisation as source of rents, and the assumption of equilibrium conditions, make it difficult to interpret the innovative process of a firm using the resource based strong model.

Regarding the innovative process, the resource based weak version is the more appropriate to analyse it. The emphasises of this version on the dynamic aspects of the resources makes it appropriate to investigate how the firm organisation creates rents through the innovative process.

The innovative process always involves a fundamental element of uncertainty (Dosi, 1988). Causes of uncertainty for a firm can be considered:

1. The imperfect information on the opportunity-set generated by the technological context of the firm is set in.
2. The imperfect information on the different strategic alternatives that are available to the firm for the exploitation of the opportunity-set .

The study of Miller and Shamsie (1996) has been a seminal attempt to test the performance of the firm's resources in certain and uncertain conditions in a systematic way. Their notion of uncertainty is limited only to the imperfect information about the consequences of known alternative decisions. The study doesn't assess the alternatives, but rather the effects of each alternative. Because of that, the notion of uncertainty utilised in the study of Miller and Shamsie needs to be completed when related to the innovative process always characterised by uncertainty and sometimes by strong uncertainty. The evolutionary theory provides a wider concept of uncertainty that involves *"not only lack of knowledge of the precise cost and out-comes of different alternatives, but also the lack of knowledge of what the alternatives are"* (Dosi, 1988). The managerial and organisational processes which yield the competitive advantage of a particular firm, may often face the choice between adaptation (high uncertainty) and learning (uncertainty), between exploration and exploitation.

"Adaptation" refers to the exploration of high uncertain opportunities in order to fit new environmental conditions. It may imply a change of routines, strategies and a reconfiguration of the firm's specific assets (Dosi & Malerba, 1996; Teece, Pisano & Shuen, 1997). Learning refers to the exploitation of existing knowledge by improving

and modifying what is already known. While adaptation is characterised by high uncertainty, learning is characterised by lower uncertainty.

The following figure schematises the common elements between the resource based models and the evolutionary model. It also shows in which case it is possible to use the resource based weak version to analyse the connection between firm's resources and innovative process.

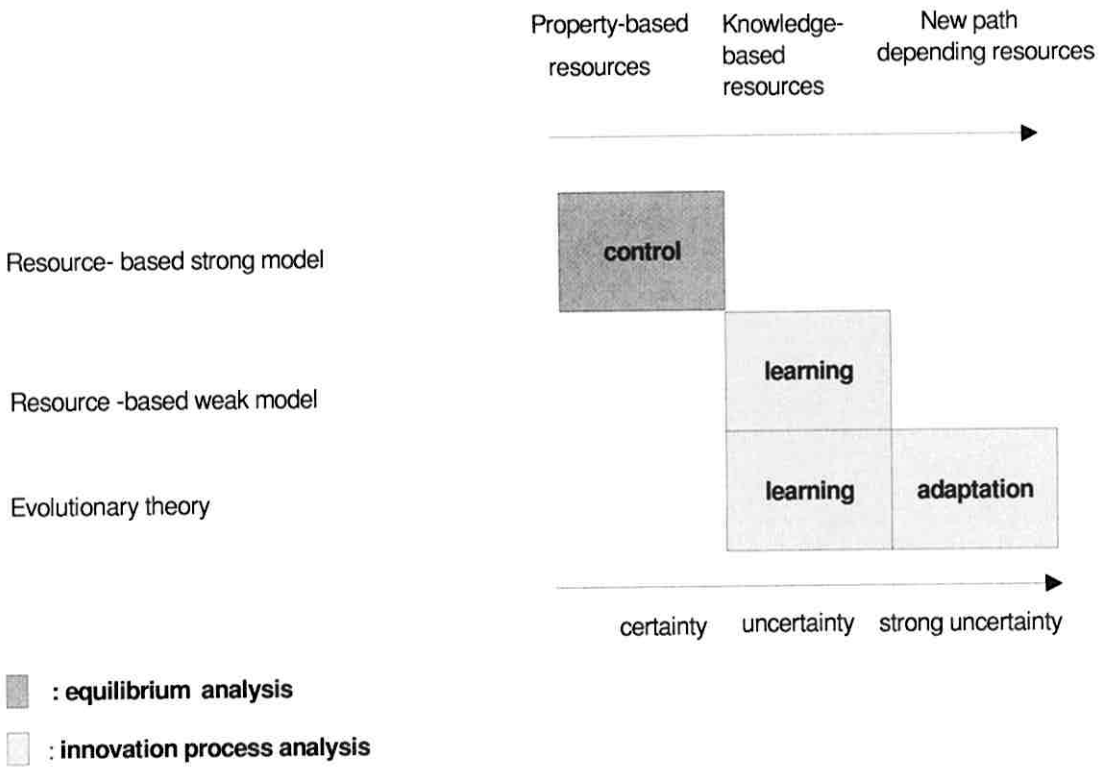

Figure 2.1: Firm's resources and innovation process in the resource based models and in the evolutionary models.

As mentioned above, the assumptions of equilibrium conditions and of resources scarcity, make the resource-based strong model proper to analyse the sustainability of rents in stable and predictable settings. *"In such environment it is simpler to estimate the life expectancy and thus the value of most properties, claims and contracts"*. (Miller and Shamsie, 1996). Predictability ensures that the capacity of property-based resources to generate rents remains constant until the equilibrium conditions will continue.

The resource-based weak model through the analysis of dynamic aspects, provides a theoretical framework suitable to emphasise the key role of the strategic management in responding to uncertain environment by improving and modifying the existing resources (learning and exploitative process). In a dynamic environment the property-based resources are threatened with obsolescence. Knowledge-based resources are on the contrary more flexible to be upgraded and renewed (Miller and Shamsie, 1996).

The evolutionary theory otherwise distinguishes between uncertain innovative search (learning) and high uncertain innovative search (adaptation/exploration):

- Learning and exploitation. The responses to the environmental changes are often made through continuous strategic choices, through continuos exploitation of the knowledge developed over time. These choices are influenced by past choices, bound to them by links of continuity. Firms thus follow a certain trajectory or path of competence development that *"not only defines what choices are open to the firm today, but also puts bounds around what its internal repertoire is likely to be in the future."*(Teece, Pisano & Shuen, 1997).
- Adaptation/exploration. Continuity is an attribute that often, but not always, characterises strategic choices. Adaptation refers, in fact, to the exploration of high uncertain opportunities in order to fit new environmental conditions. Strong uncertainty involves *"not only lack of knowledge of the precise cost and out-comes of different alternatives, but also the lack of knowledge of what the alternative are"*. (Dosi, 1988). The phase of technological change characterised by strong uncertainty, is defined as preparadigmatic by Dosi (1988). In such a phase the firm create the building block of a new trajectory of development going over the bounds set by the previous path of development and thus interrupting the continuity with it.

2.3.1 The innovative search: a trade-off exploration-exploitation

The innovative search is a dynamic process. The term dynamic refers to the upgrading or modification of the specific assets of a firm, so as to achieve congruence with the changing business environment. Through the innovative process the strategic management adapts, integrates and reconfigures internal and external organisational skills, functional competencies to match the requirements of a changing environment (Teece, Pisano & Shuen, 1997).

We intend to construct a model of analysis able to relate a firm's technology strategies to firm specific resources and to the level of uncertainty characterising the innovative search. With regard to that, it seems important to provide some definitions related to the firm's specific resources, the uncertainty characterising the innovative search and the technology strategies.

- Any set of specific resources is characterised by two different elements: cumulativeness and appropriability.

1. Cumulativeness. That means that specific organisational resources and previous innovative activities form the base and the building block of today's innovative activities. The higher the degree of cumulativeness is, the tighter the innovation is linked to the pre-existing resource system, enhancing the range and comprehensiveness of that system. In this case we can define the innovation as systemic. A low cumulative degree is associated to discrete innovations that arise independently from previous innovative activities of the firm. As such they do not improve the comprehensiveness of the pre- existing resource system of the firm.

2. Appropriability, i.e the degree to protect innovations through contractual regulations (such as patents, secrecy, legal control of complementary technology) and through specific competence, knowledge and capabilities (deriving e.g. from learning curves, lead time advantages etc.). Moreover knowledge based resources are more relatively effective ways of protecting process innovation while property based resources are relatively better protection for product innovation. (Dosi, 1988).

- As noted, the uncertainty in the innovative search can present different levels :

1. Strong uncertainty will involve *"not only lack of knowledge of the precise cost and out-comes of different alternatives but also the lack of knowledge of what the alternatives are"* (Dosi, 1988). The decision to pursue highly uncertain innovative activities is understandable through the high opportunities provided to reach a high pay off in case of innovative success. High level of uncertainty are always characterised by high level of opportunity.
2. "Normal" uncertainty that typically characterises innovation activities (Dosi, 1988) and is connected with lower level of opportunities.

- For technological strategy we define:

1. Adaptation that refers to the exploration of new opportunities with high uncertainty in order to fit new environmental conditions.
2. Learning refers to the exploitation of existing knowledge by improving and modifying the existing technology of the firm.

