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Technological Development in Networked SME Clusters

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Summary

This chapter presents recent research on SMEs (small and medium sized enterprises) in networks and clusters in the South and the implications of this research for technology policy and the promotion of technological upgrading in SMEs. First, the cluster concept is explained, and the importance of understanding clusters as an expression of social connectivity, and rather than mere spatial agglomerations, is established. The types of linkages prevailing in different types of clusters are analysed, as well as their implications for technological change. It is emphasised that the mechanisms of enterprise growth and innovative activity are different in each type of cluster and that policies must take account of this circumstance. Reasonable policy goals in this context are summarised next, and it is argued that moving from elementary clusters to more advanced and dynamic types calls for increasing the available pool of distributed technical and engineering capability. The main obstacle to this are communication gaps between technological cultures and local path-dependence, and this can lead to stagnating rather than dynamic clusters. In lieu of a general solution, four support approaches are outlined, which merit further consideration. They are: South-South-cooperation, field experiments conducted by local educational institutions, industry-based vocational training and a focus on resource based strategies.[2]

The cluster concept

Clustering means basically that enterprises are close to each other and that this proximity creates opportunities for collaboration, creates externalities, etc. However, this colloquial use of the term is somewhat problematic. Exactly how proximate firms need to be in order to constitute a cluster depends on the context. In the literature we also find clusters which are identified in quite specific locations within cities, such as the Timber Market in Accra (Sverrisson 1997), the Gamarra cluster in Lima (Visser 1996, 1997, 2000) and the tile making cluster analysed by Sandee and Rietveld

(2000), etc. In other cases, clusters are coterminous with a branch of industry within a town, e.g. building (Rasmussen 1992) furniture making (Sverrisson 1990, 1992), shoe-making (Rabellotti 1994, Knorringa 1995), or spread their tentacles over larger areas (Schmitz 1996, Meyer-Stamer 2000), etc.

It is possible to solve this problem by defining clusters as features of social network topologies (Scott 1991, Wasserman and Faust 1994). If the economy is seen as a complicated network held together by economic transactions, clusters can be seen as those areas of this network where connections are particularly dense *and* economic transactions are overlaid by (or embedded in) other types of relationships. Immediate proximity is only one among possible relationships, others being e.g. technological cooperation, subcontracting, common ethnic background, shared educational characteristics, division of labour, etc. etc. After all, there are e.g. software development clusters which are manifested mainly on the internet. The spatial connotations some writers attach to the concept are therefore somewhat unfortunate. However, proximity of firms is often the first indication that something interesting is happening and proximity can even be useful as an operational variable (e.g. in Visser 1996).

A review of well established research results

In this section, some well established research results are presented, which are of immediate relevance to the policy issues in later sections.

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Clustering happens 'spontaneously' and is ubiquitous

The large number of cases now available which analyse some kind of cluster from one angle or another has established two findings which are important for policy considerations, namely that one can find clusters everywhere, and that they form 'spontaneously.' This phenomenon has been observed in many parts of the world throughout history and it is therefore neither a specifically 'Southern' nor 'modern' phenomenon.[3] From this follows that in order to understand what happens in clusters in the South today it is useful to know what has happened in clusters elsewhere and earlier. However, attempts to transfer and impose 'models' are as unlikely to succeed in this case as in others. The main point, however, is that support to clustering per se is not called for.

Collaborative networks can form within and between clusters

Many of the networks which form within clusters tend to be collaborative in character. Small enterprises do for example help each other with large orders (Sverrisson 1990, Sandee and Rietveld 2000), produce components for one another (Sverrisson 1997, Knorringa 1994), share the use of machinery (Sverrisson 1994a), share technical information (Meyer-Stamer 2000) and attempt collaborative marketing (Visser 2000), etc. However, in most clusters such collaborative networks do not include everyone to the same degree, and they should in particular not be interpreted as manifestations of trust or similar subjective attitudes if these cannot be observed independently (cf. Knorringa 1995, Bagachwa 1997, Trulsson 1997). Further, within clusters one can often observe more or less developed forms of vertical integration meshed in otherwise collaborative relations (Sverrisson 1993, Scranton 1997). In yet other cases, vertical integration is the prevalent form of production organisation, and horizontal connections or linkages in the cluster are rather found at other levels (Rabellotti 1997, Pedersen 1997b, Meyer-Stamer 2000) although in some cases vertical integration and flexible small scale production are united in a single production system (Cho 1994, Takeuchi 1991).

