From Firm Network to a Sector-System of Production and Innovation: A Case Study of Innovation Policy Initiative

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Abstract

This paper examines innovation policy making during the transition of innovative ideas into mature industries within building/construction and mineral extraction/mining industries. The main focus is how interaction occurs between major stakeholders and intermediating actors and how industrial change processes are orchestrated. A case study approach examines the rather complex processes occurring within industrial sector development. Two main success criteria were observed: (1) continuity in initial vision and leadership and (2) a clear intention to achieve strategic interplay and knowledge fusion between heterogonous industrial sectors. Currently, this has been achieved in a classic way using R&D and technology development approaches combined with explorative market development to co-ordinate and allow knowledge fusion between the sectors. The transition process is illustrated in four phases: (1) idea and start-up, (2) formation of a technical R&D programme and networking, (3) consolidation of actor networks and formation of an embryological innovation system, and (4) development of a more sector-based production and innovation system.

Keywords: Mature industries, sector innovation system, transition and change management

1. Introduction

Baldwin (2006) refers to globalisation as the "great unbundling" – as not just the slicing up of value chains and the relocation of various stages of production processes to more comparatively advantageous regions, but also as the elevation of innovation and intrinsic knowledge to a dominant position. Public policies and scientific prospects in the face of the gleaming development and prosperity produced by a footloose flow of knowledge and global competition between regions and networks of firms and individuals have for some time been collected under the heading knowledge society. The assumption that future social development and prosperity is largely in the hands of high-tech innovation, technology, and production of new scientific knowledge has, as in other countries, a decisive impact on Swedish government R&D policies (OECD, 2005; SOU, 2008).

This outlook – with its seemingly narrow perspective on knowledge and innovation – may be overlooking the industrial and technological development potential of traditional non-high-tech, non-research-intensive industries (Hirsch-Kreisner et al, 2005). A broader view of varying modes of innovation and knowledge production could well require policies and policy measures to be revisited, especially concerning innovation modes typical for low-tech – but often knowledge-intensive – firms and industries. Since the 1970s, policy-making insights have mainly occurred through intervention in (i) the scientific-based R&D and knowledge transfer from universities to firms and (ii) early-phase projects in various sectors and industrial branches that are in varying stages of their life cycle to maturity. Like elsewhere, policy making and policy measures in Sweden – the channelling of knowledge, communication, and net-

works between universities and single firms or networks of firms – have been characterized by their one-way mode (SOU, 2008).

In recent decades, a wider concept of networks and the power of networking has received much attention in policy making, particularly concerning entrepreneurship, innovation, and business organization (Håkansson, 1993; Laestadius & Berggren, 2000; Etzkowitz & Klofsten, 2005). Köhler's recent paper (2008) states that innovation must be embedded in coherent business strategies to be effective; compared with in R&D-intensive industries, economic performance and the capacity to innovate in low-tech or in mature and less research-intensive industries are much more a result of smooth interplay – networking – between the stake-holders of competitive firms in value-chain sectors and clusters. Innovation in mature, non-high-tech industry tends to be incremental, and this type of industry seems to attract process innovators rather than product innovators (Edquist, 1997). Companies that mainly embrace process innovation seem to base their innovations largely on contributions from others (Bender, 2006). Up-grading existing production processes and products is the primary tool for satisfying consumer demand. For example, in mineral extraction and mining industries, separating process from product development can be difficult and determining a distinct divide may be impossible. In summary, the innovativeness of non-high-tech – but quite often knowledge-intensive – industry seems to be largely based on its capability to absorb knowledge generated elsewhere and transform it internally according to their needs and situation (Robertson et al, 2003).

2. Frame of reference

Since the mid-1980s, innovation and innovation processes in industry have been considered crucial for sustainable development and economic growth. Economic research inspired by Freeman's (1987) and Lundvall (1992) initial work related to the OECD Technology and Innovation Policy (TIP) studies, proceeds by the seminal works of Nelson & Winters (1982), have concurred in this standpoint. And many studies have discussed the strong connections between (i) investments in innovation and R&D and (ii) economic growth of companies, branches, and community sectors. North (1990) and DiMaggio & Powell (1991) feel that it is the differences in the underlying institutional structures and their surrounding economic, cognitive, and political environment that explain the causality and elasticity of these connections. Malerba (2002) made the point that the degree of elasticity in this connection between innovation and R&D investment and economic gain and productivity efficiency varies between the different industrial sectors and R&D areas. Such variations are coupled to differences in factors such as technical or economical maturity (Lundvall, 2004) and differences in competence and learning.

Differences in development stage, socio-economic structures, and communicative closeness have recently become more important (Malerba, 2003). These factors lead to the conclusion that effects of different innovation and research initiatives will differ depending on sector, development area, and development stage. And these effects will differ because of underlying variations in communication and time-related interaction patterns. Dorsi (1982) introduced the concept of technological paradigms as a plausible explanation and overarching determinant of traits of path dependencies and transitions in technological socio-economic systems. Other influential scholars, like Malerba (2002), consider sector approaches to make up the core unit of analysis for economists, policymakers, and scholars – not least in the examination of innovative and production activities. Sector-system innovation visualizes innovation as an interactive process between various asymmetric firm and non-firm actors (e.g. research institutes and policy organizations). These actors have bounded rationalities, and their actions are shaped by collective institutions and accepted beliefs and practises (Edquist, 1997; Carlsson & Stankkiewicz, 1991). Sector-system production is a set of firms and non-firms that produce a set of products and other artefacts for a particular market (Bergek, et al, forthcoming). More pre-

cisely, Malerba (2006) views the concept of sector-system innovation and production as a way of providing a multidimensional, dynamic view of the sectors. Systems of innovation and production can thus be defined as a set of agents (e.g. firms and non-firms) that carry out market and non-market interaction to create, produce and sell new products and other artefacts (including commoditization knowledge) for market niches.