We shall present two matrixes of basic technology strategies trying to define the possible alternative strategies that are available to a firm using the dimensions of the level of uncertainty present in the innovative search, of the appropriability level and the level of cumulativeness of the innovation.

High uncertainty

	High cumulativeness	Low cumulativeness
High Appropriability	I Exploration Exploitation	III Exploration
Low Appropriability	II Exploration Exploitation + increasing appropriability	IV Exploration + increasing appropriability

Low uncertainty

	High cumulativeness	Low cumulativeness
High Appropriability	V Exploitation	VII No innovative activity
Low Appropriability	VI Exploitation + increasing appropriability	VIII No innovative activity

Source: freely inspired by F. Malerba and L. Orsenigo (1996).

Fig. 2.2: Firm's basic technology strategies.

The high risk **explorative search** is pursued only when the firm is exposed to high uncertainty by a changing technological environment. In such a case the firm can try to fit the new environmental condition through the exploration of the opportunities present in a high risk search. The high uncertainty generated by the changing environment is a necessary, but not a sufficient condition to undertake an explorative search. The firm in fact should be able to acquire the rents that the innovation will produce (Quadrant: I, II, III, IV). The appropriation of the rents is possible either because the innovation is not imitable[6] (Quadrant: I, II) or because the innovation is imitable[7] but the firm will follow strategies aiming at strengthening appropriability and obtaining complementary assets (Quadrant: III, IV).

The exploration of new technologies can be followed by the successive exploitation of these technologies only when they present a high grade of cumulativeness with the organisational context they are generated by. A high grade of cumulativeness is associated with systemic innovations that enhance the range and comprehensiveness of the specific organisational resources of the firm. That link makes it possible for the firm to continue along the trajectory traced during its explorative activity and to exploit all the opportunities offered by the innovation (Quadrant I, III).

As mentioned a low grade of cumulativeness is associated with discrete innovations arising independently from previous innovative activities of the firm. Discrete innovations do not improve the comprehensiveness of the pre-existing resource system of the firm. The lack of links between the specific organisational resources and the discrete innovation does not make it possible for the firm to continue along the trajectory traced during its explorative activity and to exploit all the opportunities offered by the innovation (Quadrant II, IV).

The **exploitative search** is followed when the changes in the technological environment expose the firm to a lower situation of uncertainty. In such a case the firm can achieve congruence with the changing environment by improving and modifying the existing technology already present in the firm (Quadrant V, VI). The risk, although lower than the one characterising explorative searches, is accepted only if the firm can appropriate the rents that the innovation will produce. The appropriation of the rents generated by the innovation is possible either because the innovation is not imitable (Quadrant: V) or because the innovation is imitable but the firm will follow strategies aiming at strengthening appropriability and obtaining complementary assets (Quadrant: VI).

The considerations of low cumulativeness and lower level of risk characterising section VII and VIII, prevent the firm to undertake innovative activities at all.

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6 A non imitable innovation is characterised by a high level of appropriability and is protected by legal or knowledge barriers.

7 An imitable innovation cannot be protected by legal or knowledge barriers. Consequentely the innovation is characterised by a low level of appropriability of the rents that are generated.

3 Methodological approach

Based on the previous theoretical perspective, the study will be guided by the following model:

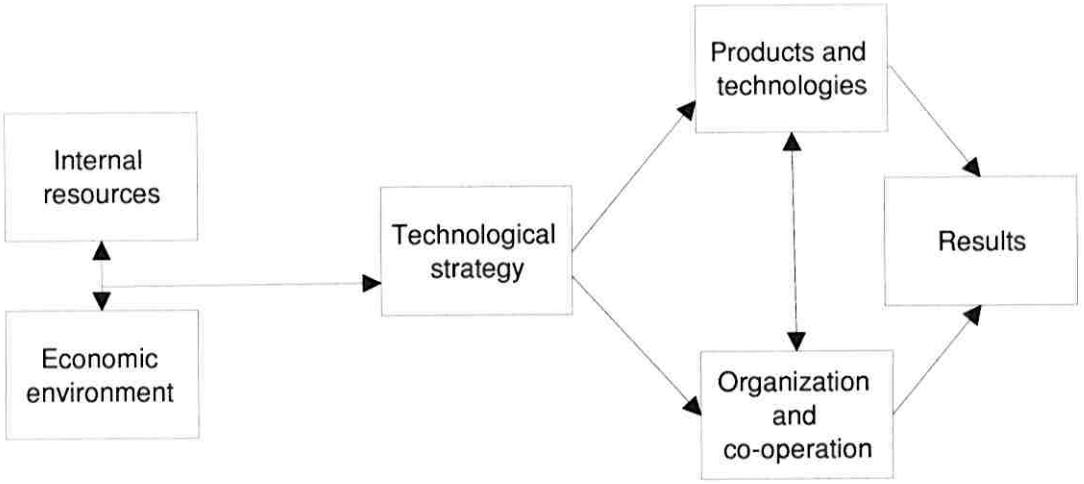

Figure 3.1: Analytical model.

We assume that the economic environment and the internal resources, considered as an independent variable, are determinant for the technologic strategies available for the management. Consequently, the project has focused on:

- Changes in industrial organisation of the Norwegian oil industry generated by the Norsok process.
- The internal resources of oil related contractors we interviewed.
- The technological strategies that, by addressing the creation, replacement or improvement of rent-generating resources, identify how the firm responds to the changes in the competitive arena.

As illustrated by the figure, we are particularly interested in the innovative process which concerns:

1. The forms of organisation and co-operation of the firm.
2. The improvement and the development of new products and technologies.

More precisely, we have first analysed the threats and opportunities created by the reorganisation of the branch. Those threats and opportunities have not been equally considered in relation to the areas of activity or the established suppliers hierarchy. The cause of that is due to the information received during carrying out the project. Two key threw light on the fact that Norsok's influence on the changes in work organisation and in co-operation's forms varies significantly on the diverse areas of activities. Consequently, it seemed meaningful to segment the Norwegian oil industry in order to analyse the changes. Based on the classification presented at "Feltutbyggings-konferansen '95[8], we identified five areas of activities:

1. Construction activities. (3)
2. Sub-sea installations. (3)
3. Operation and maintenance of vessels. (4)
4. Drilling activities.(3)
5. Wells; installation and operation. (4)

The 21 companies and organisations we had in-depth interviews with, operate only in three of these areas[9]. Due to that, we focused only on construction, sub-sea and drilling activities.

Furthermore, the analysis was divided between main contractors and subcontractors in order to separate the threats and opportunities generated by the different typology of contact (direct and strong for main contractors/indirect and weak for sub-contractors) with the final clients (oil companies). The quantitative study, complementary to this one, focuses only on the sub-contractors. The necessity to include primary suppliers was identified as of relevance in the course of the qualitative study.

The interviews with companies operating in construction enlightened the differences between subcontractors and co-contractors. Co-contractors can be defined as actual subcontractors that previously supplied oil companies directly. This supplier consolidation process is particular to that area.

After the analysis of threats and opportunities created by the reorganisation of the industry segment, we have focused on how the firms carry out their strategic adaptation over time, i.e. the strategic process has been in focus. We analysed three technological development projects aimed at improving cost effective drilling, reservoir exploitation and the interpretation of seismic data. We followed the complete innovation process from the research stadium to the market introduction of the finished product.

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8 In parenthesis the number of main suppliers of each area of activity. (Source: Geir Worum: "The industrial policy consequences of the new models of working out". Paper presented at Feltutbyggings-konferansen '95).

9 Three among the 21 companies and organisations, were main suppliers.

4 Innovative searches in three segments of the oil industry

4.1 Construction activities: presentation across the supply hierarchy

4.1.1 Primary suppliers

4.1.1.1 Pre-Norsok

In the Norwegian oil activities, the oil companies traditionally managed the pre-suppositions of the construction projects for platforms and installations supplied by large engineering companies[10]. They had total control and co-ordination of the activities of their suppliers through an extensive use of bureaucratic procedures and through extremely detailed technical specifications. The primary suppliers, involved for single commissions in the projects, had an organisation which reflected the necessities deriving from working on different and independent tasks: the companies were divided in independent divisions such as engineering, construction, installation and maintenance divisions[11].

In the long run, such a bureaucratic organisation created an overlap between the competence of the oil companies and primary suppliers, increased the time and price of the delivery and prevented a full exploitation of the abilities and experiences of the suppliers. Thus reduction in the oil price and limited new discoveries pressed the Norwegian oil industry in a direction of new relations between operators and suppliers and of new and more cost-efficient re-organisation of projects and work[12].

4.1.1.2 Norsok effects

Primary suppliers have played an active role in the Norsok process through their representatives in the Federation of Norwegian Engineering Industries (TBL). Due to this, we would expect them to have complete control over the effects that reductions in costs and delivery time should have caused. This has not been the case. Norsok goals were developed under the "ancient regime" when the oil companies still maintained full responsibility for carrying out the projects and when the internal organisation of the suppliers was structured in separate economic units. There was neither previous experience nor a proper company organisation and culture that could help to forecast the combined effect of cost - time reduction and of augmented responsibility in developing

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10 Norsok delrapport nr. 3, 1995.