Further, competitive pressures or social cleavages sometimes create an atmosphere in which both horizontal linkages, collaboration and information sharing are severely curtailed (Sverrisson 1992, Knorringa 1994, McCormick 1997), and international linkages sometimes shape forcefully developments within a cluster, including the forms of networking (Knorringa 1995, Bagella and Pietrobelli 1997, Meyer-Stamer 2000). Hence, the observation that firms are located close to each other does not necessarily imply that firms collaborate in any concrete sense of the word nor that this is necessarily the main source of economic dynamism (for a summary and further analysis of this issue see the introduction and conclusion in Sverrisson and van Dijk 2000 by the editors).

Hence, it is *essential* that the cluster concept is operationalised in network terms. It is sometimes impossible to do this rigorously, particularly in secondary analysis, but even qualitative consideration of social connectivity and network proximities are far superior to simple concepts based on spatial distributions.

Different types of networked clusters have been identified

It follows from the review above that there is no single type of cluster, and looking for the paradigmatic cluster is likely to be counterproductive. However, it is necessary to reduce the plethora of case studies which have been produced to manageable proportions, and the following

typology of networked clusters is designed to accomplish that, which is still subject to development, criticism and change.

Typology of manufacturing clusters

TYPE or STAGE	Observable indicator	Main observed benefit	Technical dynamic
Location	**Proximity of firms**	**Information exchange**	**Imitation**
Local market	**Many similar activities**	**Easy access/competition**	**Product development**
Local network	**Division of labour**	**Specialisation**	**Complementarities**
Innovative	**Local Novelties**	**Adapting (e.g. materials)**	**Reverse engineering**
Industrial district	**Formalised cooperation**	**Collective competition**	**Collective invention**

The cluster types are listed in the first column. For each type of cluster, it is indicated in the second column what is the main observable indicator of each type. The main observed benefits are summarised in the third column. The fourth column names the technological dynamic found in each type according to the available case studies.

The first row of the table shows the location type of cluster, observationally indicated by proximity of firms (indeed, sharing premises is not all that uncommon) in which the main observable benefit is the easy exchange of information that flows from cramped conditions, closeness, working outside, etc. The main technological dynamic in this type of cluster is imitation. This cluster type is inter alia represented by the archetypal 'informal sector' area.

The next type is the local market cluster, in the second row, which is indicated by the (relative) proximity of many *similar* activities and outlets, who cater for a *similar* category of customers. The main benefit, and the reason to establish oneself in the cluster, is easy access by customers, and the competition that flows from that, which leads to product development, relative to others in the cluster, niche strategies and other attempts to stand out from the competitors close by. The benefit of easy information flows remains in this type of cluster, and product development is therefore often followed quickly by diffusion through imitation, and a development dynamic, if somewhat limited, results (cf. King and Aboudha 1991, Sverrisson 1990, 1992, Visser 1996).

The third type is the local network cluster, characterised by at least rudimentary division of labour. The main benefits here are those associated with specialisation, focusing on one or a few activities within a larger production chain, e.g. shoe soles (Knorringa 1995) or turned table legs (Sverrisson 1997). The technological dynamism that follows is characterised by the development of complementary activities within a networked cluster, rather than everyone trying to do same or similar things. However, imitation is usually rife and local information access easy in clusters where this dynamic has started to appear.

The fourth type is here called the innovative cluster, shown in the fourth row. They produce locally developed novelties, which can be 'exported' or imitated elsewhere, based on adaptation of known techniques to e.g. locally available materials or the local competence situation achieved mainly through the process known as reverse engineering. Research on Japanese industrial development has provided many examples of this phenomenon, as has research in Korea, India and elsewhere (Yamasaki 1981, Takeuchi 1991, Cho 1994, Jacobsson 1991). Imitation of imported technologies, local product development, and splitting up of processes to develop flexible production systems form the basis of reverse engineering, but the *differentia specifica* of this type of cluster is that an innovative edge is gained which can be turned into a competitive advance in other locations/countries/regions. At this point, therefore, merchants and marketing agents, which have been accorded a small role in the previous types, become key elements (cf. Schmitz 1996, Nadvi 1997, Pedersen 1997b, as well as Sandee and Rietveld 2000, Meyer-Stamer 2000).

