Fitting resources into a context – How to deal with governmental support

Tim Torvatn
Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management
Alfred Getz vei 1,
N-7491 Trondheim,
Norway
Phone: +47 73 59 34 93
E-mail: torvatn@iot.ntnu.no

Elsebeth Holmen
Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management
Alfred Getz vei 1,
N-7491 Trondheim,
Norway
Phone: +47 73 59 04 64
E-mail: holmen@iot.ntnu.no

Ann-Charlott Pedersen
Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management
Alfred Getz vei 1,
N-7491 Trondheim,
Norway
Phone: +47 73 59 35 03
E-mail: pedersen@iot.ntnu.no

ABSTRACT
This paper focuses on small and medium-sized companies who have received support from the government for development work. All companies acquired a new resource, but the situations were found to differ in terms of how the new resource was fitted into the existing resource collection. In this paper, three such situations are analysed, and a taxonomy for classifying such situations is suggested.

INTRODUCTION
Small- and medium-sized companies are generally seen as the growth potential on the industrial scene, but also perceived to have problems with financing crucial development activities in order to make true on this "promising future". For this reason, many governments struggle to find ways of supporting small and medium-sized companies by helping their development work.

In Norway, some of these governmental activities have been gathered in a programme called BRIDGE (The Programme for Bridging the gap between Industry and Research). BRIDGE is partly financed by the Norwegian Research Council and partly financed by the firms involved in the programme, and has a yearly budget of 160 million NOK. The goal of BRIDGE is to improve relations between small- and medium-sized enterprises (hereafter called SMEs) and the research institutes in Norway, and thereby to increase the use of researchers among SMEs.

BRIDGE runs four major subprogrammes, two of which are TEFT (technology transfer from technological research institutes to SMEs) and SMEC (SME COMPETENCE – the recruitment of highly skilled staff to SMEs). In the TEFT programme, BRIDGE partially funds a development project where a company employs researchers from a research institute to help in the development. TEFT covers the research institutes' efforts in the TEFT project but only as much as 75 % of the total cost of the project, and the company must provide at least 25 % of the total cost. The normal contribution from TEFT is approximately 50-100.000 NOK. Furthermore, the TEFT project must focus on a product or process development necessary to achieve the company's long-term goals.

SMEC is another BRIDGE programme to which a SME can apply for support. In an SMEC project, the company hires a newly educated student (hereafter termed a candidate) for a one-year project. The one-year project must include a market, product or process improvement where the competence of the candidate is useful. BRIDGE partially helps finance the recruitment of this candidate (i.e. they pay 80.000 NOK to the company towards his or her salary). Furthermore, BRIDGE grants an extra sum of 25.000 NOK to pay for a supervisor based at the candidate's former university or college, which can help the candidate when he or she has questions related to the theoretical background of the project.

The empirical work underpinning this paper is a study made on behalf of BRIDGE where the authors investigated two TEFT projects and two SMEC projects. The aim of the study was to acquire information on how these four companies, which have been supported by BRIDGE, have improved their development work.

EMPIRICAL BASIS

In this section we shall present three cases from the study mentioned above. The three cases will serve as the empirical base for this paper. The first two cases focus on TEFT projects and the last case focuses on a SMEC project.

Case A: Forestia Van Severen AS (Van Severen)

Case A was a part of the TEFT project. In this case, Van Severen, a large sawmill, received support from TEFT for the development of a computer-based maintenance system. The technical group responsible for maintenance at Van Severen had seen the need for such a system for several years, and it had systematically tried to find support and financial backing for a project in which such a system could be developed, but their efforts had met with only limited success. A joint effort to find a maintenance system for all the sawmills in Norske Skog Trelast (the larger group which Van Severen was a part of), had resulted in an analysis of the existing maintenance system, and a need analysis for the new system. However, it had failed in implementing a new system due to a lack of financial backing by Norske Skog Trelast. In 1998, the joint efforts ended and Van Severen finally found financing for a project within TEFT. At that point in time, many of the details of the project had already been worked out, and some possible suppliers of computer-based maintenance systems had been contacted. A connection to a research group at the research institute SINTEF in Trondheim had also been established.

Thus, when the financial backing was secured, the project could finally be launched. Five suppliers of computer-based maintenance systems had been contacted during the joint effort, and one (Prodoc, a local supplier) was chosen for the task. Researchers from SINTEF participated in the introductory phases, and assisted with the customising of the supplier’s system for Van Severen, as well as helped with setting initial values for maintenance intervals based on their experience.

The involved parties saw the project as very successful. The maintenance system was installed, and is used by the maintenance staff. It has improved the precision of the production equipment, and has been a great help in reducing downtime due to unexpected production breakdowns. Furthermore, it has also helped the planning of preventive maintenance. The supplier stated that they had found the process very helpful too, and that they had learned a lot about how to introduce such a system into a company; many elements of which they have now included in their handbooks. This was possible due to the involvement of, and support by, the researchers from SINTEF.

Case B: Micro-control AS and Odim AS
Case B concerns a TEFT project called "Reliability of cable handling system". The project was a co-operation between a small firm, Micro-control, which develops, produces, and sells remote control systems (primarily equipment for electrical and hydraulic cranes and machinery) and one of their largest customers, Odim, which produces and delivers cable handling systems for seismic vessels.