11 Interviews 15.08.97, 22.08.97.

12 Norsok delrapport nr. 3, 1995.

new projects[13]. The external environment was experienced as unstable because its changes exposed the main contractors to high uncertainty. Firms resources were no longer suitable to predict and control market changes. From the interviews three kinds of pressures challenging the main-contractors appear to emerge:

- Technological pressure: The combination of the new fields' small extensions and extreme weather conditions makes it necessary to find alternative solutions with regard to new installations. In order to ensure the profitability of the small fields, the construction costs have to be kept down. This is an obstacle for projecting permanent platforms which give a push in direction of the cheaper floating installations. On the other hand these present technical difficulties if installed in extreme weather condition areas.
- Time pressure: The new platforms have to be projected, built, installed and ready for production in a period often not longer than 30 months.
- Responsibility pressure: with the new EPC/EPCI contracts, the contractor became responsible for engineering, procurement, construction and eventually installation.

The main suppliers that no longer had a competitive position in the market, experienced unsuccessful tenders for total concept projects. Thus, they were challenged to an innovative search addressing the creation, replacement and improvement of rent-generating resources in order to maintain the position of main contractors. The degree of uncertainty present in the innovative search was high. According to our interviews the principal suppliers, grown up in the "ancient regime", were caught unawares at what alternative innovation strategies were available to them or whether these strategies were at all feasible[14].

Contracts outside the Norwegian continental shelf and EPC contracts for delivery of systems were identified as adapting instruments for the principal contractors. The new experiences were instrumental in constituting the pivots upon which the principal contractors could base further organisational changes. Five main building blocks of the adapting process can be identified:

- Focusing on core competence and scaling down activities the firm has no competitive advantage on[15].
- Adaptation of the company's internal structure to the new structure of the contracts. Since EPC contracts cover all the deliveries connected with a project, the contractors have to gather and use all the internal resources in order to meet the demands of the contract. "Acting as a unit" has become a great challenge for them.
- Sharpening market surveillance and procurement abilities.

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13 Interview 15.08.97.

14 Interview 15.08.97.

15 The complementary study to this one (RF-1998/122) confirms that the reduction of the number of activities is a normal strategy in the successful firms.

- Improve ties with its own subcontractors in order to develop new products and services[16].
- Sharpening the ability to reduce delivery time by using oil companies subcontractor lists.

The new knowledge developed in the course of the re-organisational process became more and more centred on marketing surveillance, co-ordination and collaboration abilities and thus became increasingly tacit and firm specific. In terms of resource-based perspective (weak model), these innovations had the potential to become systemic knowledge-based resources[17] characterised by high level of appropriability and cumulativeness. As a matter of that, main suppliers were also able to follow strategies of incremental innovations[18] after having explored the opportunities contained in their new organisational structures (Quadrant I of the matrix). Main contractors developed specific abilities in the re-organisational activities such as:

- Total concept approach making them able to take the complete responsibility for delivery from the evaluation phase up to installation.
- Integrated organisational structure making them able to cut delivery-costs and time through the co-ordination and exploitation of all the internal assets and resources.
- Specialisation and full exploitation of the company's core abilities in order to be able to offer competitive solutions.

The innovative ability of the main suppliers was also challenged to technological development aimed at improving installations suitable for the minor extensions of the new oil fields. A strong competition pushed them to improve floating installation in order to make their technical characteristics as close as possible to those of the permanent ones. At the same time, they are challenged to reduce their delivery time and costs. The improvement of their ability to buy on the market innovative components and services is a very strategic resource in this context. The main contractors have to improve their ability to involve the under suppliers early in the projecting phase in order to assure the precision, the cost efficiency and the quality of the delivery. Having already its own network of sub-suppliers provides the main supplier with the possibility of saving time and receiving supplies in conformity with its own requirements[19]. For this reason a stable system of relations with under suppliers can be interpreted as a source of competitive advantage for the main supplier. Alternatively, main suppliers can

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16 The complementary study to this one (RF-1998/122) confirms that continuous and strong co-operations are an indicator of good economic performance.

17 The complementary study to this one (RF-1998/122) shows that the development of systemic resources help the firms to have a better control on their rule in a co-operation agreement.

18 Interviews 15.08.97, 22.08.97.

19 See note 10.

adopt the supplier lists of the oil companies. This is an option some oil companies prefer because it makes them able to use the same system and equipment on their installations.

To sum up, the explorative search both in organisational and technological areas was pursued by main contractors in order to fit the new industrial structure that exposed them to great uncertainty and risk.

4.1.2 The co-suppliers

4.1.2.1 Pre-Norsok

Traditionally, platforms and other constructions were carried out through a module system of supplies controlled and co-ordinated by the oil companies. When a project had been worked out, the construction was carried out by many co-suppliers. Their deliveries had to conform to the detailed technical specifications, developed by engineering companies. Each co-supplier was directly responsible for his own products to the oil company. The drawback of the module system of supplies was the inefficient use of the administrative and organisational resources, preventing a full exploitation and integration of the suppliers' experiences and abilities[20]. On the other hand the traditional supply system presented also some positive aspects:

1. The medium sized companies supplied the oil companies, on equal ground with the main contractors' production units.

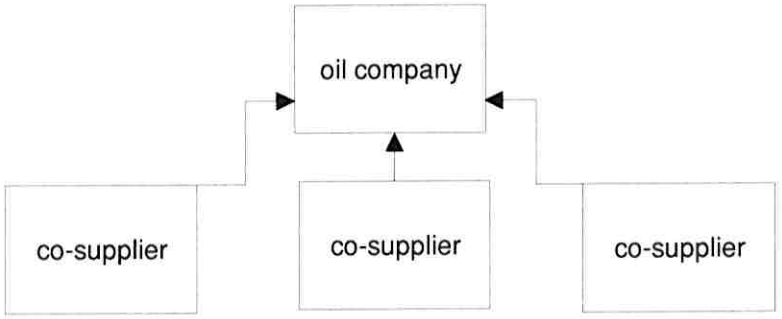

Fig. 4.1: Pre-Norsok relations between oil companies and their co-suppliers.

2. Engineering companies produced all the technical specifications for oil companies, for large companies' production units and medium size companies, causing identical problems and advantages for all of them. On the one hand medium size suppliers had to deal with bureaucratic obstacles and communicative problems; on the other hand there was no need for a separate engineering department in the supplier's organisation in order to undertake the delivery. Because of that competition between large companies' production units and medium sized companies was undistorted.

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20 Norsok delrapport nr. 3, 1995.

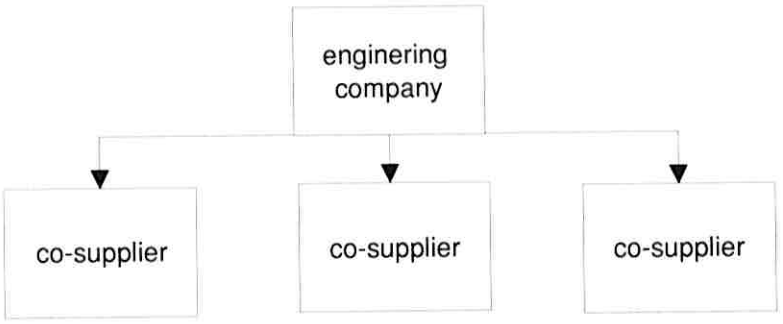

Fig. 4.2: Pre Norsok relation between engineering companies and co-suppliers.

4.1.2.2 *Norsok effects on co-contractors competing with main contractors' production units*

As mentioned, the need to avoid both the bureaucratic organisation and the overlapping of competence between oil companies and primary suppliers[21] kicked off a process leading to EPC/EPCI contracts. The total responsibility for an integrated system of engineering, procurement, construction and installation has caused the reorganisation of the principal suppliers' internal structure. They have gathered all their internal resources to be able to act as a unit and thus manage integrated supplies. Such a wide industrial reorganisation has generated different effects on the co-suppliers[22]:

1. Distorted competition: The industrial reorganisation turned into an oligopolistic market structure, where the principal suppliers have become responsible both for the construction and for the purchase of products and services. It is very difficult for the co-suppliers to be taken into account if they have to compete with the primary suppliers' production units and factories.
2. Multiplication of the number of contracts: Due to limited delivery in each contract, medium sized companies have become dependent on their involvement in a large amount of smaller contracts[23] in order to maintain the level of offshore turnover. This causes, among other things, the necessity to employ many resources both in the administrative management and in social relations in order to obtain new contracts.

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21 Norsok delrapport nr. 3, 1995.

22 Interview: 08.08.97, 22.08.97.

23 The complementary study to this one (RF-1998/122) shows that the purchaser portfolio is less unstable in the successful firms.

3. Bureaucratic choice of the primary suppliers for the development of small oil fields. One of the goals of the Norsok process was to use the specific competence of medium sized companies to develop small fields. This has not been the case. In order to avoid the costs of tenders, just the first 4-5 companies on the suppliers list are invited to tender for deliveries connected to small fields[24].