The fifth type is what can be called a fully fledged industrial district. Cooperation is formalised, and focused on competence infrastructure, physical infrastructure, joint marketing efforts and quality control schemes and other similar tasks. The cluster becomes an explicit and identifiable community, which competes with others such and collective invention (i.e. the normal form of innovation) prevails over individualised adoption (Allen 1983). Sharing of information is achieved through both formal mechanisms and informally. Hence, easy access to information, imitation, local product development, complementarities and reverse engineering are still moments in the life of the cluster, but now utilised for competition with other clusters rather than within the cluster.

An important conclusion from this review is that policy measures must be adopted to the type of cluster they are aimed at (van Dijk 1999).

An evolutionary sequence is implied

The typology attempted above implies an evolutionary sequence. Clusters can develop from one type to the next. However, the types, as presented here are not exclusive and completely distinct, but rather nested, that is, 'lower' types of cluster mechanisms tend to be nested within and existing on the fringes of 'higher' types and *vice versa*, companies and company groups which operate according to 'higher' types will often find themselves immersed in an environment in which 'lower' type operations prevail. Hence, the issue is not so much how to get from a 'low' type to a 'higher' type, as how to generate a 'high' type from within a 'low' type (Sverrisson 1993, Sandee 1995).

Pedersen (1997a) has suggested a different typology, in which clusters are divided into four types. These are petty commodity clusters (household production and related forms), market town clusters (retailers and small producers), both catering for low-income markets, subcontracting clusters and diversified industrial clusters, aiming at high income markets. However, according to Pedersen, a development path cannot be delineated going from the petty commodity clusters to the diversified industrial clusters in which the other two types are intermediate stages. Rather it is possible that each of the three first-named types can develop into diversified industrial clusters, with varied degrees of sophistication, and eventually, in this way, become the vehicles of dynamic development, or alternatively, they can stagnate or even regress from their current state into survival oriented crisis management.

The policy considerations flowing from each methods for classifying clusters are somewhat different, in that we have chosen to emphasise here intermediate types of clusters, entirely left out household production, and emphasised technological change. The main difference between Pedersen's proposals in the article referred to and those developed below is, however, that Pedersen suggests that development is best facilitated through growing markets and proposes a repertoire of measures to accomplish this, whereas our emphasis below is on the facilitation of enhanced technological communication within clusters and between them and their social environment (cf. also McCormick 1998).

Different branches develop unequally

An important consideration, which has been left out above for clarity of argument, is that different branches develop unequally. Hence, in any particular town or region, one will find a mesh of production chains, which are moving and changing at different paces and periodically stagnating as well, in terms of economic growth and technological sophistication, etc. Most studies handle this

problem by focusing on a single production chain and its local and global ramifications (tiles, furniture, clothing, shoes (been quite popular), food processing, soap-making), often combined with a spatial focus in the form of a particular town or market area. The analysis above has been based mainly on such studies, referred to above. Others have drawn the lines somewhat differently (multiple services, informal sector, regions) and have been able to elucidate interrelations between different branches and activities (Pedersen 1994, 1997b, van Dijk 1986a,b, 1994). From a technology policy perspective, the single chain approach has much to recommend it, as technological aspects are easier to lay bare in this way than when many different processes are involved. However, community dynamics are hard to grasp this way, as well as the role of services used by actors from many different branches, such as transport, accounting services, management education etc., which tend to be easier to study if a broader approach is employed.

Networked SMEs coexist with vertically integrated firms

A further complication is that small enterprises, clustered and networked or otherwise usually coexist with vertically integrated firms (Sverrisson 1993, Schmitz 1996, Knorringa 1995). If anything general can be said about production chains it is this: they always come in pairs. Obviously, there are activities (hairdressers, for example) which only become parts of vertically integrated product chains in the case of (mainly) public institutions, prisons, armies and hospitals. There are also activities in which economies of scale are such that small scale enterprise is hardly an issue (e.g. nuclear power generation). However, most things can be made either through a network of complementary small enterprises or by a vertically integrated production chain. Further, vertically integrated chains in one sub-sector can and often are supported by the existence of networked small enterprises in other sub-sectors which make something or the other needed for the smooth operation of the vertically integrated process, and vice versa. The main types of these links can be summarised as follows:

?? **Input links**

?? **Raw material links**

?? **Subcontracting links**

?? **Service links**

?? **Labour links**

Input links refer to the supply/acquisition of multiple inputs needed for some products characteristic of the product chain in question but not others. In furniture making, this can include screws, nails,

doves, glue, clamps, metal hinges etc., that is one or more of the possible means of joining pieces of wood. Quite typically, such items are produced in vertically integrated product chains but used in networked small enterprise chains as well (Halimana and Sverrisson 2000)

Raw material links refer to the provision of the basic materials needed, where the options tend to be more limited. Textiles are optional for furniture makers, but not for most dressmakers. Wood is not optional for most furniture makers, but it is for dressmakers. In both cases products of vertically integrated and/or large scale activities are typically input into small scale/networked and clustered activities, although there are numerous exceptions to this (Sverrisson 1992, McCormick 1997). Smooth raw material links are essential for survival, whereas input links are not. Therefore, raw material links tend to be the first to be concatenated into a vertically integrated chain (Trulsson 2000), and integration of input links comes later or even never (cf. Halimana and Sverrisson 2000).

Subcontracting links are an intermediate form, in that this kind of links tends to prevail in situations where inputs are not standardised and/or widely available, and vertical integration of the functions involved in making them is not feasible (Cho 1994). Subcontracting is in other words an alternative solution to vertical integration as well as open sourcing. However, it also implies a rather different type of business culture. If open sourcing of standardised items on a cash and carry basis is possible everywhere, with minimal communicative hurdles, and vertical integration creates a situation in which information obstacles and reliability issues are shortcut by bringing them under direct control, subcontracting always implies communication and reliability problems of one kind or another. Therefore, it can only be maintained in fairly homogenous environments (socially speaking) in which the room for negotiation, opportunism and misunderstandings has been reduced by the establishment of generally acknowledged norms for the proper conduct of business. Some of these may acquire legal or quasi-legal (or religious) forms and other may be more implicit in how live is lived in that particular society. Fukuyama's (1996) argument about trust is one example of how this issue can be approached but there are, of course, many others, ranging from Weber's Protestant Ethic and the Spirit of Capitalism (1930) to Storper and Salais' Worlds of Production (1997).

Service links go both ways: small lorry operators carry goods made by large vertically integrated factories, small scale operators utilise railroads for moving their products and materials (Sverrisson 1990, Pedersen 1997a). In general, small enterprise can often get and hold a position in service activities, including retail trade, more easily than in manufacturing because of the lower degree of standardisation involved. Car repair and other maintenance work, machine rehabilitation,

marketing, accounting and money lending, catering and cleaning in factories, personal services of all kinds, these activities are often the cement that keeps a cluster together, particularly in the 'lower' stages (Pedersen 1997b).

Labour links, lastly, is the type of linkage which has attracted least attention by researchers, which tend to construct their objects as firms and agglomerations of firms, rather than for example as learning communities or on the basis of local identities. However, careful reading of the available literature turns up quite a few suggestive examples. Sandee and Rietveld (2000) for example analyse a very interesting case in which small-scale operators also work as wage labourers in larger operations, making kitchen utensils on Java. The products of the large scale firms were headed for urban markets and exports in this case whereas the products of small scale producers were designed for and sold in local markets. In my own research I have come across many instances in which the basic elements of a trade has been learned by someone in a large factory, who then has stricken out on his own (Sverrisson 1994b). Fiona Wilson, in her study of small and medium scale clothing industries in Mexico shows how skills acquired for domestic purposes can be utilised in commercial operations (Wilson 1991). On a more general level, as documented in several studies cited above, wage goods purchased by workers in large factories tend to be made by local small scale producers, and the efficiency of and even lower incomes in such activities provide, in effect, a subsidy for vertically integrated production chains without which they could probably not survive.