The project started when Odim contacted the research institute SINTEF and suggested a TEFT project related to a reliability analysis of the cable handling system which the firm delivered together with the supplier Micro-control for seismic vessels. After starting up the TEFT project, Micro-control and Odim agreed that the reliability analysis should focus on the technical part of the winch system and the Man-Machine Interplay when using the equipment (the cable handling system) on a vessel. Furthermore, they decided that the project team was to go on a tour with a vessel to see how the equipment worked 'in reel operation mode'. However, this proved too difficult to arrange, so they ended up only visiting a vessel laying in the boatyard. In addition, it was hard to get Odim to prioritise the project because they where in the middle of finishing a large order for an important customer.

After the project had started, SINTEF pointed out that the scope of the project was too broad given the resources available, and they recommended focusing only on the Man-Machine Interplay. Furthermore, SINTEF stated that they had a lot of expertise in the research area of Man-Machine Interplay, and that they were the only research institute in Norway who could do such an analysis. Odim was too busy with finishing their latest order and made no final decision on the scope of the project, so Micro-control finally contacted SINTEF and suggested that the project team should focus only on the technical part of the winch system. The reason for this was that Micro-control was interested in a reliability analysis of their remote control because they would like to get a specific EU certification for their products. Odim and SINTEF finally agreed on Micro-control's suggestion. After the aim of the project thus had been settled, the main researcher from SINTEF had few problems performing the reliability analysis using fault tree analysis techniques, even though she had preferred to do Man-Machine Interplay analysis.

Case C: Scandinavian Handling Systems AS (SHS)
Case C was a project within the SMEC programme. In this case, the focal unit was SHS, a small company in Southern Norway who constructs sub-systems for waste management systems. In the spring of 1998, SHS was approached by a Danish company who asked if they could take care of some of the sub-systems for an order for one of the Danish company's customers in the UK. The order was large (compared to the annual turnover of SHS) and included both sub-systems which SHS knew well (conveyors and silos), and some sub-systems (pneumatic transport of waste in a powder form) which SHS at that point in time had no knowledge of. Thus, SHS either had to develop this knowledge, or they had to tell their Danish partners no, and then loose the whole contract, because the British customer wanted one supplier for all the sub-systems mentioned above.

SMEC enabled SHS to develop the necessary knowledge. Through the SMEC project, they acquired money for partial financing of one year's salary for a candidate. As the company needed the candidate to acquire competence within the field of pneumatic transportation, and since this area of competence was regarded as important for the company, it easily fulfilled the requirement that the candidate should work with a specific project which was important to the continued existence of the company. In accordance with the requirements of the SMEC programme, a researcher was brought into the project as a supervisor for the candidate. The supervisor was central to the project, since he had a strong interest in, and knowledge about, powder transportation, could facilitate access to a laboratory where tests could be carried out, had an interest in helping small- and medium-sized enterprises, and had a fairly extensive knowledge of SHS (based on former and on-going co-operation between the researcher and SHS).

This SMEC project is regarded by the involved as a success story. The sub-system for pneumatic transportation was developed, thereby enabling SHS to take the order. This type of sub-system has now become part of the product range at the company, and the candidate has been hired for a permanent position in SHS.

THEORETICAL BASE

Problem formulation

As described above, the empirical background of the paper was three companies which received support from the government for their development work. A challenge, both for BRIDGE, and for the company receiving support, is how to use this money to acquire resources to actually improve and develop the business situation of the company.

A main point of the Industrial Network Approach is that development work is inextricably related to the business context of the company which is to be developed (Axelsson and Easton 1992 and Håkansson and Snehota 1995). In an article (Håkansson 1994, p. 254) this has been formulated in the following way: *"Development within a single actor (company) is formed [...] through interaction with its counterparts"*. Hence, the development work in a single company is regarded as being embedded into a network context of other companies' development work.

Thus, when the government fund support to a company in order to further its development, it is necessary for this company to fit these resources into the business context it works within, in order for the funding to be of any value. All types of development work is circumscribed with uncertainty, not only about the resource(s) which are given to the company, but also regarding the context the new resource is to be fitted into. Thus, the process of fitting a new resource into a context in order to get something valuable, is difficult and involves considerable amount of experimentation, learning and adapting by many involved actors as the value will depend on the degree to which a large number of resources and activities changes and adapts in order to make the new resource useful. When the initiative for such a process is exogenous to the business context it works within, the problem becomes even more difficult to handle as the importance of knowing the context is not fulfilled by the party supplying the resource/funding.

The purpose of this paper is to look more closely at the fitting of a new resource into an existing resource collection of a company.

Fitting a new resource into an existing resource collection

The theoretical foundation for this paper is the Industrial Network Approach as represented by for example Dubois (1998); Ford (1990); Ford et al. (1998); Håkansson (1982) and Håkansson and Snehota (1995). More specifically the point of departure is the part of the theory which focuses on technological development and is concerned with the nature and uses of resources (Holmen and Pedersen 1999a; Håkansson 1993; Håkansson 1994; Håkansson and Snehota 1995 and Waluszewski 1990).

One of the three main concepts of the Industrial Network Approach (as described by Håkansson 1987) is the resource concept (the two other concepts being the activity concept and the actor concept). In the Industrial Network Approach, resources are generally described in the following way: *"Various elements, tangible or intangible, material or symbolic, can be considered resources when use can be made of them"* (Håkansson and Snehota 1995, p. 132). The way of using resources is to tie them together by using a number of such elements in an activity. *"Resource elements are tied to meaningful wholes from known ways to accomplish something valued by somebody (a certain activity pattern)"* (Håkansson and Snehota 1995, p. 132).

Further, resources are conceptualised on three different levels. At the company level, the concept of *resource collection* refers to the resources controlled by a single company actor. *Resource ties* relate resources from two companies in a relationship, and a number of resource elements tied together and belonging to different actors in a network, are termed *resource constellations*. All these three concepts are closely interrelated with comparable concepts in the activity and actor dimensions, as presented in Håkansson and Snehota (1995, p. 45).