The sector-system perspective has many advantages. First, a sector-system innovation and production strategy results in a more precisely targeted innovation policy. Second, because sectors may differ in the nature of change and because sector participants may differ in experience and technology and skill capacity, an upsurge of new knowledge and techniques may result in outcomes that vary widely at the sector level. Third, adaptation of a sector-system approach allows better insight into the system and better assessment of the forces underlying innovation and competitiveness. Innovative behaviour and innovation output merely co-evolve with institutional settings and structural properties of sector (Nelson & Nelson, 2002). Using an economic perspective, Malerba (2006) studied how innovation firms relate to their environment during sector-system innovation and production and defined three key factors as crucial to the analysis in mature sector-systems:

- Market demand in terms of competent users and innovative procurements.
- The knowledge base within the sector and the adsorptive capacity and competence at the firm level.
- The dynamics of collaboration in innovation and R&D network.

To explain the emergence of innovation in sector-systems, Breschi & Malerba (1997) focused on four attributes in these systems:

- Opportunity in relationship to revenue expectations. Level of market scale, variety in technological solutions, market permeability, and input sources affect this relationship.
- Innovation conditions. The capability of adsorbing innovative knowledge or invention and how well specific findings on innovation can be enclosed and obtain protection determine whether or not these conditions are favourable.
- Reservoir of technological knowledge. The ability to accumulate, pool, and exploit technological knowledge affects the development of innovations.
- Complementarily of the knowledge base. How well the accumulated components in the knowledge base relate to and supplement each other affects the emergence of innovation.

To sum up, economic and evolutionary literature define the technical paradigm and regimes of innovation and production systems in slightly different ways: innovation is studied using the sector-system approach described above or an evolutionary viewpoint. The economics perspective emphasizes understanding the economic relationship between the innovating firms and their environment; the evolutionary approach, focuses on the technology itself and its environment (c.f. Carlson & Stankkiewicz, 1991; Jacobson, 1997). Similar to Dorsi's (1982) concept of technological paradigm, Rip and Kemp's studies (1998) of transition and technology shifts, for example, define the technological regime broadly and inclusive as: ".. the ruleset or grammar embedded in a complex of heuristic practices, characteristics of product & production technologies as well way and procedures of handling relevant artefacts and division of innovative labour, as way of defining problems; all of them embedded in institutions and infrastructures" (p. 340).

3. Aim and scope

As discussed by Godö (2009), although both approaches to sector-systems of innovations and production are fertile for explaining innovation dynamics within a technological regime, neither is capable of explaining how a new sector emerges and a new technological regime is established. From the perspective of policy design, intentionality and institutional embeddings at the actor level are an open question with these approaches. The sector-systems approach and the evolutionary approach are well capable of describing a particular technological regime – but not of explaining why it changes or why and how new technological regimes emerge. The research focus of this paper is thus: How does interaction between major stakeholders occur? and How do intermediating actors orchestrate the industrial change processes within these three industries?

Transition literature recognizes and often discusses (Geels 2004; Geels & Schot 2008) how a radical technological innovation becomes the seed for the establishment of a new technological regime and a new innovation system This occurred with GSM in the case of the mobile communications sector. In the encounter with incremental innovation, however, transition literature appears to explore transition management preconditions in traditional industrial branches to a lesser extent. This paper discusses lessons learned in the ongoing case of MinBaS. The focus is the process of incremental regime changes in mature branches that are subjected to increasing environmental pressure. These insights, we believe, will add to our theoretical and practical understanding of transition management. Transition processes concern not only structural, cultural, and institutional transformation but also the ways these changes are organized in matured industries.

4. Method and case background

Eisenhardt (1989) considers the case study approach to be a practicable way of examining rather complex processes, such as the emergence of a new industrial sector. The technique allows processes and causes of complex social phenomena to be assessed and understood. In Yin's view (1999) a 'critical' case that is representative of a focal phenomenon can provide detailed insights. And the outcomes of such a study can have implications that reach beyond the scope of the case. MinBaS was selected as a focal organization because it had made an important commitment to the pursuit of sustainability and environmental conservation in a sector-system perspective. Case information was collected via periodic participative observations between 1995 and 2009. Two more sets of standard case evaluation procedures were done in 2005 and 2009. Three rounds of semi-structured interviews with firm actors and project management occurred in 2002–2009, together with two one-day workshops of hearings.

5. The MinBaS case

MinBaS as an acronym for a joint Research, Technology and Innovation (RTI) programme between three traditional and relatively small industrial branches: industrial minerals, crushed rock aggregates, and dimension stone producers. Resting on historical causes, their own regimes of R&D, and business tradition, a more than 15–20-year period of transition is today targeting a plausible fusion of the three branches. The initiative behind MinBaS and the ongoing change process can traced to the mid-1990s and an informal discussion on co-operative interaction between a small group of major stake-holders and representatives in the three industries. Quite soon into the discussion, this informal group became aware of the need to involve the government. in order to undertake a governmental authorized foresight dealing with the issues of future development of a joint development aiming to create a new branch structure. Discussions with the Geological Survey of Sweden (SGU) and the Ministry of Enterprise, En-

ergy, and Communications (formerly the Ministry of Trade and Industry) resulted in SGU carrying out a foresight study with the participation of the concerned sectors.

From a policy perspective, timing is crucial. A few years later, the Ministry of Enterprise, Energy, and Communications commissioned SGU to conduct another study to investigate the prerequisites for enhancing innovation performance and production in the Swedish minerals and rocks industry. The study resulted in suggestions concerning the production chain from geology and prospecting via product and process development to market use (e.g. application technique in users' products and processes). The frame program – with over 200 experts and scholars from industry and academia involved in the program design of RTI activities – proposed joint financing of EUR 35 million during five years between government, industry, and academia. But due to governmental reorganization, difficulties in financing the proposed MinBaS programme arose. In 2002, the problem was partially solved and the project continued for the next three years, creating a substantially smaller technical programme – the MinBas I – and involving a core network of key actors from the three branches.