Reasonable policy goals

Obviously, policy goals cannot be based on research findings alone. However, it is possible to identify a range of reasonable alternatives, which are discussed in this section, on the basis of the research reviewed above. It is suggested that policy could and should aim at enhancing what is already there, facilitate movement from 'lower' to higher' stages of networked clusters and support work to increase the pool of engineering and technical capability. The assumption is that industrialisation without SME development is about as plausible as a one-legged long-distance runner. Although it is not probable that SME development can form the only basis for industrialisation, it is equally unlikely that industrialisation can happen without change in this sector of the economy, because of the links outlined above.

First recommendation: enhance what is already there

The first step is to enhance what is already there. One of the findings of recent research is that there are strong social, technical and organisational continuities in SME development, in which gradual improvement of technological reverse salients[4] go hand in hand with gradual competence development and increased network efficiency without concomitant radical social change. This finding holds for such examples there are in Africa, where mechanisation of informal sector activities is a ubiquitous phenomenon without having diffused to everybody. In Asia, similar developments have taken place along with more developed activities. Further, the industrialisation histories of Japan, Korea, India, United States and Europe are replete with instances of this (Sverrisson 1993, 1994b)

This process is fundamentally different from the introduction and development of mass production techniques. Although mass production techniques also go through a gradual trajectory during which they are adapted and fine tuned, their social effects tend to be much more deep going, not least the changes in class structure which their proper functioning requires. To put it bluntly, factories cannot develop without the simultaneous development of a working class. The social costs, always high, can be prohibitive in the short run. The competencies needed, both organisational and technical, also tend to be quite different from what is in place, and need to be developed through educational efforts the results of which take a long time to materialise. Although there is a pool of such competence in most Southern countries today, which is 'released' as government and parastatal activities are reduced, there are limits to what can be achieved in this way in the short run, particularly in Africa. Lastly, vertically integrated mass-production systems need stable supplies, secure markets, etc., as well as smoothly functioning technical systems in production itself and in order to achieve this, credit, communications and transport must develop to the point where some degree of predictability is achieved. None of this is impossible, but implies a major reorientation of entire economic systems. This process is much easier if it is supported by simultaneous development of small scale activities, which breaks the ground by creating social groups unfettered by ties to agricultural production, creates a pool of local entrepreneurship, creates the mass basis for transport systems and eventually other communication infrastructures (in which government activities also play a major role, of course) and so on.

Second recommendation: Move from 'lower' to 'higher' stage

Enhancing what is already there in networked clusters implies generating 'higher' type activities from within 'lower' type activities in the cluster typology proposed above (or some similar), i.e. expanding the capabilities of existing clusters. This can mean support for new companies intended to function as 'leaders' in a cluster, but one of the less controversial findings of SME research is that it is easier to work with existing entrepreneurs and also more likely to give tangible results. We also noted above that clustering per se hardly needs special support, although zoning regulations etc. can be more or less conducive to cluster development.

It is probable that the mechanisms facilitating the expansion of a new type of cluster dynamics in the context of 'lower' types of technological dynamic are somewhat different depending on the stage in which a particular cluster finds itself. The changes which have taken place in existing clusters and the resulting transitions are as yet inadequately understood, and it remains a future task to systematise the available evidence in order to get a better grasp of how different growth mechanisms arise, and what they require to be successful. In discussions about SME development, phenomena which should be seen as different kinds of growth and technical change, belonging to different stages, tend to be conflated because of this (and this writer has sinned as much as others). Therefore, it is difficult to be exact about the relationship between them. The typology above is meant to open up for a more fine grained understanding of these issues.

From a policy point of view, however, this means that there needs to be room for experimentation, but, perhaps more importantly, policies need to be developed in a two-way communication between 'donors' and receivers. It is not so much an issue of democracy here as of reliable knowledge. In areas where the task is very simple, to move from location to local market clusters, for example, very simple means may be appropriate. Curtailing police harassment by striking out the bylaws it is based on and promoting realistic health and safety regulations, etc., etc., would take us a long way and generally, the more of this is taken care of at municipal level the better (van Dijk 2000). The issue is, if 'donors' should bother with this at all.

In clusters where the task is to move from local market clusters to local network clusters, facilitating product development and the introduction of novelties is essential. Moving on to mechanisation and division of labour involves credit arrangements and collaborative efforts of some kind among the companies in the clusters, and therefore brings in a whole new dimension. It is

perhaps here that one can expect 'donor' efforts to be most effective in the long run, but in the short run, such initiatives are bound to increase inequalities within clusters, and among them as well.