Finally, we need to introduce the concept of *resource heterogeneity* as a way of expressing that the value of any resource is not given, but is based upon the combination the resource is used in; that is the resource collection, the resource ties and the resource constellation(s) in which it is a part (Håkansson 1993 and Håkansson 1994). This assumption changes the focus of economic development from an allocation problem (the distribution and use of *given* resources for *given* uses) into a problem of experimentation, learning and discovery. As Håkansson (1993, p. 210) puts it: *"The effects of heterogeneity is that knowledge and thereby learning come into focus,…"*. Another important observation comes a bit later in this article, where he claims that: *"The economic question is not just how to allocate resources, given their relative prices, but how to exploit their properties in a more or less unique way; i.e. to develop their value at given prices"* (Håkansson 1993, p. 211).

Based on these concepts; we could make the claim that a firm's production is based on it's existing collection of resources, and on the way in which these resources are tied together with resources controlled by a number of its customers, suppliers and other companies in the firm's business context. This resource *constellation* has been worked with, and improved upon by all the involved actors, in such a way that it, at the time we look upon it, represents the best way of utilising the existing resources that the actors involved have been able to construct, given the ties that the resource collection of each individual firm has to resource collections in other firms. Thus, a lot of money, time and thought have already been invested into an individual firm's particular resource collection.

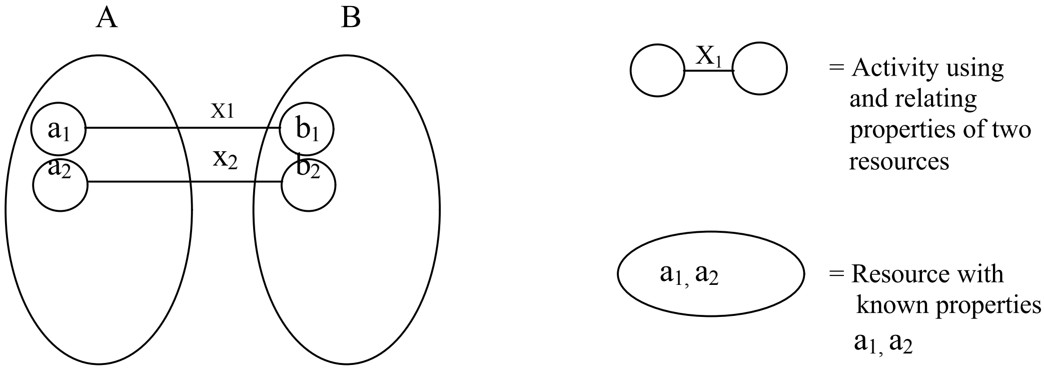
For many economists, these heavy investments are seen as a "problem" for development, in the sense that the already performed investments represents a binding to something which needs to be kept unchanged for the costs to be recovered. Thus, former investment has been seen as a mechanism of conservative power, as explained by Håkansson and Waluszewski (1999). On the other hand, we should keep in mind the dynamic nature of industrial networks. A very important facet of this is the very same resource collections. This is important for two reasons:

1. Because of the work put into improving and adapting the existing resource collections, the actors controlling them also have a great deal of knowledge about the collections, their weak sides, some alternative uses of the resources involved and some ideas on how to improve the collection further.
2. The existing resource collection thus represents a strong basis for further work. In this way, the existing resource collection becomes a fixed point which change can be anchored to.

Thus, it is evident that a firm's existing resource collection works both as a conservative mechanism resisting change, and as an anchor and a springboard for further development. This is expressed in the following way by Håkansson and Waluszewski (1999, p.2): *"...how in certain situations the existing path-dependence even seems to facilitate technical change."* Also, any development work will have to relate to the existing resource collection, whether it includes changing existing resources, replacing existing resources with new ones or introducing new resources into the collection. This process of relating then becomes the emphasis of development work within the Industrial Network Approach, (see for example Ford et al. 1998 and Holmen and Pedersen 1999b)

In this paper we try to build a taxonomy of development situations when a new resource is to be fitted into an existing resource collection. Using the concepts developed by Holmen and Pedersen (1999a), we can model the existing resource collection as consisting (in its simplest form) of the two resources A and B, both within a single company. Each of these resources has two known (and used) properties which we will term a_1 and a_2 (properties of resource A), and b_1 and b_2 (properties of resource B). In this simple model, property a_1 is tied to property b_1 through the activity x_1, and likewise property a_2 to b_2 through activity x_2. There may also be other known properties of resources A and B which are currently not in use (there is a debate within the Industrial Network Approach on whether a property can be known without being used. For a thorough discussion on this, see Holmen and Pedersen (1999a). We will here assume that it is possible). The resulting system is illustrated in figure 1 below.