4. Difficult co-operation: Because of the industry's reorganisation, the principal suppliers' engineering departments have become much more "in house" oriented and are less willing to co-operate for the development of the design of products supplied by co-suppliers.

5. Transfer specific resources from manufacturing to product design: The utilisation of functional specifications instead of technical specifications doubles the task of the co-suppliers that are also responsible for the development of the final design of their products. This causes specific resources to be transferred from fabrication to product design and creates the need to establish an engineering department in the organisational structure of each co-supplier. As a matter of that, the Norwegian market of engineers is altered and many medium sized companies have difficulties to employ new engineers[25].

6. Difficulty to use internal resources. A large number of medium-sized companies functions as capacity suppliers[26] when primary suppliers' factories have problems with their productive capacity. Because of that it becomes difficult for the oil industry to exploit all the specific resources and competencies lying in those firms.

7. Weak relations between oil companies and co-suppliers: Medium-sized companies have often been reduced to mere sub-suppliers of primary suppliers' production plants. Due to mediated relations, oil companies manage to get information on the price of co-suppliers' supplies, while it is more difficult for them to evaluate the qualitative parameters of such supplies[27], [28].

8. Innovative effort: As displayed above, the restructuring of Norwegian oil industry has reduced co-suppliers' role to that one of sub-suppliers. While the main suppliers were challenged to amplify the range of their tasks, co-suppliers were challenged to reduce it. In this prospective (and only in this sense) we can affirm that the risk characterising innovative efforts of co-suppliers was lower than the one of main suppliers.

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24 Interview 08.08.97.

25 Interviews 08.08.97, 11.08.97.

26 Norsok secretariat defines capacity suppliers as suppliers whose delivery is based on technical specifications and whose compensations is based on instalments and cost-pluss

27 Interview 22.08.97.

28 The assertion is not confirmed by the complementary study to this one.

The reduction of tasks, has effected the potential of some resources of co-suppliers to produce quasi rents. This is particularly manifested with respect to:

a) The competence necessary to qualitative improvements of their products.

b) The organisational competencies necessary for working out deliveries of EPCI contracts in the small oil fields.

Our study showed that other resources, such as engineering and manufacturing competence, already present in co-suppliers' firms became strategically important for the creation of quasi-rents. A better exploitation of that competence was the strategic choice made by co-suppliers in order to meet the requirements generated by functional specifications and the pressure towards lower time and cost delivery. The production process was ameliorated in order to offer a cheaper standardised product proper to meet the specific functions it is meant for. The possibilities offered by the cumulativeness existing between the improvement of the production process and the standardisation of the product were fully exploited. As said above, during the innovative process, the knowledge base became more and more centred on design and engineering thus becoming increasingly tacit and specific. Therefore, the innovative activities were protected by knowledge barriers and were characterised by a high level of appropriability.

To conclude, it seems to us that co-suppliers followed exploitative search in order to match the risk they were exposed to by the reorganisation of oil industry. They achieved congruence with the changing environment by improving competencies protected by knowledge barriers that were already present at firm level (Quadrant V of the matrix).

4.1.2.3 Norsok effects on "complementary" co-contractors

The analysis previously carried out is related to co-suppliers whose main offshore competitors are the primary suppliers. The Norsok process has had different effects on co-suppliers companies whose main activity is complementary to that of the primary contractors. First of all they are different by being product suppliers[29]. They provide particular products and are not commissioned to solve capacity bottlenecks within primary suppliers. Their position in the market is special[30]. As the other co-suppliers they are not commissioned directly to oil companies. Like the primary contractors they take full responsibility of their supplies from the concept phase to the delivery of the final product/service. The Norsok restructuring process has revealed new opportunities readily exploited by "complementary" co-suppliers thanks to their specific resources[31].

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29 Norsok secretariat defines product suppliers as suppliers that have the control on the development of their products. Their delivery is based on function descriptions, and compensations are based on market price.

30 Interview 11.08.97.

31 Interview 11.08.97.

This is of particular relevance to:

1. The competence needed to improve their products and services.
2. The organisational competence needed to reduce lead time through the systemic co-ordination and exploitation of all internal assets and resources.
3. The ability to acquire complementary products and services.
4. Organisational competencies necessary to establish close and strong relations to their own subcontractors so as to develop ideas and concepts and offer competitive solutions.

The improvement of existing products and of organisational abilities are not the only innovative activities undertaken by "complementary" co-suppliers. Technological change is also stimulated by the need to meet the functional specifications of their supplies. The establishment of functional specifications, instead of technical ones, has stimulated those co-suppliers to develop a knowledge base increasingly focused on product design and engineering. Consequently, the knowledge base has become more tacit and firm specific. Cumulativness and appropriability of technological changes increase and these co-suppliers are able to follow strategies of incremental innovation (Quadrant V of the matrix).

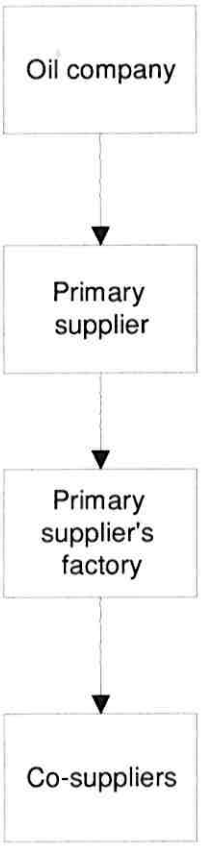

Fig.4.3: Norsok relations between oil companies and co-suppliers

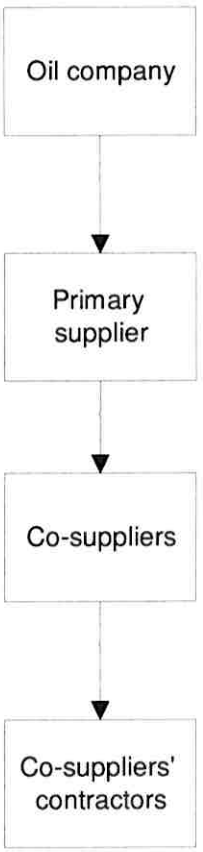

Fig.4.4: Norsok relations between oil companies and complementary co-suppliers

4.1.3 The sub-contractors

4.1.3.1 Pre-Norsok

Traditionally the position in the market of sub-contractors depended on the possibility to be connected to an oil-company through framework agreements. The main reason for such agreements is to be found in the role played by oil companies. They demanded a strong control and co-ordination of the activities in order to manage the projects. Framework agreements were conceived to protect the interests of both parties. The sub-suppliers were sure that in the course of the contract period they should deliver their products/services every time the oil company had the need for them. The oil-company was sure to receive components compatible to its own systems and instruments[32].

4.1.3.2 Norsok effects

The Norsok process mainly aimed to reduce costs and delivery time of 40-50%. Substituting the firms'internal specifications with a set of common standards was one of the suggestions formulated in order to achieve this aim. The equipment standardisation and the heterogeneous procurement strategies in the oil companies have had some contradictory effects on the sub-contractors. On the one hand, the sub-contractors needed to be flexible in order to meet the oil companies procurement strategies. On the other hand, they were increasingly in competition with the production units of primary contractors in supplying standardised products[33]. The pressure for price reduction became therefore double: the structural incitement to reorganise in order to remain competitive and the exploitation of the scale economies by primary suppliers have both increased price competition within construction activities.

The strategic choices made by sub-contractors in response to the combined effect of these pressures can be summarised as:

1. Frame work agreements with oil companies. Even if the EPC contracts have transferred the responsibility for project administration to primary suppliers, some oil companies still prefer to install equipment and systems delivered by their own subcontractors.

   These frame working subcontractors through a full exploitation of their systemic resources, follow strategies of improvement and modification of their existing range of products (Quadrant V of the matrix).

2. Alternatively sub-contractors may enter into alliance with main contractors. Some primary suppliers have responded to the new market demands by completely reorganising their internal labour division. The reorganisation process has sometimes also involved the relations with their own subcontractors. Close and strong relations among the different partners improve the potential to develop ideas and concepts, to

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32 Interview 06.08.97.

33 Interview 07.08.97.

offer competitive solutions, and to ensure the precision, the cost efficiency and the quality of delivery. Sub-contractors, exploiting the opportunities that the relationships with their partners offer, can develop specific organisational resources and a specific knowledge base in manufacturing activities. Organisational and product improvements are the strategies mainly followed by those subcontractors (Quadrant V of the matrix).

3. Niche strategies. Because of their organisational flexibility, the sub-suppliers can orient their marketing towards particular niches. This is a decision often made when they are not competitive in standardised product markets[34]. The problems of exploiting extensive scale economies and to have access to huge markets, are the main reasons for the above mentioned lack of competitiveness. Through the choice of niche strategies, those subcontractors can exploit the opportunities present in the knowledge base and thus work out product designs that can satisfy the special needs of a limited clientele. The orientation of innovative activities towards engineering and design activities makes the knowledge base more and more tacit and specific to the firms. The cumulativeness and appropriability of the resources involved in technological innovations thus increase and the sub-contractors can follow a strategy of incremental innovations (Quadrant V of the matrix).