The next step in core activities addressed networking and system aspects. The same the key actors in the first stage – producers in the industrial minerals, crushed rock aggregates, and dimension stone industries – were financed by the Ministry of Enterprise, Energy, and Communications from 2007 to end 2010. Currently, planning activities are ongoing to extend the program for another five years by the potential subjects and challenger of "green job" and environmental issues.

5.1 MinBaS as an organisational metaphor for branches in transformation

As a metaphor for a transition process, MinBaS covers a time from when the first conceptual ideas were formulated in the mid-1990s until today, when changes are beginning to culminate in an embryological fusion of the three industrial branches involved in the RTI program. The results of the change process have been achieved using traditional research and technological development techniques as well as explorative market development strategies to co-ordinate and fuse knowledge. For a long time, a contributing success factor in the current MinBaS process has been the well-established interaction on a conceptual basis between a visionary team and an executive project organisation through the Swedish Mineral Processing Research Association (MinFo, established in 1976). The change process has spanned nearly 20 years, and group members have naturally shifted during this time:

- The pre-incubation period – from the early 1990s, when the MinBaS idea first emerged and then manifested in the MTU project in 1997.
- The incubation period – from 1997 to the present.

The stepwise advancement of this process has several analogies with the processes that Vinnova, the Swedish government agency for innovation systems, identified for spurring sector and regional innovation and R&D renewal. Vinnova currently uses its processes in its regional Vinn Growth initiatives. The concept design of Vinn Growth is based on the idea of combining (i) the approach of sector systems of innovation and (ii) triple helix modes of collaboration. In potential regional growth areas with reasonably strong knowledge bases, the triple helix collaboration modes promote innovation and R&D capacity between regional localized parts of (i) a particular industrial sector, (ii) a university, and (iii) regional authorities.

An activity flow of production and innovative development, MinBaS can be described at the micro level as a manifold of activities. At this level, viewed horizontally and vertically, the

companies and the sub-sectors are heterogeneous, concerning issues of business concepts, firm size, experiences of R&D, collective co-operation, and knowledge-driven ventures. Analysis problems of the fuzzy interfaces between branches also occur, for example, how to determine how far along the refinement/processing chain each sub-sector must go before another branch sector takes over. Many of the companies in MinBaS's domain of stake are due to supply agreements part of larger production structures and net of supplies connected to users in other branches, for example, the building and construction industry, the pulp and paper industry, the chemical industry, the steel and base metal industry as main constituents (c.f. Dahmén, 1958, and his concept of development blocks). MinBaS – as an overarching branch structure – can schematically be described as a mixture of large and small companies working with development and production in three main product and market segments.

Industrial minerals applications with its central stake in traditional chemical, pulp and paper, and pyro-metallurgical industries, aggregates for physical transport infrastructure and construction industry and dimension stone products mainly for application in buildings and in the outdoor infrastructure. Production value in the MinBaS sector – for the three sub-sectors combined – is approximately SEK 10–15 billion.

5.2 Pre-history of MinBaS

Retrospectively, the main incentive to MinBaS can be traced back to the Swedish government and its white paper on Mineral Politics (1980), which gives R&D priority and legitimacy to industrial mineral production in its own right as a public research and development area. But in line with this, two other R&D initiatives in the 1980s seem to have had a pronounced impact on further endowments. The Atik project: Industrial Mineral, the mining industry's and Department of Trade & Industry's flagship project to develop high quality products and advanced industrial production based on tailings from the Atik copper mine in northern Sweden. The project was initiated in 1976 and terminated 1983. The project showed after six years of development work that the basic philosophy of development about production of industrial mineral products from tailings of mines failed due to facts that was not possible to met user demand of robust and eve production of high quality products.

This caused the Swedish National Board for Technical Development (STU), one of the financers of the Atik project, to reconsider the basic development philosophy and initiate Focus Area Industrial Minerals, a mission programme that was conducted between 1985 and 1989, along with a number of associated projects, under the auspices of MinFo's Industrial Minerals Section. The Focus Area created this section to manage business-oriented tasks and market issues, which at that time were unaccounted for in STU's organisational structure and policy framework. The programme borrowed some positive features from the Atik project concerning identification of promising niche markets but shifted focus to exploring process and product technologies to enable exploitation of natural mineral resources "in a green state" and formation of an appropriate research base at a university and research institute. This mission programme, which for the times, contained several new policy measures on a micro level, later evolved into MinFo. Its purpose was to stabilize and consolidate previous investments in network building and established customer and supplier relations, together with its achievements, in a knowledge base and interconnected research network.

5.3 Key actors and critical events

In the early and mid-1980s, the prevailing policy at the former Department of Industry and its subordinate agency, STU, had its locus in basic industry. Unease over basic industry's vulner-

able situation as an export sector due to the oil crisis in 1974–1976, not least concerning the pulp and mining industries in northern Sweden and how these could be strengthened in the otherwise low employment environment of the northern regions of Sweden was a central issue for executive management at the Department and at STU.

At the same time, new policy ideas – outgrowths of Dahméns (1950, 1958) conceptual theory building and studies on industrial development blocks – began to circulate within STU. The ideas involved the dynamics of complementarity and how tension between these blocks could be used to stimulate renewed development and break lockups in mature sectors and sector-systems. These new policy ideas evolved into the design framework for STU's mission programme Focus Area Industry Mineral and became implementation guidelines during 1985–1989. The emergence of the Focus Area created a unique arena for executive managements of mineral producers and key Swedish customers in strategic market niches to meet. Twelve persons from these managements were invited to become active members of the Focus Area's board. On the initiative of SCA's board members on Focus Area's board, a special industry section for industrial mineral questions was formed in MinFo in the last half of 1985. Members on the producer side of the Focus Area's board comprised the board of the new industrial section's operations.