FIGURE 1
Tying two resources A and B through activities x_1 and x_2



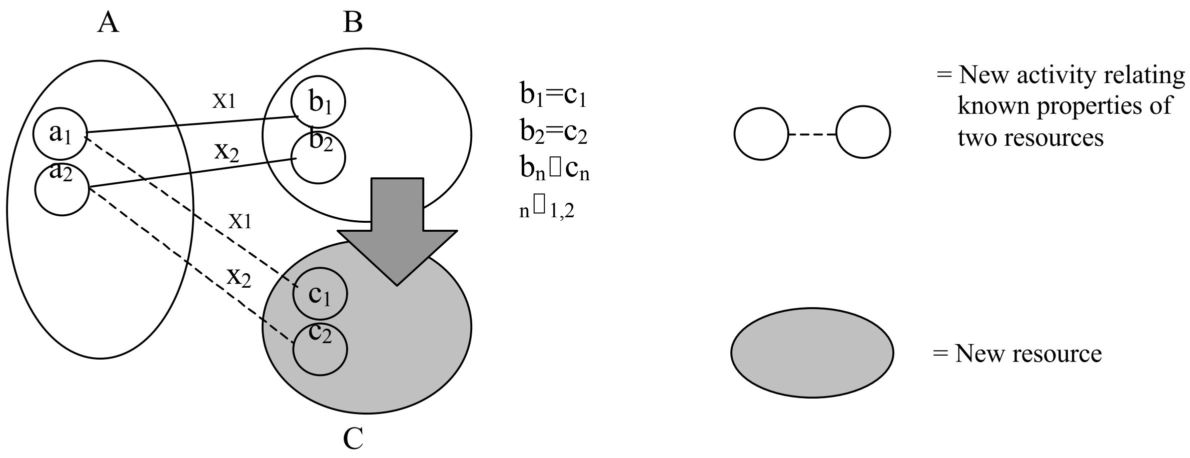
When we want to introduce a new resource C (from another company or a research institute) into this simple system, we will make two basic assumptions about the way this is to be done in our model:

1. Resource C has certain properties associated with it, which we will call c_1 and c_2
2. The way in which resources A and B are tied together is to remain constant throughout the process of adding a new resource.

Based on these two assumptions, we observe that to fit resource C into the existing resource collection (the system represented in figure 1) can be done in four basic ways, each of which will create a very different situation for the actors trying to fit the resource into the collection. We will describe in more detail each of these four situations below.

Situation 1: Capacity expansion - no adaptation
In the first basic situation, we want the new resource C to increase the capacity of the existing system. This means that the focus is on duplicating relevant properties of resource B, so that the total capacity of the activities x_1 and x_2 can be increased. In order to achieve this, the properties c_1 and c_2 of resource C must be similar in all aspects to the properties b_1 and b_2. It is possible for C to have more properties than B, or even for C to have different properties from B with respect to properties not used; but for all used properties of B, there must be a corresponding and similar property of C. In this way, the relevant properties of resource C can be tied directly with the properties a_1 and a_2 in the same way as resource B is. For all practical purposes, C becomes equal to B in its function in the existing resource collection whereas resource A is to remain unchanged. The situation is illustrated in figure 2 below.

FIGURE 2
Capacity expansion - no adaptation



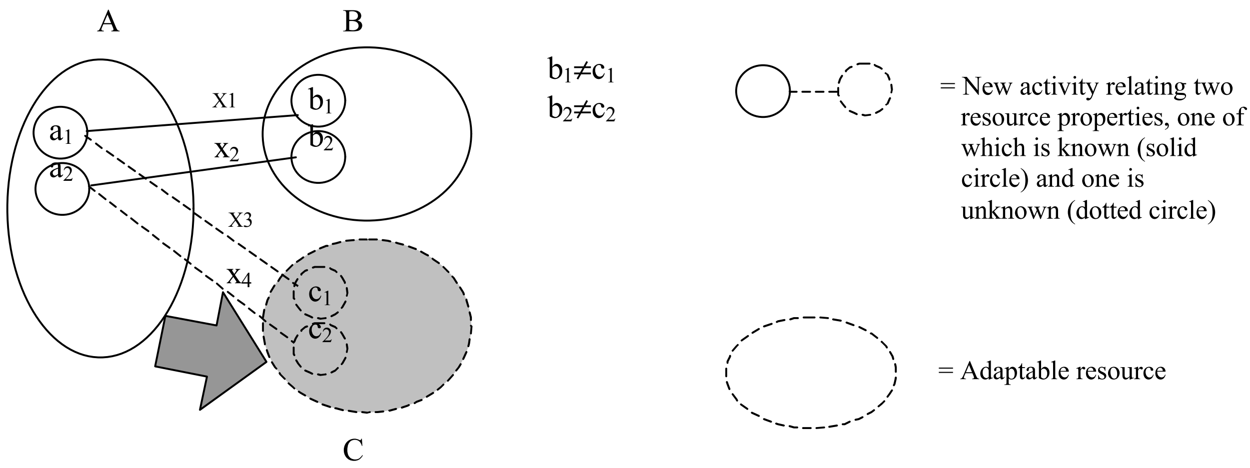
When this type of basic situation occurs, it is, in fact, a question of *capacity expansion and no adaptation*. The new resource C can be fitted into the existing resource collection if, and only if, it has properties similar to resource B. Thus, the focus of the "development" work is to identify a resource C which can be fitted into the resource collection because it has properties c_1 and c_2 which are so similar to properties b_1 and b_2 that they can be used as a basis for the same activities. Systematic search for a resource with the wanted properties is necessary, making sure that all properties of the existing resource collection remains unaffected, as they are tied strongly to other resources and no change of these ties is contemplated. In short, we can say that we look for a piece of the puzzle which can fit directly into the existing resource collection without any changes taking place. We use B and what we know about B to look for C (as the shaded arrow depicts).

Situation 2: Unilateral adaptation of the new resource

A second basic type of development work is the situation where the new resource C is going to fit with some specific properties of resource A. This case is different from situation 1 in that we have not decided in advance which properties of C we are going to tie the properties of A to. However, the properties of A which we would like to tie them to, are known. In other words, we will have to discover properties c_1 and c_2, and then tie them to the already utilised properties a_1 and a_2. We can term this type of development a *unilateral adaptation of the new resource*, since it is the new resource which is being looked at and adapted so as to fit into the existing resource collection of the company. This situation is illustrated in figure 3 below.