4. Choice of other more stable areas of activity or other markets. Constructions more than other segments in the oil industry have been very much influenced during the Norsok process. The ability of oil companies to develop their own systems of sub-contractors through frame work agreements, has found equivalents only among few primary suppliers. Because of that many sub-contractors prefer either to find new economic sectors or to switch to other offshore activities (such as sub-sea)[35] considered more stable and less uncertain.

4.2 Production activities: presentation across the supply hierarchy

4.2.1 Pre-Norsok

The competence of shipyards in module construction and the international experience of shipping companies assumed a crucial importance when Norwegian enterprises emerged as suppliers of concrete constructions and operators of rigs and supply ships. In contrast, drilling technology was closely tied to oil activities and only the international companies had the specific know-how. Drilling and well operators were used to have close work relations with oil companies to co-operate on the innovative activities and to ensure the compatibility of systems and equipment on the installations.

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34 Interview 10.09.97.

35 Interview 07.08.97.

Except for incremental innovations, drilling and well technology didn't go through dramatic changes for a long period of time[36]. At the beginning of the nineties the incapacity of improving the efficiency of the production activities contributed to an increasing and diffuse pessimism within the oil industry. The oil price was 50-60% lower than in 1985. The extent of the new discoveries was too limited to allow their commercial exploitation. Exploration activities almost came to a halt. Some important solutions arose in drilling and well technology. Horizontal drilling[37] was further developed and then applied on daily operations. It permitted a better draining of thin oil reservoirs, of low permeability reservoirs, of low productive reservoirs and generally provided better access to oil reserves. The need of wells and platforms was therefore greatly reduced while the profitability of the fields was improved.

4.2.2 Norsok process

4.2.2.1 Primary suppliers

In the nineties, some oil companies began to focus towards a reduction and simplification of administrative documentation. This forced the suppliers to form alliances and partnerships in order to cut the total number of contracts necessary to be involved in. The Norsok process gave a new direction to the changes. The establishment of new relations between operators and primary suppliers makes these two categories interpret new roles for themselves. Oil companies used to lead and co-ordinate suppliers' innovative activities, have a new philosophy now. The development of new tools and equipment is no longer their task. They are now interested in carrying out and competing with each other only on their core activities. It is no longer the time to double competence, to hamper a full exploitation of suppliers experiences and abilities. The low profitability of the fields causes changes in the market structure, increasing the competition among the contractors[38]. These have to find new technological solutions and improve those already available on the market in order to augment the cost effectiveness within drilling and well activities. They are challenged to exploit the potential of combining new technologies such as horizontal drilling, with automation and information technology.

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36 Petroleum industri mot 2000. Olje og energidepartementet.

37 It permits a better draining of thin oil reservoirs, of low permeability reservoirs, of low productive reservoirs and generally provides better access to oil reserves. The need of wells and platforms is therefore greatly reduced while the profitability of the fields is improved.

Source: Petroleum industri mot 2000. Olje og energidepartement.

38 Interview 10.09.97.

The talent of a main contractor to offer unique solutions improves its competitive position on the market. The competition among contractors is exceptionally hard and generates a strong urge to protect innovations[39]. "In house" research and development activities are typical solutions while co-operation with outside public research institutions is avoided[40]. The multicustomers projects often carried out in those institutes represent a threat to the necessity of protection of innovative products. Due to that many competencies specific to research institutes don't manage to be transferred to the industry .

An alternative solution to "in house" innovation activities is to develop new products together with manufacturing companies. Alliances between drilling and well operators and manufacturing companies are more used because of the complementary resources involved. The Norsok process has encouraged many suppliers to sell out their non-core activities. Engineering departments are among those that have been affected. Thus many drilling and well operators now rely on their technological development partners in order to carry out the design of new products[41]. Alliance agreements always contain strong protection clauses giving the rights to exclusive utilisation of the product to the service partner for a certain period of time (2-3 years).

Protection clauses are essential because other competitors share the same knowledge base. Hence, they are able to identify the innovations and adapt them to the their own products (low appropriability at firm level). Research activities conducted "in house" or through alliances aim to increase the cumulativeness between the specific capabilities of manufacturer in product design and engineering and the uncodified knowledge of the drilling operator deriving from the use of the current equipment. During the search activity the knowledge base became more and more specific and tacit leading to a higher level of appropriability. As a consequence, drilling and well operators are able to follow a strategy of exploitation (Quadrant VI of the matrix).

4.2.2.2 Sub-suppliers

The previous discussion of the new role of primary suppliers in undertaking complex supplies, has generated the necessity to co-operate with sub-suppliers who control complementary resources and knowledge or who offers complementary services. Strategic alliances with producers of equipment and tools are common because they permit the joint development of new products requiring large amount of resources and complementary knowledge bases. The alliance with the client, allows the producer to acquire an in -depth understanding of the drilling operator applications. Consequently it became possible to develop products that combine automation technology with drilling

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39 The complementary report to this one (RF-1998/122) confirms that the use of patents is a normal state in suppliers to exploration, drilling and production services/products activities, while this only occurs to a minority of suppliers to other industry segments.

40 Interview 10.09.97, 25.09.97.

41 Interview 25.09.97.

technology. The cumulativeness degree of the two technologies therefore increases and the knowledge base becomes more and more tacit and specific to the producer. In conclusion we can say that producer companies follow a strategy of incremental innovations by modifying and adapting their products to drilling technology (Quadrant VI of the matrix).

To enlarge the range of their deliveries, main suppliers often choose vertical integration with a small group of sub-contractors offering complementary services. Such a strategy permits the sharing of competence and knowledge through common projects and tasks. It is thus possible to exploit possibilities offered by cumulativeness of the resources and to develop integrated services. In such a process the knowledge, previously divided between the partners becomes more and more specific to the integrated organisation. The appropriability of the profits that new integrated services can generate thus increase and sub-contractors can follow exploitative strategies (Quadrant V of the matrix).

The sub-contractors which don't manage to enter into alliances with main suppliers, are obstructed from gaining access to complementary resources necessary to improve their basic services. They don't manage to combine their specific capabilities with complementary resources needed both for innovation (such as R&D budget and R&D laboratories), and for the appropriation of rents generated by innovations (such as direct contacts with the final user of such services). Due to the lack of organisational resources, standardisation instead of innovation is the only possible strategy for these sub-contractors[42].

42 In this respect, the complementary report (RF-1998/122) shows that this activity area doesn't differ significantly from the oil supply industry as a whole.

4.3 Synthetic overview on the technological strategies followed by contractors operating in construction and production activities

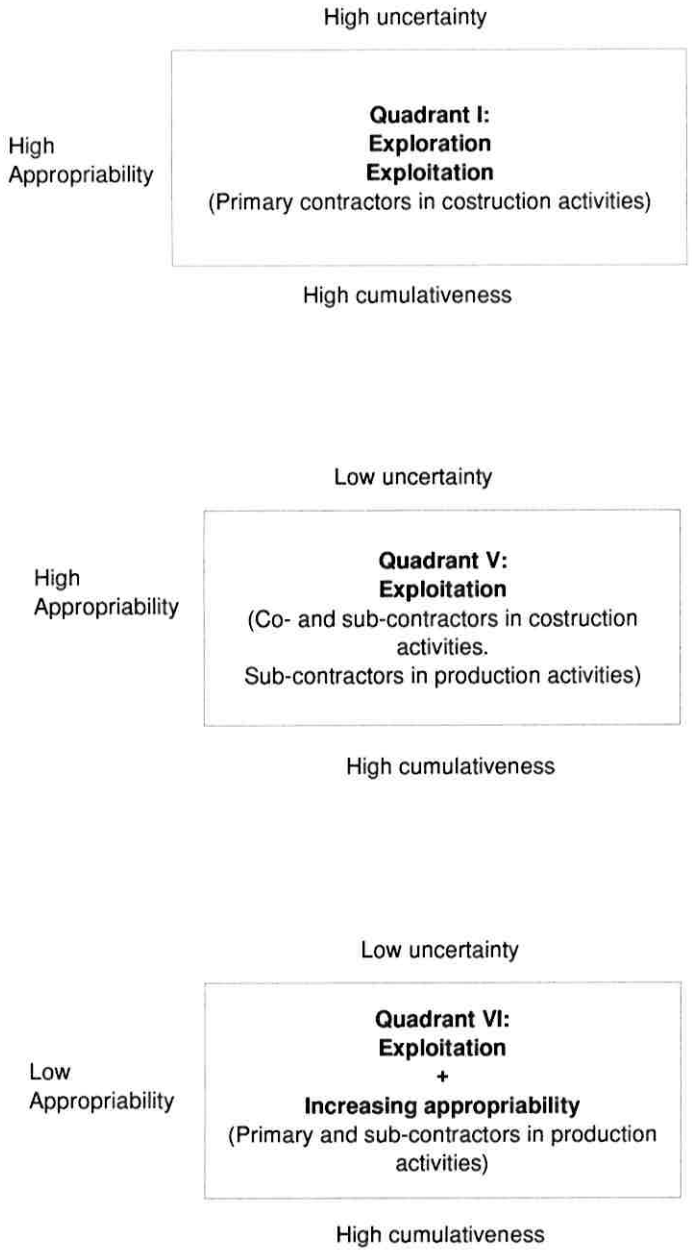

Figure 4.5: Technological strategies followed by contractors operating in construction and production acitivites.