The discussions between the industry members of the Focus Area's board during its 5-year lifetime (1985–1989) and the bilateral dialogues with and between the companies within and outside of the Focus Area's immediate action framework during this time created a cognitive platform of common interest. This became the intellectual foundation of the processes that occurred during the rather long incubation and lead time that resulted in the formation of Mineralteknisk Utveckling AB (MTU) in 1994 and was the intellectual starting point for MinBaS. This more than 5-year cooperation in the Focus Area for industry minerals and its extension through MinFo's programme and project activities made it possible for companies and branch and research organisations in the industrial mineral sector, together with nearby user branches, to develop joint routines and development projects to strengthen preconditions for competitive Swedish industrial mineral production. The cooperative efforts were based on a mutually growing insight that several things would be needed to succeed: (i) extensive cooperation between mineral producers and various categories of customers, (ii) development alliances with suppliers of services and equipment on both sides, and (iii) assistance from government permitting agencies and other standard-setting organisations in the development processes. For example, a fruitful partnership and development cooperation between STU's Focus Area and the Board for Government Mining Properties [Statens Nämnd för Gruvegendomar] was developed to exploit industrial minerals. This realisation, of the necessity of partnership, laid the group for MinFo's actions in the MinBaS programme and its predecessor, MTU.

5.4 The long incubation time and the creation of MinBaS' predecessor, MTU

In the rather long incubation time, and during period 1990 to 1997, which culminated in MinBaS's idea and start-up phase, MinFo played a key role as an intermediary in development, both as idea carrier and as administrative actor with the ability to orchestrate and maintain ongoing processes. In the early 1990s, Sweden underwent a deep economic crisis. Substantial structural changes and elimination of production capacity in Swedish industry created an anxiety concerning previous industrial trade policies.

This unease (anxiety) caused policymakers to seek new ways of addressing the issue and to speak increasingly of knowledge and competence development as the decisive factor in economic growth. This view is exemplified in political statements during 1992-1993, that "knowl-

edge is becoming the most important production factor in industrial life". For the first time, the term knowledge society makes its way onto the Swedish political map. As a concept and an ideal, knowledge society, which had entered Swedish research circles at the beginning of the 1980s, now became the focus of industry and research politics.

This shift had great consequences for the Swedish Agency for Economic and Regional Growth (Nutek), STU's successor. The new focus was on generic technologies and knowledge generation in academic environments. The academic world's third task – to disseminate knowledge – was being formulated. In the face of the threat of drastic budget cuts and fund transfers to the academic-controlled research councils, which occurred in the constant struggle between the Ministries of industry and education, a competence centre programme was introduced for interdisciplinary cooperation between academic research and industry. As a consequence, this programme deviated from earlier forms of cooperation between industrial companies and mature industrial branches that were considered low technology.

At the same time, a historic sector-thinking was more or less cemented, with an inherent loyalty to attempt to fulfil previous commitments. Simplified, expressions such as knowledge diffusion and knowledge transfer became basic elements in the emerging policy. Knowledge was considered an object that could be manipulated, that could be "commodified", and which should be transferred and spread as effectively as possible from higher learning institutions to small and medium-sized firms in vulnerable regions. Large companies' historical importance for technological advancement also had a clear role in this policy. Universities and large companies were more or less considered providers of knowledge to smaller and medium-sized companies in this modified policy.

5.5 Stakeholders in firms and non-governmental organisations

At the same time, MinFo and the group of idea generating stakeholders in MinFo's network began to get signals from Nutek that an extension of the ongoing funding for branch-specific programmes and framework appropriations would be reviewed in light of Nutek's new programme focus. For MinFo, this was cause to announce a reorganisation and to see over its core of member firms and operational structure.

MinFo's management had long felt a need to expand operations and took Nutek's signals to heart. This resulted in efforts to (i) interest junior prototype firms and entrepreneurs in the exploitation of industrial mineral finds and (ii) to develop the small-scale traditional dimension stone companies. Likewise, these two categories see in MinFo and the proposal to MTU an opportunity to (i) obtain administrative support for and help with public co-financing for R&D work and (ii) get access to beneficial research and business contacts in MinFo's network. Thus, these parties actively committed themselves in the preplanning stage of MTU. MinFo, which has worked up substantial competence in creating and running R&D programmes and experience in negotiating with the government, starts up in advance a corporation – MTU – and sells shares to potential participating firms.

Nutek encouraged MinFo to apply for funding for MTU within the framework for a temporary regional pilot programme, which Nutek administered on behalf of the government. The programme targeted technology diffusion and knowledge transfer to local networks of small and medium-sized firms (< 200 employees) in regions with high unemployment.

In its first formulation, MTU's programme proposal was too controversial for Nutek to approve it. The proposal did not fulfil the stated criteria. The difficulty was that the proposal comprised

a mixed constellation of (i) large companies belonging to corporations (ii) small prototype firms run by entrepreneurs and which aimed to exploit potential mineral deposits, and (iii) traditional, established micro firms in the dimension stone sector. For various reasons, Nutek was anxious to find an acceptable legal and structural solution. After several drafts, such a solution was reached and the MTU proposal was approved.

MinFo, which has worked up substantial competence in creating and running R&D programmes and experience in negotiating with the government, starts up in advance a corporation – MTU AB – and sells shares to potential participating firms. The aims behind formation of MTU AB were to (i) engage participants in a common concern and (ii) create a neutral business structure. The newly created board of directors for MTU envisioned long-term development opportunities arising from a broader collaboration between several branches. One goal, then, was for each member to have at least one project important to the member accepted in the programme.

This way of structuring the programme became the standard for MinFo's future programmes. When it assumed programme administration in MTU, MinFo wanted to show with this new programme structure that it could expand operations beyond its circle of member company and specialty of competence networks. So MinFo focused on the project groups with little experience in collective research to expedite work, which mean creating a structure where programme management and the board actively assisted the project groups when needed without taking over leadership. The type of knowledge management and communication pattern that emerged consisted of (i) a functional board that representing all sub-sectors (ii) a communicative chairman of the board – an entrepreneur , self-made businessperson, anchored and well known in the regions, (iii) a small office for daily project guidance and coordination consisted by MinFo's research director, and a consultant with good knowledge of the firms and sector needs. In short, MTU created the organisational form for MinBaS, and the industrial mineral focus area contributed the intellectual cognitive model and strategy.