FIGURE 3

Unilateral adaptation of the new resource



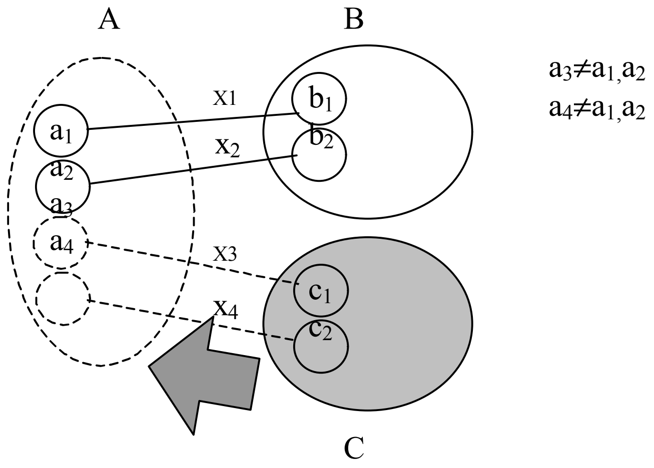
When unilateral adaptation of the new resource is the issue, the focus of the development work is to find properties of C which may be tied in a meaningful way to known properties of A. Instead of looking closely at C and determining whether it has certain properties or not, we are now looking at C to determine what properties it have, and which of them can be tied to the known properties of A. In this situation, a certain amount of experimentation and learning regarding the properties of C is necessary, but there is still no freedom in terms of changing or adapting the existing resource collection (resources A and B and the internal ties between them, expressed by the activities x_1 and x_2). In short, we can say that in this situation, we are looking at the new resource C in the light of resource A (shaded arrow), and we are willing to change resource C (or to be more precise, the way we view resource C) in order to make it fit into the puzzle.

Situation 3: Unilateral adaptation of the existing resource collection

In the third basic situation, the development work is based on a number of properties of the new resource C, which, for certain reasons, cannot be changed (they may perhaps be of importance because they are already tied to other properties of other resources). These properties, which are known, are viewed by the acquiring company as useful, but it is not clear how they can be fitted into the existing resource collection. Thus, the acquiring company need to discover properties of resource A which may fit with the known properties of resource C. This situation is different from situation 2 above, as this time a part of the existing resource collection (resource A) is allowed to change (and thereby changing the existing resource collection), whereas the properties of C to be used are not changed. This situation, which we will term *unilateral adaptation of the existing resource collection*, is illustrated in figure 4 below:

FIGURE 4

Unilateral adaptation of the existing resource collection

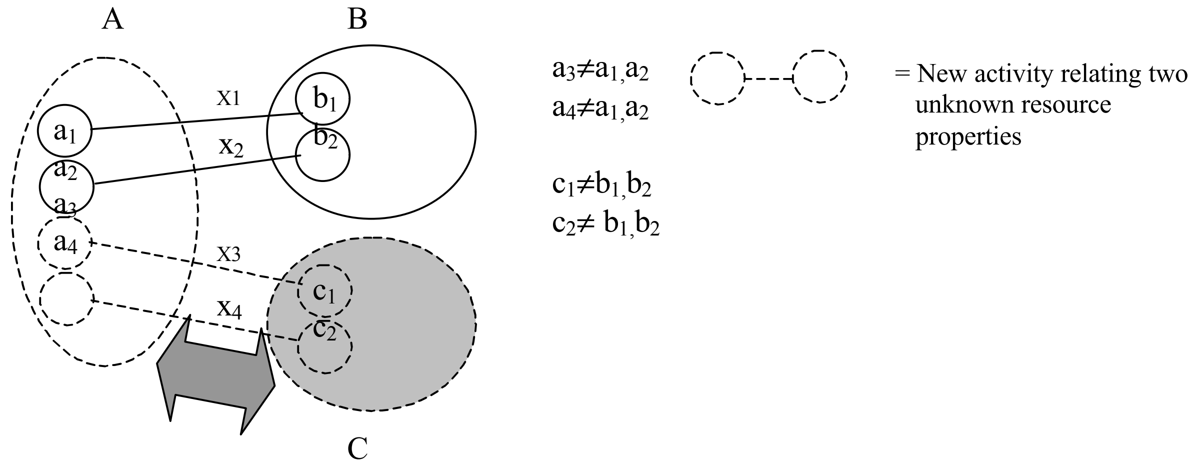


In this situation, the focus of the development work is to experiment with a part of the existing resource collection to see if it has properties which can be tied to resource C without changing the way that existing properties are used (more specifically, the properties a_1, a_2, b_1 and b_2 together with their tying activities x_1 and x_2 are all fixed, and cannot be changed). A relevant starting point for the search is to look at the properties of A which is known, but currently unused in relation with B, but the search for useful properties of A to tie with C will in many cases have to go beyond these properties (to the unknown properties of A). In short, we can say that in this case, we are willing to look upon the existing resource collection in the light of what we know about resource C in order to make room for resource C (shaded arrow).