4.4 Sub-sea activities

The first utilisation of a sub-sea system in Norwegian waters was made by Philips Petroleum for the early production at Ekofisk in 1971. Four sub-sea wells were connected up to a modified jack-up drilling vessel. A high oil price and a sub-sea technology not yet matured, prevented further implementations of sub-sea systems. A first full scale sub-sea system was put in operation by Elf Aqitaine on North East Frigg in 1983. After the fall in oil prices in 1986, sub-sea installations have been gradually introduced in the operations in the Norwegian waters.

The oil companies are the only customer group in the sub-sea market. This is a different situation compared to topside-related products and drilling equipment, where we find other petroleum related customers even more demanding than the oil operators[43]. For these products oil operators are free to benefit from the product developments resulting from the other customers' requirements. Because of the single customer situation in the sub-sea market, the operators take great responsibility for the development of sub-sea technologies. The interdependency existing among operators and suppliers of sub-sea equipment, generates *"an almost symbiotic relationship which is supposed to benefit both parties"* (Asbjørn Larsen, 1992).

At the beginning of nineties Statoil, with several distinguished operators co-operated with all majors suppliers to develop the next generation of sub-sea technologies[44]. Since than, the co-operation was mainly restricted to only one system supplier. In 1994 Statoil, Mobil, Elf and Shell signed a technological development agreement with Kongsberg Offshore (KOS). In 1995 on the base of this agreement, Statoil established a team at Kongsberg, working closely with KOS in order to develop more active sub-sea system components for deep waters (1200m+)[45]. In the same year a technology agreement was signed between Saga petroleum a/s and a consortium of independent ABB business units and their sub-contractor companies[46]. *"Through the agreement Saga is supplying not only expert personnel, but also funding of selected development work which is particularly important in connection with their business plans"* (Rune Sletten and Ole Berg, 1996).

Each alliance has its own system of production, of equipment and contractors. The specific knowledge needed in each system, makes the parties dependent on each other

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43 Asbjørn Larsen: "The future of subsea technology on the Norwegian shelf". Saga Petroleum as. Paper presented at the "7th Underwater Technology Conference", Bergen 1992.

44 Cato Wille: "Cost effective application of subsea technology". Statoil. Paper presented at the" 9th Underwater Technology Conference", Bergen 1996.

45 Interview 07.08.97.

46 Rune Sletten and Ole Berg: "Techtrain 2000" - The ABB technology project for Subsea". ABB Offshore and Technology as. Paper presented at the "9th Underwater Technology Conference", Bergen 1996.

and creates huge barriers for outsiders to break. The pressure of the Norsok process in direction of EPC/EPCI contracts and of total system package deliveries, has enforced the strong alliances and the role of primary suppliers. Many sub-contractors are eager to enter in to the sub-sea segment[47]. The motives have been:

1. The potential to use all internal resources and production competence: the specific system knowledge and the co-operation between sub-contractors and the primary supplier provide an efficient execution of projects and tasks[48]. Different from construction activities, the sub-sea sub-contractors don't need to divert specific resources from production in order to develop a detailed design or to adapt the internal organisation to the project[49].
2. The potential to survive without involvement in a large amount of small supply contracts[50].
3. Closer ties (through the system) with the oil companies which can easily asses the supplies. This makes the sub-suppliers more motivated to improve their products[51].

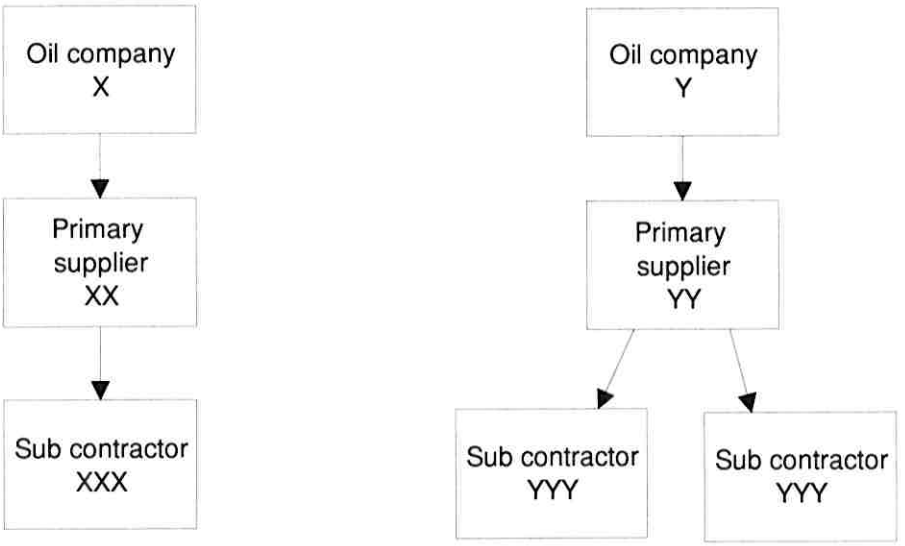

Fig 4.5: Sub-sea market's structure: Each oil company (X) co-operates with only one system supplier (XX) denying co-operation with other system suppliers (YY).

47 Interview 08.07.97.

48 See note 10.

49 Ref. p. 20.

50 See note 17.

51 Interview 07.08.97.

On the one hand the structure of the sub-sea branch makes it almost impossible for external innovations to make breaks through such closed systems. Unnecessary costs could surly be cut if the system was more open to alternative solutions. On the other hand strong and close relations encourage communication between the parties. The establishment of mixed teams between operators and suppliers for projecting and designing is the advantages of such a system. The potential for developing innovations closely related to the specific technology of the system is very high. A mixed team has multiple positive aspects:

1. It has a full information of the knowledge, skills, routines, processes and products not only of each company but also of the entire system. It allows a general overview on the capability of the single suppliers to meet customer's requirements.
2. For each partner of the team, specific resources can be used without the need to transfer resources from specific activities to general ones[52].
3. Innovative products and processes are projected to fit both the technical structure of the manufacturing partner and the specific demand of the oil company[53].
4. It allows to share with the other partners technological development costs connected with high technological risk projects[54].
5. To test prototypes and discover possible problems related both to production and use.
6. To gain know-how during the innovation process closely linked to the existing processes and products and thereby to add value to the internal resource system.

To gain specific know-how during the innovation search allowing a full exploitation of the technological potentials of the innovation[55].

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52 Ref p. 20.

53 Interviews 08.08.97, 07.08.97.

54 Rune Sletten and Ole Berg: "Techtrain 2000" - The ABB technology project for Subsea". ABB Offshore and Technology as. Paper presented at the "9th Underwater Technology Conference", Bergen 1996.

55 Interview 07.08.97.

5 Technical innovations: three case-studies

5.1 A Pre-Norsok R&D program: Integrated drilling system

5.1.1 The program and its outcome

Integrated drilling system (IDS) is the result of a project developed by RF in co-operation with Esso Norge, on the basis of a frame work agreement signed in 1991. The agreement assigned 100 million NOK to five years research programmes on drilling, reservoir and geology. IDS is a typical example of the pivotal role played by oil companies in the development of products and tools. It also illustrates the general innovative process in the Norwegian oil industry prior to the Norsok process. The investment was pre-evaluated by the Esso Norway, while Exxon Production Research, at the corporation head quarters in Houston, took the responsibility for the technical aspects of the project. It is not accidental that the decision to invest in such a programme was carried out locally by Esso Norway. During the eighties and the first three years of the nineties, the technological and industrial co-operation between oil companies and Norwegian institutions and enterprises was very much influenced by the existence of the so called "Good-will agreements". These were technological agreements containing the clause that oil companies should carry out at least 50% of their R&D activities in Norway in order to receive a preferential treatment during the subsequent licensing rounds. Such a mainstream strategy was followed at that time by the oil companies in Norway encouraged by the Government.

The development of automated and remote controlled rigs was considered as an important factor in improving the cost effectiveness of oil activities. The agreement between RF and Esso aimed at developing a long-term project compatible with the research institute's know-how in drilling and information technologies and technical structure (well rig). The complementarity of the project with other research activities in the oil company was guaranteed by the supervision of the Exxon Production Research in Houston. The aim of the project was to exploit the potential of combining I.T. and drilling technology in order to develop a product suited for drilling operations. The innovative activity involved the development of collaborative relationship with two business partners, Smedvig Offshore Europe and Hitec. The collaboration was necessary to guarantee the access to complementary resources needed in testing, production and marketing. Smedvig Offshore played a vital role as a consultant due to their long experience in the use of drilling tools. Hitec was involved in the final design, production and commercialisation of the IDS. The access to complementary resources and the protection of full property rights[56] represented an important requisite for the appropriation of the profit generated by IDS. Due to the high level of cumulativeness regarding both the knowledge base (I.T. and drilling technology) and the organisational resources controlled by the allied firms, and due to high appropriability of the

56 The full property rights held by RF were successively transferred to Hitec.

innovation's revenue, it was possible to follow a strategy of exploitation of the opportunities offered in applying I.T. to drilling operations (Quadrant 5 of the matrix). As a result, a complete process control network was developed. It included drilling machinery control units, computer hardware and software programs permitting the automation of BHA and the remote control of the drilling operations.