5.6 The kick-off of MinBaS

The question of closer cooperation between the industrial mineral firms represented by MinFo and the other two sub-sectors – dimension stone and crushed rock aggregates – arose early 1994 during MTU’s founding, and it’s project start up of cooperation in between a group of small new industrial mineral and established dimension stone firms and the MinFo’s group of larger industrial mineral companies and that was conducted in 1995–1998. But it was first in 1997, during this MTU project, that an informal cooperation group comprising the visionary idea bearing team of board members in MinFo and the executive management from the Swedish Aggregates Producers Association (SBMI) and the Swedish Foundation for Strategic Research (SSF), sector associations, to discuss questions of common interest. In these discussions, it emerged that the companies had a great desire for an official investigation into the conditions for a mutual development of the sub-sectors. After many formal and informal contacts with the Ministry of Enterprise, Energy and Communications, the Ministry asked SGU in 1998 to carry out, in close cooperation with sector representatives, a forward-thinking inquiry into Swedish industry's future in the production of industrial minerals and rock.

The inquiry found a need for development work in not only geology but also in production and process technique, and market and user applications The inquiry suggested that a common R&D programme with a focus on technique and marketing development be formed in cooperation with the industry.

5.7 A prospective frame for a large research, technology, and innovation programme

Plans for an R&D programme on business development per the inquiry's proposal were begun in November 1999. SGU provided project management and coordinated the work as intended state organiser. Nutek, who perceived growing difficulties in maintaining government responsibility for R&D in the mining and mineral extraction sector, financed the inquiry. Nutek had inherited this responsibility from STU, but the government was cutting research appropriations to the sector and shifting focus by doubling funding to the IT industry and for IT use, so Nutek pushed for a new state organiser for the sector, so it would develop well. Approximately 200 experts and researchers from firms, research organisations, and public authorities were involved in working out the details of a programme proposal that spanned geology and prospecting, product adaption, and market development. The proposal, which totalled SEK 300 million over five years, was presented in November 2000 to the Ministry of Enterprise, Energy and Communications.

5.8 A reversed smaller programme as a possible solution – MinBaS 1

For various interdepartmental reasons, the Ministry of Enterprise, Energy and Communications cited difficulties in obtaining necessary in-house acceptance by the Swedish Government Offices for the proposal. Apparently, MinBaS had gotten caught in the middle of an interdepartmental policy tug-of-war during a reorganisation in the Offices. As the initiator of the MinBaS proposal, MinFo began to experience a credibility and funding gap. In such a critical situation, it became vital to keep industry's interest alive and retain organisational credibility as a professional intermediary. Some support was had by pointing out two short projects: the newly formed Vinnova (2001) and a negotiated project package from the Swedish Energy Agency (STEM) that was lifted out from the proposed MinBaS programme (2002–2004).

After repeated proposals from SGU's new management and key stakeholders concerning the MinBaS sector need for a development programme, the government commissioned SGU in spring 2002 to write a programme proposal for what the Ministry named as a cluster net covering the three mineral extraction sectors. The commission was contingent upon SGU consulting with Nutek and Vinnova on the focus and formulation of the proposal. In June 2002, SGU submitted a proposal on the purpose and funding of the programme to the Ministry of Enterprise, Energy and Communications. In September of the same year, the government decided to assign SGU a frame of SEK 15 million from resources intended for regional balancing. The money was to fund a 3-year programme to develop the industrial metal, crushed rock aggregate, and dimension stone sectors. The work to adapt the initial proposal to the new volume, MinBaS I, was thereby begun.

So how did the political landscape look at the time of the MinBaS proposal, which led to a considerably smaller project that was 1/6 the volume of the original that had been presented to the Ministry of Enterprise, Energy and Communications in November 2000? In short, the playing field could be summarised thus:

- The Ministry of Enterprise, Energy and Communications find it difficult to obtain acceptance in the Swedish Government Offices for the MinBaS programme due to varying views on internal policy.
- Nutek is in the process of involuntarily spinning off its third leg – the R&D department – according to a directive to the new Vinnova that was starting up. Having financed the inquiry together with SGU, Nutek authorizes a Tran regional cluster venture.

- Vinnova is newly started up from R&D sections of three government bodies and needs to create an image for itself distinct from, for instance, Nutek. Vinnova shows little interest for mature sectors such as the minerals industry and, due to budget cuts, divests frame support to mature sectors that are considered non-research-intensive. Vinnova adopts a wait-and-see view.
- SGU conducted inquiries into the development of the MinBaS sectors in 1998 and 2000. It now attempts to actively lobby for MinBaS, among other reasons, because of SGU's stated environmental goal of radically reducing use of pit run gravel in the industry.
- STEM is interested in those sections of the proposal concerning large carbon dioxide generating and energy consuming industries.

The picture that is emerging is that it was in the late 1990s that cluster policy issues were beginning to be more seriously discussed at the ministerial level. Not least, cluster policy was being seen as a more realistic alternative for industrial development in lower regional politics. Porter's (1990) business economic–oriented cluster concept appealed not only to Nutek – with two of its three legs in (i) business development and SME-support and (ii) regional balancing and business support – but also to wide circles of researchers and policy makers, where it won acceptance in surprisingly short time. In a neo-economic perspective, teaching and learning institutions had previously drawn attention to the micro-plane at the firm level; this was what Porter now, in an attractive way, bound together into a broader development perspective in his cluster concept.

Networks and clusters were two dominant concepts that became fixed tenets in Nutek's programme policy. Concepts such as the teaching economy and innovation in a comprehensive system perspective had been discussed in research circles since the mid 1990s, but such concepts had rarely reached the policy level. This was especially true for the process- and system-oriented concept of innovation system in the international discourse that first later, during the formation of Vinnova in 2001, became an operative policy concept in Sweden. Further, it can be noted that environmental and energy aspects, which have always been vital determinants for the mining and mineral extraction industries, became increasingly so for development and research in the MinBaS sectors.