Higher stages than this are rarely relevant in Africa so I will leave it at that on this occasion. However, the main point here is to identify the critical salient(s) in each transition and attack it, rather than purchase the pretended acceptance of imposed western values, as happens in micro-enterprise-projects which preach salvation through orderliness, particularly bookkeeping, or through 'trust' and inauthentic and sometimes fraudulent business associations.

Third recommendation: Increase the pool of engineering and technical capability

This is undoubtedly an area where 'donor' efforts can make a real difference. Organisational competence, planning capability and 'rational calculation' are cultural artefacts and therefore bound to be manifested in widely diverging forms from one country to the next. The discovery of the 'Japanese way' is a nice reminder that there are many ways to manage all the intricate relationships involved in running a company and maintaining workable contacts within clusters. The only thing one can be sure of is that the locals are much better at it than visitors and that the practitioners are considerably more innovative than the theorists.

However, engineering and technology is also about the manipulation of the material world and interconnections among things, and many of the problems encountered in this regard tend to be similar everywhere, just as the force of gravity is, for all practical purposes, a global constant. Hence, the opportunities for knowledge transfer are in principle endless (Sverrisson 1994b). The issue is rather what is needed to make such transfer effective.

Engineering knowledge and technical skills become effective and useful through systems of distributed and locally adapted knowledge. This has two corollaries. First, it is not how much we know which is most important but how many know what is known. Second, it is more important to know how to find out (know how to read blueprints, for example but also where to find information etc.) than to know about some specific piece of science or engineering. A conclusion is that it makes more sense to spend money on diffusing available knowledge than on creating new knowledge, which is also the normal priority. However, systems for diffusing engineering skills and technical knowledge are in a very sad state in most African countries, including apprenticeships systems and on the job training but also schools and training projects of all kinds, and this is where a major effort is needed (Sverrisson 1997).

SME Technology Policy and SME Innovation Problems

It is now possible to be a little more specific about SME innovation problems. If distributed knowledge is what we need in order to enhance what is there and move up the cluster ladder, we should focus on the obstacles to knowledge distribution. Two aspects of this will be discussed briefly below, communication failures and path-dependence.

Communication failures

There are three types of communication failures which are central from a policy point of view, which can be addressed with some reasonable hope for success. The first is the communication hurdles between TNCs and local companies. The second is the gap between companies/entrepreneurs and bureaucrats. The third is the distance between universities and companies/entrepreneurs. In all these cases, communication failures are the results of different economic cultures (Sverrisson 2000). Indeed, TNC and government spokespersons often find it difficult even to take SME operators seriously as businesspeople.

This situation leads to repeated failures of technology transfer, in the broadest sense. The problem, however, is not so much technical (although this is sometimes at issue as well, e.g. the issue of regular maintenance, exact measurement and fine tuning of production facilities etc.). It is rather that each part in the potential transaction tends to conceptualise the problems in different ways according to the predilections embedded in the business culture in which they live and work. It is no coincidence that SME development, development of large technical systems via government agency and the development of vertically integrated production chains follow their own and separate paths virtually everywhere (Sverrisson 1993). It is also a moot question whether something can or should be done about this. However, it is reasonable and patently necessary to improve the communication among those who are following these different paths, if only because successful industrial development requires them to develop if not in harmony then at least within the reach of each other.

One vehicle of such communication is the diffusion of engineering knowledge and technical competence, that is, the creation of shared frames of reference about how to see and manipulate the material world and the world of things. Almost per definition, people in these different spheres of activity will have different ideas about how to go about their daily business, but if collaboration is to

work they must share the same frames of reference about the material aspects of the world. A (perhaps deceptively) simple example: a company which uses the metric system cannot subcontract components to a company using the imperial system without cumbersome translations (Law and Bijker 1992).