The definition of some strategic targets during the working out of the research programme was not free from problems. The principal causes are:

1. The need to join different research orientations. Within RF there were two different views on the direction to be given to the scientific results of the program: one in the focusing on applied research, the other focusing on a more basic theoretical research. This situation created a lot of rivalry between two different RF departments about priority of sub-projects. The activities were more focused on the dispute between the groups, rather than to offer the best solutions to the client. The problem emerging was poor communication caused by an unclear project organisation. The situation lasted for two years. After complaints from Exxon, the project organisation was restructured and the focus put on applied research.

2. The need to combine different approaches in marketing strategies between RF and Hitec. While RF researchers were long term oriented, Hitec was short term oriented. The short term orientation materialised in a focus on a reduced end product, while the long term orientation focused on a more sophisticated end product. The Hitec solution was accepted at last, excluding from the end product some of the four software modules developed in the project. Since the strategic choices of Hitec was characterised by a gradual development of products in order to adjust market goals to the financial resources, it was decided that only two IDS software modules, safety features and integration services, should be wholly included in the final product. Many of the functions in the drilling process control and tripping process control, were postponed for later implementations. The marketing strategy has to be considered successful. More than a 100 IDS have been sold in less than two years. furthermore the advanced autodrilling and the automatic tripping, two of the functions postponed, are to be implemented for some service companies' operations in the Gulf.

5.1.1.1 Conclusion

Two main peculiarities characterise IDS:

1. Pre-Norsok rule of Exxon. It took the responsibility for the development of equipment belonging to their non-core activities. In the pre-Norsok setting Exxon, as the other oil companies in Norway, led the development of technologies used by their suppliers. Therefore the whole oil branch benefited from those innovative efforts.

2. Good will agreement. It encouraged Exxon to invest a large amount of money in a research project oriented towards a long term improvement of the cost effectiveness of oil activities. Strategic choices guided the decision to invest in the research programme.

5.2 R&D in the Norsok transformation period: Extended reach coiled tubing vibrator

5.2.1 The program

The objective in the Extended reach CT vibrator research project is to develop and test a ready- to manufacturing new vibration technology tool, able to improve run-in length of coiled tubing. The idea was presented by RF at a brainstorming meeting organised by Statoil in 1995. It immediately received a very favourable feedback from the oil company. The general need to improve the access to the oil reserves makes CT operations more and more utilised in highly deviated wells. The idea of a tool able to reduce friction and to prevent buckling and lock up the CT through vibration was evidently well received. RF was invited to send a project proposal to Statoil. The invitation was not followed by significant funding from the oil company. ProCom, a subsidiary company of RF had to fund the commercial activities, while the feasibility study was covered through the limited funding of Saga and Statoil. The next five phases of the project have not yet been funded. Thus, a sustained program doesn't find the necessary economic resources to be carried out. This is symptomatic for the extensive changes that have characterised the oil industry since 1993.

5.2.2 The changes in the oil industry and effects on development of tools and equipment

At the beginning of 1994, due to EEA agreement on free competition, the Norwegian Ministry of Industry and Energy terminated the preferential technological agreements between the Norwegian Government and the oil companies. During the licensing rounds, the preferential condition of the oil companies, carrying out the 50% of their R&D activities in Norway, was thus annulled. As political considerations have dwindled, the oil companies became less encouraged to support long-term projects. In addition the Norsok effects may have augmented the changes generated by EEA competition regulations. The establishment of new relations created new roles both for the operators and the suppliers. Oil companies have reduced their involvement in innovative activities aiming for the development of new tools and equipment. They are now more interested in carrying out and competing with each other only within their core activities[57]. Oil companies aim not to compete any more for the access to innovative equipment and instruments, but rather for the seismic and geological data they possess, the ability and know-how involved in interpreting these, as well as the processing and the marketing of the fuel. Their research investments are more directed towards those areas than towards the development of new drilling instruments. In the new setting, the service companies have been challenged to use their experience and abilities in order to offer new and competitive products and services. Focusing on those areas in which they have specific knowledge, is the key to remain competitive in the market: many service companies have scaled down the engineering department, and the engineering competence has now been integrated in the major manufacturing

57 Interview 12.08.97.

companies[58]. Because of the complementary assets between manufacturing and service companies, there is a new tendency to establish alliances for the development of specific tools. The necessity to protect innovative products is ensured by strong protection clauses ensuring the service company the exclusive right to utilise the product during a limited period of time[59].

5.2.3 The role of the research institutes

The brief description of the new roles played by the oil companies and their contractors throws light on some possible reasons for the financial problem, that the Extended reach CT vibrator project has met. RF's traditional way of carrying out its projects is no longer adapted to the changed market conditions. The former strategy of carrying out its own research programs is outdated and no longer profitable[60]. In the area of product development, RF is no longer competitive: its leading role in developing tools matched the Pre Norsok scenario. In that setting, the overlapping of competence among the different actors created good market potentials for the research institutes in developing and co-ordinating technological innovations programs[61]. On the one hand, they had the competitive advantage to possess specific resources in research that were not shared by others. On the other hand, they could benefit from the advice of oil companies and their contractors when testing innovations or adjust them to the specific market demands.

In the new Norsok setting most companies carry out and compete only in their core activity. A common conviction is that the research institutes have to adapt their product strategy to the changed market. Their specific resources can be a source of competitive advantage only if joined with complementary resources managed by other actors. The new specificity of manufacturing companies in developing products has to be considered when elaborating new product policies in the research institutes. The research institutes are challenged to develop specific competence and knowledge so as to offer unique services and products[62]. Such a strategy could have the advantage to avoid competition with the manufacturing and service companies making them more susceptible to establish alliances with research institutes. Protecting technologies and innovative products, as said before, is an important prerequisite for many suppliers in this industry segment[63]. Alliances among non-competitors possessing complementary resources are more frequent in order to join common R&D projects through the sharing of financial expenses, organisational supports and know-how. Evidently, it is not easy to establish new relations with potential partners, to adapt the organisational structure to

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58 See note 9.

59 Interview 25.09.97.

60 Interview 25.09.97.

61 Interview 25.09.97.

62 Interview 25.09.97.

63 See note 17.

the new market setting and to identify new market targets. This a process that has concerned many agents in the oil industry and seems now to concern research institutes also.

5.3 A pre Norsok program and its further development in the Norsok period: Basin Modelling Toolbox

5.3.1 The program

Basin Modelling Toolbox (BMT) is a software product used in the oil companies exploration departments. It is the result of a development contract signed by ProCom and five oil companies: Amoco, Conoco, Enterprise Oil, Esso, and Phillips. In the period 1991-1994, the contract assigned 10,4 millions Nok to ProCom for developing a basin modelling system for exploration activities in mapping new and established areas. As for IDS, this project was also initiated when the "Good Will agreements" still guided technological development in the Norwegian oil industry. The length of the project period and the rather large investment with respect to the type of product (software for exploration activities) to be developed, were typical characteristics for "Good Will agreements" research projects[64].

Having the opportunity to conduct a long term project, ProCom aimed to achieve a product (BMT) clearly different from two competing products: the fluids stream models and the two dimensional basin models. The fluids stream models, already in the market, were rather unprecise in estimation of geologic development[65], while the existent two-dimensional basin models were either too difficult to use or not completely developed. ProCom aimed to offer an integrated product based on the fluids stream model and able to consider the geologic development of the basin. In order to reach the goal, the original project was planned to include in the end product a model for warm stream, a model for geological subsidence, a model for the description of geological development, a temperature model, a model for estimation of the pressure, a maturation model and a fluids stream model.

The project was developed in different phases:

1. Market analysis: it mapped the need of the potential clients. From previous researches[66] it was clear that the market required a product that could estimate the streams of fluid through an advanced modelling of the geological development.
2. Specification phase: in this phase geologists of ProCom, RF and of the clients co-operated in order to decide the specification of the end product.

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64 Interview with Langfelt: 21.10.97.

65 ProCom software and services a.s. corporate plan.

66 ProCom software and services a.s. corporate plan.

3. Design phase: geologists and systems developers of ProCom and RF decided to include different models of analysis in BMT in order to offer a product based on the fluids stream model and able to examine the geologic development of the basin.

4. Development phase: during this phase it was discovered that the development of BMT, in its complexity, faced a range of unanticipated technological obstacles[67]. As a consequence, it became impossible to work out the project within the estimated time and costs. ProCom decided to make a new simplified model version without the models of fluids stream and of estimation of pressure. Thus ProCom didn't manage to fill the technological gap that divides the fluids stream models from basin models. ProCom only managed to offer an incremental improvement of the products produced by competing companies. The technological strategy initially pursued aimed to explore technological opportunities characterised by high risk, high cumulativeness and high appropriability[68] (Quadrant 1 of the matrix). Since it was not possible to fill the existing technological gap, ProCom had to adapt its strategy focusing on improvement in its basic product. This successive phase of the innovative search was thus characterised by a lower risk in technological search and by high levels of cumulativeness and appropriability (Quadrant 5 of the matrix).