The result of the authorities' positioning and actions was an offer in early spring 2002 for a very small MinBaS programme – SEK 30 million with SEK 15 million in government financing – from the Ministry of Enterprise, Energy and Communications, which considered the full MinBaS proposal difficult to finance. The government commissioned SGU in spring 2002 to draft a programme proposal for a cluster network spanning the three mineral extraction sectors. The formal decision meant that SGU would draft the proposal together with the three sectors after consulting with Nutek and Vinnova.

SGU submitted a proposal in June 2002 for the aims and financing of the programme. In September 2002, with funds earmarked for regional balancing, the Swedish parliament decided to assign SGU a frame of SEK 15 million for a 3-year programme to develop the industrial mineral, crushed aggregate, and dimension stone sectors. Thus, the work to adapt the previous proposal to the new volume began.

The MinFo groups of industrial mineral and dimension stone firms – which had already developed links through the MTU project and had positive administrative experience in the later stages of MTU – decided to continue and try to effect a new, larger R&D programme with gov-

ernment co-financing. The crushed aggregate sector and the Swedish Aggregates Producers Association (SBMI), on the other hand, were indecisive. Sole proprietorships in the aggregate sector on the west coast were driving forces for collaboration, due to the need to produce increasingly larger shares of crushed rock and to find new techniques. In their eyes, SBMI and the Stockholm firms were not concerned enough about these issues. MinFo had already begun some R&D that was highly relevant to the aggregates industry, for example, concerning crushed aggregates in cement, because the industrial mineral companies in MinFo were interested in whether they could deliver filler quality that would solve some of the issues with using crushed aggregate instead of sand in cement.

The dimension stone industry, which after MTU had had its own government co-financed research project with Nutek, wanted to start a new, larger programme. So the industry decided to work collectively for the start of MinBaS I to (i) satisfy its sector's development needs and (ii) get assistance in rigging and administrating larger programmes. The aggregate industry, which had no previous experience in the premises and requirements of collective research with government funds and had only conducted projects under the auspices of the sector organisation, wanted to tone down R&D activities. Internally, the industry was split. The pit run gravel issue and the changeover to crushed rock began to interest more firms, even though the official sector policy was to effect a change in the environmental national target of reducing the industrial use and extraction of natural sand and gravel . So SBMI was initially hesitant, unsure of how everything would turn out, but the larger firms soon pressured it to initiate a more long-term research project. SBMI eventually participates in SGU's sector inquiry and in the development of the larger RTI programme for the MinBaS sectors.

MinFo's board, of which the dimension stone industry is a member, and the executive managements that were firmly committed to bringing about the first common sector programme for the MinBaS sectors, assisted SGU in the start-up of the greatly reduced government proposal for MinBaS I. These two groups worked with SGU in spring 2002 to clear up cooperation issues and refinements of aims and organisation. A solution similar to previous ones for project companies was chosen. Equal amounts of share packages in MTU AB were offered the sector organisations in the stone and the aggregate industries. In this way, a neutral legal unit for forming the MinBaS project organisation and a node for coordinating project activities in MinBaS I was created. This was done when the government passed its resolution in fall 2002.

MinFo is anxious for this first common sector programme to succeed and make a positive impression at higher levels. MinFo, who is responsible for the company's reorganisation, drafts the budget and organisation plan for the MinBaS I application – to be submitted in December 2002. MinFo also (i) conducts negotiations and contacts with SGU, (ii) drafts routines for follow-up and reporting in collaboration with SGU, (iii) assumes administrative responsibility for MinBaS AB, and (iv) ensures that there is a contract with SGU in spring 2003.

5.9 MinBaS II – a prolongation toward a sector system

In 2004, political unease for Sweden's industrial base again appears, and a renewed political policy with roots from long back begins to emerge. The government at that time makes a direct proposal to industry and suggests bilateral sector discussions and follow-up sector inquiries to create growth and innovation in sectors what, for Swedish standards, are important for employment and the economy. MinBaS I has begun plans for a new MinBaS programme and notifies the Ministry of Enterprise, Energy and Communications of its wish to participate in discussions.

MinBaS' participation in sector discussions on issues and development needs relevant to MinBaS faces an important challenge: in policy matters, sub-sectors are traditionally referred to the construction and the metallurgy and mining industries. During the sector inquiry for metallurgy, which begins in 2005, MinBaS is invited to participate via NCC/aggregate, Sweden's second largest construction company. At the same time, a slight policy shift occurred in 2005. The previously clear-cut thinking on clusters was being broadened at the policy level – under pressure of the discourse on learning economies and innovation systems that had taken place since the 1990s. Much of this was owing to the establishment of Vinnova, which raised the questions politically through its efforts to operationalise the concepts.

In short, the political policy landscape, its authorities' raison d'être, and its actions related to MinBaS can be summarised as follows:

- The Ministry of Enterprise, Energy and Communications, which is finding it difficult to get the necessary acceptance in the Swedish Government Offices for the programme proposal, initially shows no interest in 2004–2005 for MinBaS II. During the metallurgy sector inquiry, which began in fall 2005, the MinBaS II proposal is accepted. But no notification of government co-financing is given during the 2006 election year. Those behind the proposal bide their time during instalment of a new government, but word at the civil servant level is that a somewhat slimmed version of MinBaS II may be in the future. The co-financing agreement is announced in April 2007. SGU is again chosen as state organiser.
- SGU, which early on was interested in a continuation from the executive office and civil servant side and which as state organiser wished to carry out a MinBaS II, follows the sector inquiry closely. SGU puts in a good word for the programme with the government and finally is awarded the MinBaS II commission in April 2007. SGU pushes through MinBaS's work by revising programme plan II per the new directive. SGU announces that it will administrate and follow up the programme per earlier decisions and routines worked out for MinBaS I. It will, however, be more directly involved in programme work and more active as future R&D executor in the project.
- Nutek/Vinnova, who are involved in the governments sector inquiries, shows no special interest for MinBaS. The mining industry, which perceives MinBaS as competition, prefers Vinnova as a government co-financier and organiser, with the expectation of potentially greater economic muscles and a more wide-reaching competence network.
- STEM again shows interest in supporting a project package in the mineral industry – this time for the quicklime product CO2.