Situation 4: Bilateral adaptation

The fourth basic situation is when both the useful properties of resource C, and the properties of resource A they will be tied to, are unknown in advance. Development work in such situations is very difficult, because the number of possible permutations are large, and the possibilities and consequences are largely unknown. In short, neither the new resource nor the existing resource collection constitutes a fixed 'use-related' starting point for the search. A number of alternative uses and ways of adapting the two resources to each other must be tried, and the company may “fail” (that is, try out solutions which at a later stage are discarded) many times during this process. The development work is further complicated by the requirement that the existing internal ties between A and B must still not be changed (that is, a_1, a_2, b_1, b_2, x_1 and x_2 are all fixed). This situation, *bilateral adaptation* is described in figure 5 below:

FIGURE 5
Bilateral adaptation



In this situation, there are few 'use-related' fixed points which can form a starting point for the development work. The involved parties simply know too little about what they need. In order to handle the situation, it is necessary to create temporary fixed points for certain periods of the development work. For example, the parties involved in the development work may decide that a specific property of C will be used as such a temporary starting point. In the example, the creation of the temporary starting point allows the involved parties to “reduce” the development situation to a situation 3, something which enables them to work with the existing resource collection to see what properties of A they can fit with c_1, the temporarily fixed point. After some time, the work on properties of A have come far enough for the involved parties to “abandon” their temporary fixed point, and to assume these newly found properties of A as a new temporary fixed point. Of course, the process also works in reverse with properties of A as the first temporary fixed point.

In other words, the situation is approached from two directions sequentially; one direction is to discover and define properties of resource C, and another one is to discover properties of resource A which can be tied to the different properties of C as they are uncovered (in some ways, we can say that the company is performing situation 2 and 3 sequentially). Again, the ability to use the existing resource collection and the knowledge about it is important in order to shorten the time spent searching, as well as increasing the quality of the adaptations chosen for testing. In short, this situation can be said to be one where we do not know neither the pieces nor the puzzle. We only have a general idea of what the puzzle will look like in the end, and even this will often prove to be different from the solution chosen, since the testing, evaluation of alternatives, and the learning resulting from testing different alternatives, is such an important part of such a development situation (shaded arrow).

METHODOLOGY

Our study performed for BRIDGE represented a fairly traditional case methodology. The aim was to produce narratives of the development processes financed by BRIDGE in a number of case firms, and each of these stories were to concentrate on a small number of noticeable results (positive or negative) of the projects. The descriptions should, in turn, be used by officials and administrators within the Norwegian Research Council in order to understand specific BRIDGE programmes, thus adding to the existing body of knowledge about governmental programmes which primarily is based on traditional evaluation studies.

The cases were chosen by the research group from the available project "pool" of completed projects in the BRIDGE programme over the latter 3 years. Aspects important to the researchers for choosing among the available projects was:

1. Geographical location (the Norwegian region of Nord-Trøndelag for the TEFT cases, and the Norwegian region of Telemark for the SMEC cases)
2. Success or fiasco, as defined by the SINTEF-personell involved in administering the programmes (a mix of success and fiasco projects was chosen)
3. Time elapsed since the project (the chosen projects were all performed fairly recently, to reduce the effect of memory loss in respondents)

An open-ended interview guide was used for the interviews related to the cases, where the following aspects were chosen as a basis for the interview guide:

1. Noticeable results of the project
2. A process description of the project
3. A description of the participants of the project, their role in the project and their experiences.
4. External relationships thought to be important to the case company, and how they were involved with the project

For each case, 3-8 interviews were made with informants at different levels in the involved companies. The majority of the respondents represented the focal company receiving the governmental support. However, others came from suppliers or customers with a particularly important role in the project (as perceived by the focal company). Researchers and supervisors participating in the projects were also interviewed, and in some cases also representatives administrating the TEFT programme.

Even though the empirical data on the TEFT and SMEC cases were gathered to fit the objectives of BRIDGE, they can also be used as data for theoretical development. During several discussions on what these data were telling us about development work, the authors discovered that the development situations faced by the companies we had studied, differed on several dimensions. Examples of such differences are related to what the companies wanted from the new resources, how the new resources were acquired and how they were fitted into the existing resource collection of the companies.

The taxonomy of development situations presented in this paper was developed abductively as a result of an extensive discussion among the participating researchers on whether the cases represented different approaches to a development project, and how this could contribute to our theoretical understanding of the nature of development situations. Thus, the research process involves several consecutive steps where theory and empirical data were used together. This implies that the process leading to the propositions in this paper is akin to an abductive approach (Dubois and Gadde 2000) where theory generation and application is strongly anchored in the empirical work.

ANALYSIS

In this section, the three cases introduced in the beginning of the paper are analysed using the different development situations presented and discussed above.

Case A: Forestia Van Severen AS (Van Severen)

In the first case, the situation faced by Van Severen was that they needed a new computerised maintenance system. Using the different situations, we can say that in this case, the production equipment at Van Severen constitutes resource A, whereas the new computerised maintenance system constitutes resource C (the new resource to be added to the existing resource collection). The production equipment represents a large investment which is acquired over time. Furthermore, a change in the production equipment is usually followed by production stops, as well as loss of production due to the learning which is associated with implementing the new machine. Thus, there were some very strong incentives for Van Severen to keep the existing resource collection.

From the above reasoning, we can conclude that the existing resource collection was fixed, and that any adaptations necessary in order to fit the new computerised maintenance system into the existing resource collection was to be made in the properties utilised in the new resource C if at all possible. Thus, Van Severen was facing a development situation 2, where the emphasis was on unilateral adaptation of the new resource in order to fit it into the existing resource collection.

One of the reasons for the apparent success of this project was that Van Severen managed to find a supplier of a computerised maintenance system who was willing to adapt its new resource to the existing resource collection at Van Severen. Prodoc, the supplier, had licensed a system, but they had only installed it in two large companies before Van Severen. Thus, they felt that it was necessary to adjust the properties of the system to the situation at Van Severen, and when the process was finished, they felt that they had learned much about how to implement such a system for a customer. An interesting observation made by the supplier was that the learning resulting from the process of adapting the system to the needs of Van Severen was subsequently used towards other customers.