5. Testing and quality ensuring phases: during this phase the characteristics of the BMT were tested with final commercialisation in mind.

6. Commercial phase: the commercial aspects of the BMT project was rather more successful than the technological aspects[69]. ProCom managed to sell BMT also to American oil companies even if they had a bigger demand for fluids streams models than for a basin model. In this respect the role of financial supporters of the project is evident[70]. The American oil companies helped to launch BMT on the American market even though the product didn't have all the proper characteristics to gain the market .

The role of oil companies in this project has been very important. Due to "Good will agreement" they were interested in financing projects like BMT whose long term results affected their own activities. Strategic and not only operative judgements were carried out. The propensity of oil companies to co-operate with each other in funding multi-clients research projects oriented towards long term technological improvements, has

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67 Interview 12.09.97.

68 Computer programs can be protected by clients codes that prevents from program's interpretation and analise and make possible its utilisation.

69 The buyers of BMT are: Amoco, Statoil, Hydro, Saga, Amaranda Hess, Conoco, Enterprise Oil, Esso, Philips, Oslo University, Bergen University, Trondheim University, Tromsø University, Norwegian Oil directorate and Oklahoma University.

70 Interview 12.09.97.

contributed to the improvement of the whole branch's technological level and to the general utilisation of innovative tools[71].

5.3.2 Further development of the program in post Norsok period

The combined effect of the dissolution of the technological agreements by the Norwegian Ministry of Industry and Energy at beginning of 1994, and the new role of the oil companies in the Norsok settings, has influenced the involvement of the oil companies in technological development projects. More operative and tactical considerations than strategic have guided the decisions on support to development projects[72]. As such, it can be useful to consider the three new proposals that Geologica (ProCom's subsidiary company) has made to several oil companies for the further development of BMT.

1. Quantitative Assessment of the Effect of Diagenesis on Fluid Overpressure Development, Fluid Flow, and Seal Integrity. The project tries to combine a model with a normal pressure structure with fluid stream diagenesis. The aim is to assess qualitatively the significance of diagenetic processes controlling the timing and the magnitude of fluid overpressure development in the Norwegian shelf and other regions.

2. Secondary Hydrocarbon Migration in BMT using the Ray Tracing Technique. The project tries to combine BMT's reconstruction section with a seismic cross-section in order to reach a integrated basin system able also to simulate the vertical partitioning of hydrocarbons resulting from leakage through cap rocks as well as from flow along faults and fractures.

3. Development of a BMT Seismic interface model. This is a project that aims to develop BMT in direction of fluid streams models. With this intent Geologica has planned to build a direct link into the seismic interpretation system's database in order to simplify the interpretation of horizons and faults. In addition to that the link will be developed to also import the seismic information of a given cross-section.

The first project proposal has not yet found possible funding. There are two possible reasons. Different from the other two, this is a research project requiring a more extended financial support ranging from 2,2 to 3,400 millions NOK. Due to the research orientation of the project, the immediate effects on the daily exploration activities are difficult to predict. Since operative and financial considerations more than strategic ones actually guide the decisions of the oil companies in funding technological development projects, it is evident that such a project is not easily funded[73].

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71 Interview 04.09.97.

72 Interview 05.09.97.

73 Interview 05.09.97.

The second project, aiming to develop the BMT towards competitor products present already on the market, has difficulties in finding financial supporters. Oil companies do not consider the advantages of getting cross product applications installed in BMT functions, sufficient for supporting the project.

The third project, different from the other two, has received favourable feedback from Saga, Amoco Norge, Ameranda Hess, Conoco and Norwegian Oil Directorate due to its limited cost and time schedules and operative applications. The different attitude of the oil companies towards the three projects would be explained considering the goals of the projects and their possible effects on the daily work of the oil companies. Development of a BMT Seismic interface model is a project aimed to the simplify the reading and interpretation of horizons and faults. It thus can ameliorate the daily activity of exploration departments. Since the project only aims to improve the characteristics of BMT, its estimated budget is limited (900.000 NOK). Operative judgements, such as a limited financial support and the incremental improvements in the seismic interpretation activities, make the oil companies willing to support limited projects like this one[74].

74 Interview 05.09.97.

6 Conclusions

As displayed, the Norsok process has mainly affected the role played by oil companies and suppliers. EPC/EPCI contracts have challenged the suppliers to an innovative search aiming at the creation, replacement and improvement of their material and immaterial assets built up over time. The wide range of supplies has forced the main contractors to:

- Reorganise their companies in order to adapt them to the new contract structure.
- Create vertical integration with sub-contractors offering complementary services and products.
- Establish alliances with equipment and tools producers.

These changes have made the organisational structures based on more marketing surveillance, generating co-ordination and collaboration abilities more appropriate to remain competitive in the market.

The Norsok process has had different effects on groups of sub-contractors, depending on the type of relations they have built up with the primary contractors. Many sub-contractors have experienced the Norsok process as an excluding one. The tender procedures utilised for the development of small fields and the extensive supplies under EPC/EPCI contracts have limited the possibility of many suppliers to gain direct access to the market. This prevents those contractors from exploiting all the rent-generating resources they have created over time. On the other hand, they are challenged to establish strategic alliances in order to create specific competence in product design, engineering and marketing, and thus to match with functional specifications and the heterogeneous procurement strategies in the oil companies[75]. These resources have a high degree of cumulativeness with the pre-existing resource system, enhancing its potential to generate rents. Although the Norsok process has established favourable conditions for the creation of sub-contractors specific competence, it has not yet created the conditions for the exploitation of this competence. The stated aim of the Norsok process of preventing the doubling of competence among the different actors in the Norwegian oil branch has not yet reached completely its goal. The previous overlap existing between oil companies and suppliers shifted now onto the level of primary and sub-contractors. Still the oil companies, operating in the Norwegian oil industry don't manage fully to exploit the organisational and technological potentiality that they have contributed themselves to build up in the Norwegian oil contractors. In this respect it seems important that the relation between sub-contractors and oil companies could no longer be mediated by the presence of main contractors.

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75 The affirmation regards the utilisation of common standards. Ref. page 23.

Sub-contractors should have the possibility to gain access to the market not only through alliances and framework agreements with main contractors, but also through the creation of alliances with other sub-contractors in order to combine complementary resources and thus compete with the main contractors. The success of such a strategy is very much depending on the role that oil companies will decide to play. As displayed by this report, their strategic decisions influence the main directions of the Norwegian oil industry.

Oil companies should take on the responsibility to challenge the sub-contractors to play a primary, independent and alternative role to the main suppliers' one. Oil companies as end customers can only benefit from an increase of the actual level of competition and of an increase of the level of plurality in the Norwegian oil industry. In regard to this, strategic choices have to be made. The condition of marginality characterising more and more the fields of the Norwegian continental shelf, shall press toward a further reduction of deliveries' price. Without technological shocks or a rise in oil price to '85 levels, the possibility for a further reduction of the rentability of suppliers have to be taken into serious consideration. Independent suppliers to oil industry have better economic results than the subsidiary companies of corporate groups[76]. If this trend continues in the long run the Norwegian oil industry has to take into serious consideration the problem that can create an eventual decision of primary suppliers to scale down their activities.

Only by supporting a pluralistic oil supplier industry with independent and alternative suppliers, it is possible to guarantee the stability of the Norwegian oil market. This appears to us the future challenge for the oil companies operating in the Norwegian market.

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76 The assertion is based on the data contemned in the table 6.2 of the complementary study to this one (RF-1998/122).

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Appendix 1: Key informants

The companies we interviewed were suggested to us from persons that have been working long in the Norwegian oil branch:

Kjetil Alfsnes, Markedssjef, Rogaland Research

Jostein Ravndal, Leader of Norsok Secretariat

Øystein Joranger, Legal Adviser, OSSL (The Norwegian oilservice companies association)

Ragnar André Hurum, Sector Manager, TBL (Federation of Norwegian Engineering Industries)

Bergsager Egil, Manager in Rogaland Research Petroleum.

Appendix 2: Publications from the project

Askevold, Emma Olivieri: *A Journey into the Unknown". Innovative and Technological Searches in Norwegian Small and Medium Sized Oil Contractors.* Rogaland Research Report RF- 1998/128.

Steineke, Jon Moxnes: *Between the Devil and the Deep Blue Sea. Exploring the Economic Performance of Suppliers to the Norwegian Offshore Industry.* Rogaland Research Report RF-1998/122.

Steineke, Jon Moxnes: *Procurement as if Price Mattered? Success Factors in Purchaser-Supplier Relationships as Perceived by Suppliers to the Norwegian Oil Industry.* Rogaland Research Working paper RF-1998/123.

Steineke, Jon Moxnes: *A Probe of the Economic Performance of Petroleum-related Suppliers to the Norwegian Oil Industry.* Rogaland Research Working paper RF-1998/124.