The knowledge and communication pattern that crystallises from this process is that the contacts that were established during MinBaS I between persons at the Ministry, in SGU, and in MinBaS management continue and become an important part of MinBaS II's birth. The good reputation that MinBaS I built up through its commitment to industry and favourable evaluation had a positive effect on relations between authorities and the industry and MinBaS.

All sector organizations and firms that participated in MinBaS I clearly stated that they were willing to continue with a MinBaS II programme. MinFo and the two sector organizations, SSF and SBMI, have strong inducements to create a larger, common programme: to improve chances for co-financing and effectives programme work. Many associated questions on envi-

ronment and legislation, EU standardisation, and harmonising of regional decisions on mining concessions act to consolidate sector collaboration.

MinBaS AB's management worked out a preliminary programme proposal for MinBaS II in autumn 2004 and submitted it to SGU and the Ministry. In subsequent sector discussions in 2005, MinBaS AB's chairman MinFo's director of research, and SBMI's head of research had the possibly to participate in the subsequent the sector inquiry for metallurgy industry with delivery of various inputs of texts and arguments a MinBaS-program , When a government decision for an extension of MinBaS was received, MinBaS management, together with the firms, drafted a modified programme that was adapted to the government directives and the budget. Groundwork for a MinBaS III is included in the programme planning. The new programme was initiated based on previously worked-up routines and networks. Like in I, work in MinBaS II was organised in five work packages and so was quickly underway on various hierarchical levels in the project network.

A mid-term evaluation in October 2009 noted that MinBaS II had accomplished much in a surprisingly short time and with limited public funds. The management network between, for example, MinBaS management and the sub-sectors, as with SGU and to some extent the Ministry, were well established, as were the operational activity network in the work package and on the project level. Also in this latter network, which was formed after MinBaS I, were regional actors and private research financers such as the Development Fund of the Swedish Construction Industry and Workers Association (SBUF), the Hesselman foundation who were now even more committed.

The critical point at this stage for MinBaS management and MinFo's role as facilitator was the necessity to get access to discussions and legitimacy as active discussion partners in the government's sector discussions with the industry. This was a strategic issue for MinBaS's continued existence and status, not least in a political perspective. The crucial points for MinBaS were (i) access to governments documents for the sector inquiry into the metallurgy and mining industries and (ii) the opportunity as propounded to continually submit documents and influence aims. In the inquiry's final document, a new MinBaS programme was identified as key to achieving growth-oriented innovation and development in the metallurgical and mining sector products.

In a larger view, the policy argument to support development projects like MinBaS, which represents fairly low-tech sectors, seems to include an ecological perspective. The by-products of MinBaS firms are fairly neutral and harmless or chemically inert raw materials that are used in other industrial sector production processes. The upsurge of new knowledge and techniques to upgrade product and production technology within the MinBaS sectors will have an economic impact in other domestic sectors (c.f. the EU PILOT project, 2005). The various MinBaS outcomes will also push development toward efficient utilisation of domestic resources in a range of economic sectors such as transportation infrastructure, the construction and housing sector, and major traditional Swedish net exporting industries like the pulp and paper, and the steel and pyrometallurgy sectors. These arguments obviously appealed to government authorities, and a MinBaS II project was in script in the final report.

6. Analysis and discussion

Broadly, MinBaS typifies a process of transition. It spans a period of more than 20 years – from a protracted period of pre-planning, incubation, and formulation of the first conceptual ideas to today's plans for a potential fusion of the three sectors involved: industrial minerals, crushed rock aggregates, and dimension stone.

Table. Phases, actors, and activities in the MinBaS transition process

Actor/Phase	**Incubation** (1985–1996)	**Idea & start up** (1997–2001)	**Technical R&D programme & networking** (2002–2006)	**Consolidation of actor networks and emergence of an innovation system** (2007–2010)
Government and agencies	The MinFo mineral programme is funded. STU/Nutek is responsible for administration and follow-up.	The MTU consortia is organised and funded as MTU AB. Nutek is responsible for administration and follow-up. SGU starts a foresight activity and develops a proposal for a 'large' MinBaS.	Re-negotiation of MinBaSand funding of a smaller MinBaS I programme. SGU is responsible for financing, administration, and follow-up.	Re-negotiation of MinBaS. Financing the MinBaS II programme. SGU responsible for administration and follow-up.
Non-governmental organisations	Initial university and institute networking activities establish a research base for industrial mineral research and user applications.	New research network through MTU AB focuses on smaller entrepreneurial businesses for exploring industrial minerals and mature dimension stone firms.	MinBaS activities start up. A joint networking programme between universities and the industrial minerals, dimension stone, and crushed rock aggregate industries is formed.	MinBaS continues with the same network of R&D actors.
Private stakeholders (firms)	MinFo coordinates industrial mineral and user firms.	Co-operation as a cluster between established mineral industries and established and new small businesses.	Co-operation expands to include firms in the crushed aggregate industry but not small firms in the industrial mineral sector.	Co-operation continues and is strengthened between firms.
Project management and organisation	MinFo is the managing organisation.	MinFo and SSF own MTU AB. MinFo supports MTU as the managing organisation.	MinFo, SSF and SBMI own MinBaS AB. MinFo administrates MinBaS.	Past ownership and administration continues.

This transition can be illustrated in four phases: (1) incubation, (2) idea and start-up, (3) technical R&D programme and networking, and (4) consolidation of actor networks and emergence of an innovation system. The table illustrates this transition process as phases, actors, and important activities.