Path dependence and lock-in

The current communicative situation is inter alia manifested in what has been characterised as path-dependence and lock-in (Meyer-Stamer 2000, Visser 2000). This is reinforced by the following aspects of the situation brought on by structural adjustment:

?? **Increased competition, less redundancy**

?? **Prevalence of 'crisis management'**

?? **Inadequate information facilities**

Structural adjustment, by increasing the competitive pressures on everyone, reduces the room for innovation and learning-in-practice (cf. Sverrisson and van Dijk 2000). Rather, what we see is a situation characterised by continuous crisis management which is compounded by the inadequate information facilities which are available in the South. Each of the three types of productive activities which are outlined above (TNCs and related, parastatal, SME) needs to be reoriented and restructured in consequence of structural adjustment, and their respective shares will probably change as well. However, much of the experience with structural adjustment so far is about resistance to change, that is, meting the shocks of structural adjustment by falling back on old and well tried methods, often increasing their sophistication (Sverrisson and van Dijk 2000).

This is only normal, companies, large and small, want and need to avoid bankruptcy, and parastatal leaders want to remain just that. How to achieve this and simultaneously make use of the opportunities eventually found in the new situation? The answer is often risk reduction which can be achieved by integrating production chains rather than opening them up to enhance flexibility and unpredictability, sticking to low risk products rather than launching new ones, adding labourers which can be fired rather than buying machines on credit, etc. Further, communicative hurdles, which might

constitute significant but affordable glitches normally now become unnecessary risks to be avoided even more than earlier.

However, this situation will not last forever. Some approaches which might help in the transition are suggested below.

Some possible paths forward

In this section, four approaches which have been proposed (by others) are briefly reviewed, in lieu of a conclusion, that is, South-south co-operation, University based field experiments, Industry based vocational training and Resource based foci. They are discussed from the point of view of their utility in African contexts.

South-south cooperation

This means in our context promotion (with 'donor' funds) of trade in capital goods between countries in the South and exchange of consultant services related to that (Carlsson and Shaw 1988, Carlsson and Jörnmark 1994). Indian, or for that matter, Brazilian, Argentinean and Malaysian machinery is often more suitable than imports from Europe in African conditions, because of materials, a simpler, more robust design, etc. A main point here is, however, the smaller communication gap, in engineering terms, between say India and Kenya, than between Kenya and Sweden, for example. Many of the problems connected with making and maintaining machinery suitable for flexible SMEs are still on the agenda in India, where they are solved without assuming *general* access to and competence in numerical control applications. Most engineers in the North are already deeply conditioned by the potential of information technologies, easy access to a wide range of new materials, as well as the promises of bio-engineering and environmentally oriented process design. Mutual learning is therefore more likely to take place in a South-South context than in a South-North context. In the latter case, one-way communication is the rule, not the dialogue Arnold Pacey (1990) has convincingly singled out as the key feature of technological learning. Because of the diffusion mechanisms internal to clusters, the prevalence of imitation, etc., such mutual learning experiences are likely to benefit many others than those directly involved, which is less likely if learning is focused on advanced, state of the art, practices which tend to remain isolated from other

cluster activities (Rogers 1983). Services provided by mechanised operators to others also help the entire cluster, but only if the available technology selected is appropriate. This type of assistance could also be combined with the next approach.

University based field experiments

The paradigmatic example here is the Kumasi Institute of Technology project, although it was by no means perfect. Machinery was provided on moderately easy credit terms to SMEs in the local informal sector area, the Suame magazine, and its installation and operation overseen by people from the local institute of technology. However, the main point, which (from what I know from my own interviews in Kumasi a few years later) was perhaps not developed to its full potential, is to educate the educators about SME considerations and problems, and thereby, enhance the quality and relevance of the teaching provided. This comes up against powerful academic and funding obstacles (the large number of people in Ghana and elsewhere involved in developing Appropriate Technology rather than supporting the diffusion of Available Technology is significant here). However, the tasks of engineering schools vis-à-vis SMEs need to be put on the agenda and defined in terms of supporting technology diffusion and adaptation, made possible through credit schemes and local purchasing for 'donor' funded projects, etc (Sverrisson 1997).