Another important success factor was that the researchers brought into the project through the TEFT programme were well equipped to handle the situation. The two researchers were the very same researchers who had been hired by Norske Skog Trelast to do a situation analysis and a needs analysis for the larger group of sawmills. Thus, they had a high degree of knowledge about the specific situation faced by Van Severen. They also had good general knowledge about maintenance systems and about the sawmill industry. Their expertise was particularly helpful in the adaptation process of the standardised system delivered by Prodoc to the specific situation at Van Severen, and both sides (Van Severen and Prodoc) felt that the researchers were useful in advancing principles and in suggesting practical solutions for ways in which the system could be adapted.

Thus, even though the existing resource collection in Van Severen had to remain largely fixed throughout the development process, the development was possible because there existed possibilities for adapting the new resource to be introduced into the resource collection. Furthermore, the researchers were able to spot the adaptation possibilities, thus significantly helping the process along. This project thus constitutes a very good example of situation 2.

Case B: Micro-control AS and Odim AS
In case B, the situation at the start of the development project is that Micro-control, together with one of their largest customers, Odim, want to use a research institute to analyse their systems regarding safety and reliability. Both companies mention that their main goal is to get a verification of the reliability of the existing systems (in Odim's case; the cable handling system, and in Micro-control's case; the remote control system). However, they are also willing to make changes in the systems if they are found to be wanting by the research institute. The development part of the project thus depends upon how the researcher from SINTEF evaluates the existing systems. If the systems are viewed as being adequate, the development project would (only) mean a certification and documentation of the existing systems (and the only development would possibly be that the companies will have a better understanding of their systems in relation to reliability). If the systems are found to be wanting in some aspects, development work can take place as Odim and/or Micro-control need to develop their systems to improve on problematic features identified by the researcher.

Since it is SINTEF and its competence which is known in this case, and the properties of the systems produced which are unknown (but not necessarily deficient), this situation is thus most akin to situation 3. How well known and fixed the competence of the researcher was in relation to what she was supposed to do (Man-Machine Interplay analysis) can be seen from the fact that SINTEF claimed to be the only research institute in Norway who could do an analysis of the type wanted in this project.

The project emerges slowly, and the main reason for this seems to be that Odim, as well as Odim's customers, do not have the time to participate in the project. In this way, the researcher assigned by SINTEF to handle the project cannot acquire relevant knowledge about how the existing resource collection at Micro-control ties with the existing resource collection at Odim. Also, the original project plan was found to be too ambitious in terms of the work needed to do a complete reliability analysis. For these two reasons, the original development project cannot be done. However, Micro-control suggests a reformulation of the original project plan which limits the scope of the project to a reliability analysis of the technical part of the winch system, and this reformulation of the plan was accepted by Odim and SINTEF. However, although being well within the competence of the researcher, this change of focus meant that SINTEF was no longer the only one who could have performed the research part of the project.

In the end, some form of limited success is achieved from the project for Micro-control in that the project resulted in a reliability analysis of the remote control system. However, very little development seems to have taken place, as Micro-control has not acquired some competence in doing reliability analysis (this was specifically denied by the company), and the reliability analysis did not bring up any major problems with the product which could have lead to a product development process.

Case C: Scandinavian Handling Systems AS (SHS)
When we look at case C, we can see that SHS faces a more complicated situation than the other two case companies. Their existing resource collection is not sufficient in itself for the company to be able to produce the sub-systems required by the British end customer. Either some new properties of this resource collection must be found, or some new resources which has the necessary properties must be added, temporarily or permanently. The addition of new resources will also mean adaptations in one way or another to existing resources. SHS chose

to add some new resources in the form of a candidate fresh from the engineering college, since they, by doing that, could receive some financial support from the government through the SMEC programme.

The candidate was quickly found, since he had already applied for a job at SHS. However, the company knew that this candidate did not have the skills necessary to help with building the sub-systems necessary for the British end customer. Thus, SHS faced a development situation 4; they needed to develop their resource C (the candidate) to acquire the necessary properties it needed, and they did not know how to adapt these properties to the existing resource collection of the company.

However, SHS also had some strong points which helped them in their development work. Firstly, the company had a solid knowledge of their existing resource collection. They knew what they could do, and, most importantly, they knew what they could not currently do. Secondly, they had access to knowledge about the requirements of the customer, both directly from the end customer (in the form of technical specifications) and indirectly from their Danish customer (in the form of knowledge about the technical specifications and interfaces with other sub-systems). And thirdly, they had an existing relationship to a professor at the local engineering college who was very interested in, and knowledgeable about, different ways of transporting powder.

The crucial point of the SMEC programme became the clause that some of the money had to go to a supervisor for the candidate. Using these money, SHS was able to pay the professor at the local engineering college (where the candidate had graduated from) to be the supervisor for the candidate. In this way they ensured that the candidate was able to acquire the necessary skills to construct the sub-system. In our theoretical terms, they first solved the problem of deciding which properties of resource C it was necessary to adapt (in other words, a development situation 2, unilateral adaptation of the new resource).

However, with that part taken care of, they still needed to adapt their existing resource collection to the newly acquired skills of the candidate (a development situation 3), so the work was only halfway done. For this other half of the problem, two elements proved beneficial; the knowledge that the owner of the company had about their existing resource collection, and the ability to let the candidate use laboratory facilities at a research institution where the supervisor worked, for experimenting with a number of different constructions related to pneumatic transportation of waste in a powder form. Good communication between the owner of SHS, the supervisor and the candidate managed to give the tests a fruitful direction and it also produced test results which SHS could use to convince the British end customer that SHS could indeed fulfil their part of the contract. In this way, the general process of construction in the firm could be adapted to accommodate and include the construction of pneumatic transportation systems. In this process, the general engineering skills of the candidate also proved very useful, but this was to be expected.