What can be said about leadership and interaction between the key stakeholders in the MinBaS transition process? In the eyes of management scholars like Ven de Van et al (1999), Garud & Karnoe (2001), and Garud et al (2009), an intentional transition management must (i) be aware of various factors of change and contingency and (ii) in a reflective way, navigate a changing environment with agility to create actual space for its own route in a flow of internal and external events (Garud et al 2009). The first observation is that leadership processes and central actors occur on four (triple-helix like) levels (c.f. Etzkowitz & Leydesdorff, 2000), from the highest level – the government and various agencies – to lower decision instances such as non-governmental organisations (NGOs: the academic system, research institute, and sector organisations), private actors, and actors at the project management level.

Phase 1. During the incubation phase, the government dominated through its agencies, which finance competence and network formation in the industrial minerals area via STU's mission programme "Focus Area Industrial Minerals". This resulted from the close interaction between STU and the industry, in particular the Swedish pulp and paper industry (c.f. Frykfors & Klofsten, 2010, "development pairs"). The outcome of this interaction was the formation of MinFo industrial minerals – the successor of STU's Focus Area Industrial Minerals. MinFo became the driving organisation behind the emerging sector programme, MTU, which later transitioned into MinBaS.

Phase 2. In the next phase (idea and start up), thoughts on a common development of the MinBaS sectors are realised in a first step by the formation of MTU AB as coordinator of the first programme. This phase is characterised by a transition from government dominance to development that is clearly driven by industry. The MTU programme exemplifies this through its focus on product and process development in the stone and industrial mineral sectors.

As in phase 1, the central organisational actor in this process was MinFo. During the MTU programme, a dialogue is initiated between branch representatives (industrial minerals, dimension stone, and crushed rock aggregates); the Ministry of Enterprise, Communication and Energy; and SGU. The purpose was to start a foresight process into the common development of the three sectors. The outcome was a joint programme study between industry and SGU on the first proposal for a MinBaS programme, which was presented to the Ministry in 2000. Via Nutek (STU's successor), the government was still important for a large part of development funding during start up. In the next phase, SGU assumed this role.

Phase 3. With time, the Ministry developed problems funding the MinBaS programme in the proposed size, primarily due to changes in directives concerning R&D funding of the base industries and traditional industries overall. This led to greater industrial involvement in the third phase, namely, to form an R&D programme and R&D networks because of the government's change of focus. The focus was more and more on high technology, such as IT and biotech, and an increasing emphasis on industrial cooperation. This third phase was characterized by strong, increasing intensity in research and innovation, primarily through cooperation between industry and academia. As a result, industry, represented by MinBaS AB and MinFo, initiated renegotiations with the Ministry and SGU concerning a substantially smaller programme – MinBaS I.

Only a few selected companies in the three branches and the innermost network of NGOs (research institutes and certain universities) could be included. The government was still responsible for the project and, via the Ministry of Enterprise, delegated funds to SGU for financing and implementation of MinBaS I. SGU was thereby given a new role as research financier.

Phase 4. In the fourth phase, a consolidation of existing actor networks occurred and was strengthened in the form of a new innovation system that began to emerge. This was the main outcome of the technical development programme in MinBaS I and II and the community of practice and project networks that were conducted by MinBaS AB. SGU is now the sole source of government support and becomes increasingly interested and committed to the technical development of MinBaS II. Development is characterised by an expansion of the MinBaS I cluster network to an embryonic innovation system through various policy issues (e.g. environmental issues) and more concentrated cooperation with an emphasis on innovation and business development between companies.

The development of MinBaS has features similar to those described by Wenger (1998) for communities: (i) the sense of joint enterprise, (ii) a mutual engagement, and (iii) a shared repertoire of means and resources. These three features are hallmarks of the management approach in MinBaS and MinFo's role in the development process. A closer look at MinFo's approach to uncovering intentions through network activities reveals thirdly an other basic mechanism in the frequent use of open participative approaches and firm commitment to the concepts of community of practice throughout all levels of the MinBaS programme. According to Wenger (1998), the heuristics of meaning within a community of practice is negotiated through a process of participation and reification by producing abstractions, concepts, and stories as well as terms, means, and tools.

7. Conclusions and lessons learned

The research questions addressed in this paper deal with transition processes between mature industries, and particular interest is devoted to interaction with key stakeholders and the role of leadership (transition management). The MinBaS case illustrates this process by showing how persistent management and stakeholder interaction occur in the transition process within three industries and how a supportive intermediate such as MinFo successfully orchestrates this transition in a landscape characterized by contingent and shifting politico-administrative policies. fundamental mechanisms can be seen in the transition process from incubation to embryonic innovation system: first, a continuity throughout the development process of a vision-oriented, idea-generating team, forming a proactive leadership with intentions to achieve a strategic collaboration between three industrial branches; and second, the assistance of an executive project organisation in the unfolding of these intentions through an orchestration of activities.

In a discussion of socio-political system transition, Marsh and Rhodes (1992) defined four categories of change processes: economic, institutional, ideological, and knowledge dimensions. Marsh and Rhodes (1992) defined four categories of processes of changes labelled as economic, institutional, ideological and knowledge dimensions that must be met by an intentional transition management to be successful. In this study, long-term, collective leadership that was able to adapt to changing political policy without deviating from predetermined development policy (Braudel, "la lounge durée") proved to be important. This ability to adapt to changing surroundings while holding to a consistent internal policy was made possible by the

visions and the strong personal commitment of the individual dominant actors (Etzkowitz & Klofsten, 2005).

What is an exogenous and what is an endogenous impact in this perspective is not always defined. The type of impact is contingent upon how the actors (e.g. in innovation systems) define their stake boundaries. What an outside observer might consider an impact by an exogenous event or change process may actually be the outcome of an activity that had been actively cultivated by the involved actors for a long time that according to Garud and Karnoe (2001) may create new paths in transitions. However it is unclear to what extent the authors include new paradigms and institutional settings. We believe that this is similar to the case of MinBaS.

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