Industry based vocational training

The main long term benefit of industry based apprenticeship schemes and other vocational training efforts, run in cooperation with companies, is that they create links between large companies and the prospective proprietors of small companies (King 1991, King and McGrath 1999). It is for example much easier for someone who has a past in a large company to understand how the ropes are worked and for example take on maintenance services or provision of components. Further, as many larger companies in Africa are not all that advanced, and are constituted by agglomerations of elementary machinery rather than integrated production systems proper (furniture in Zimbabwe, for example) much of what is learned, not least acquiring familiarity with machinery and the benefits of regular maintenance, is of immediate benefit to small-scale operators (Sverrisson 1990). There are other benefits as well, such as finding out about the market and being able to determine a suitable niche strategy, which can be gained from such experiences (Sverrisson 1993). An issue likely to require attention is incentives for large companies, which readily provide on-the-job training but then

expect workers to stay and tailor the training to that. Even for SMEs it can be a frustrating experience to train someone only to see him open a competing workshop across the street as soon as he is good enough to be really useful, or even worse, desert to the competitors (Sverrisson 1992). Hence, the policy issue boils down to continuing to develop school-administered systems in which practical training in large and small companies forms a part, and providing SMEs as well as other companies with the appropriate incentives to participate.

Resource based focus

As noted above most production activities can be organised either as vertically integrated production chains or as a sequence of flexibly connected SMEs. Which is more suitable depends on a host of factors *and* on how they are perceived. As a result, one frequently finds both variants side by side and combined in various ways (Sverrisson 1993, Schmitz 1996). In developing SMEs and particularly in promoting the maturation of clusters moving from one stage to the next it is important however to select activities which have a future in spite of the vagaries of international politics, climate etc. and a solid resource base is the best guarantee for that. This should be understood in a broad sense, including both general raw materials (wood, metals, foodstuffs, clays), strategic or rare inputs (hardwood, diamonds etc.) widely diffused skills of some kind (weaving, sewing etc.) and whatever else which can constitute a resource ranging from traditions in art and music to cheap labour (Burt and Talmud 1993). Looking at the issue of niche strategies in this way rather than 'from the other side,' that is in terms of demand, makes it possible to identify possible competitive advances, which are based on long term material, technical and cultural considerations rather than on variable relative prices (including interest rates and exchange rates) or other unpredictable aspects of the situation. In order to survive structural adjustment and move on, small (all?) industries must in the main be based on local resources rather than local or global markets. Such strategies must of course be workable in the price situations which obtain from time to time, but this is a secondary consideration.

And lastly …

All the strategies which have been briefly outlined above share two characteristics, namely that they seek to mobilise local resources and initiative and facilitate the upgrading of distributed knowledge and diffusion of appropriate technology. The theoretical consideration leading up to these strategies

are based on established knowledge, readily available in both detailed and overview form in a large number of publications. Considerable experience has also been gained in initial applications of all these support approaches, the results of which can also be accessed. The implied role of 'donors' in this context is mainly to fund various initiatives. The exact channels through which funding flows are of course a matter of negotiation and not something that can be determined through scientific analysis.

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[2] In addition to my own work on technological change in furniture manufacture and light engineering in Kenya, Zimbabwe and Ghana, this paper draws primarily on work done by participants in the EADI industrialisation strategies working group which have been presented at different group events and published in joint publications over the years (Rasmussen, Schmitz and van Dijk 1992, Pedersen, Sverrisson and van Dijk 1994, van Dijk and Rabellotti 1997, Sverrisson and van Dijk 2000 (in press), and Knorringa, Sandee and van Dijk, forthcoming). See also Späth 1993, Nadvi 1994, McCormick and Pedersen 1998 and Schmitz and Nadvi 1999. This paper is part of a joint effort by MP van Dijk and me, who have served as convenor and co-convenor of this group, to summarise and draw out some general conclusions from the wealth of case studies published over the years.

[3] There is a large literature about networked aggregations of industrial firms, their dynamic growth and/or stagnation. Marshall is usually credited with the first systematic observations on the phenomenon which was also analysed early on by Lewis Mumford (1962). Historical forms have been studied by inter alia Yamazaki (1981), Kriedte, Medick and Schlumbohm 1981, Sabel and Zeitlin (1985), Isacson and Magnusson (1987), Takeuchi (1991) and Scranton (1997). A number of relevant and recent case studies can also be found in Sabel and Zeitlin (1997). Relevant studies of contemporary phenomena include Piore and Sabel (1984), Laage-Hellman (1985), Pyke, Beccatini and Sengenberger (1990), Piore (1992) and Mitsuhiro (1993).

[4] A reverse salient is an inverse protrusion (in a weatherfront, for example). A technological reverse salient is an essential moment which is lagging behind technologically compared to other moments in the same process (Hughes 1987).