In the end, this project proved to be very successful, seen with the eyes of SHS. In relation to the theoretical concepts introduced above, it is an example of how development situations which are as difficult to handle as bilateral adaptation situations, can be handled when sufficient care is taken. Crucial in this case was probably the existence of the professor at the local college, who had the right competence for this work, who could provide a laboratory for the testing (and help with the interpretation of the test results), and who also had a knowledge of the company and its business situation. However, there are also other factors which helped this project along, such as the Danish customer and the British end customer, who was able to provide SHS with some specifications which helped along in the search for important skills for the candidate.

DISCUSSION

In the above analysis, we can see some differences in the development situations faced by the three companies. We have concentrated on the differences which arose in light of the knowledge the companies involved had about their own resource collection and about the new resources to be added at the start of the project.

One of the most striking features of development work to be learned from these cases is that it seems to be much easier to do development work when either the existing resource collection or the new resource is variable or unknown, and the other constitutes a fixed point (of known resource properties) to which it is possible to adapt (in other words, situations 2 and 3). The Van Severen case is an excellent example of this, where the existing resource collection needs to remain fairly fixed throughout the work (since it is made up of expensive investments in machinery), whereas the computerised maintenance system has unknown properties which are adaptable.

That the other two situations are more difficult to handle, seems reasonable. In situation 1, there really is no common ground for development. Both the new resource and the existing resource collection must, for some reason, remain fixed, and they can, as we have already observed, only be tied together if the new resource is equal to a resource already tied into the existing resource collection. Since no adaptation is possible, we only have a capacity expansion.

In situation 4, development is possible, but the lack of fixed points to serve as a starting point makes development work difficult. However, as we discussed above, one way of handling such situations is to introduce temporary fixed points. The SHS case is an excellent example of this. In this case, the supervisor has the necessary skills regarding pneumatic transportation of waste in powder form, as well as a useful resource (a test laboratory). In the first phase of the SHS project, the supervisor teaches the candidate these skills. Said in a more analytical way, the supervisor becomes a fixed point to which the candidate is adapted, and the emphasis of the development work is changed from a situation 4 to a situation 2. Once this is done, the candidate serves as a fixed point to which unknown properties of the company's existing resource collection is adapted (focus changes from situation 2 to situation 3). The total resource base developed (the existing collection and the new resource) enables the company to deliver a sub-system which satisfies the demands of the British end customer, and SHS has in this way handled the development work sequentially; first as a situation 2 and later as a situation 3; thereby it constitutes a situation 4.

Based on the discussion above, we can summarise the four basic situations in a 2x2 matrix (see figure 6 below). We have seen that the existing resource collection is fixed in all situations with regard to the internal resource ties between resource properties a_1 and b_1 and a_2 and b_2. However, the properties of A, that we tie to the new resource C, can be either known in advance or they can be unknown in advance. Similarly, the properties of the new resource C can be either known in advance, or unknown in advance. This is depicted in figure 6 below:

FIGURE 6
2x2 matrix on the four basic development situations

		Existing resource collection	
		Known	Unknown
New resource	Known	(1) Capacity expansion - no adaptation	(3) Unilateral adaptation of the existing resource collection
	Unknown	(2) Unilateral adaptation of the new resource	(4) Bilateral adaptation

This matrix can be used to give us an understanding of what different development situations may look like "a priori" to the start of a project. However, the starting situation in the cases is not the only element which decides the outcome of a development process. At best, the starting situation can be used to say something about the focus that the development work may initially have.

Another central element is the presence of actors who can identify a useful starting situation. The Micro-control case could represent a case where this was not properly done. In this case, the starting position seemed to be a situation 3, where Odim was interested in developing their existing resource collection by using a research institute which had specific knowledge about Man-Machine Interplay analysis (introducing a new resource with known properties). However, once the development work got underway, it was discovered that the existing resource collection was not as adaptable as expected, and no development was possible in the area of the original project.

As time goes on and the development work gets underway, the actors involved may discover new alternatives, new ways of relating the resources involved and better (or at least different) ways of tying the involved elements together. This effect is what we may define as "learning". This is an element in the development work which goes beyond the starting positions mentioned in the 2x2 matrix on development situations.

Learning in a development project may in some situations lead to a project being terminated (it was discovered that the possibility thought to exist was not there). More often, however, it leads to the project changing character from one development situation to another. This is typical for situation 4, where a change in the character of the project is almost a necessity for the project to be finalised, at a later point in time. We can see an example of this in the SHS-case, where the company at a certain point in time have discovered which skills the candidate will need, and thereby "reduced" the development situation 4 to a situation 2, where the focus is on how the candidate should acquire these needed skills

Because learning is central to development, development work is also in need of actors who can help the involved actors along with the process of development. The supervisor in the SHS case is such an actor, and so are the researchers represented in the Van Severen case. This requirement may also help explaining why the Micro-control case was only a limited success, since in this case the competence of the researchers did not match very well with the goal of the project, and thus they could not take a role in helping to facilitate learning.

Even though the 2x2 matrix above is a way of expressing the intentions of the development project at its start, we can also use it as a way of describing the development process. This suggestion comprises drawing lines instead of points in the matrix. The line then becomes a function of the situation over time, and may show how the emphasis of the development project changes at different points in time.

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