



Eindhoven Centre for Innovation Studies, The Netherlands

Working Paper 00.06

**Technology Support for Small Industries in Developing Countries:  
A Review of Concepts and Project Practices**

Henny Romijn

Faculty of Technology Management

Eindhoven University of Technology, The Netherlands

March 2000

## **ABSTRACT**

The paper is a review of approaches towards technology support for small-scale manufacturing enterprises in developing countries since the early 1970s. Early programmes tended to suffer from a number of weaknesses, emanating from a limited conceptualisation of technology and an inadequate understanding of the role of the small-scale sector in industrial development more broadly. There was also a lack of practical experience with project implementation. However, in recent years important advancements have been made on all these fronts. Four features of recent technology assistance programmes that have tended to be associated with success are discussed and illustrated with evidence from three projects. Broadly, successful projects (a) embrace the notion that durable competitiveness of small producers in a competitive economic environment requires that they develop internal capabilities to effectively assimilate, use, and adapt product and process technologies; (b) are demand-driven; (c) target the assistance to groups of producers with common interests and problems, and help them to organise themselves in collective bodies that can evolve into self-help institutions; and that (d) design appropriate incentive structures based on market principles.

*Key words:* technology support, small-scale industry, technological capability, learning, competitiveness, assistance projects, industrialisation.

## **ACKNOWLEDGEMENT**

The author is grateful to Mike Albu, Jeffrey James and two anonymous referees for useful comments on an earlier draft, and to Ruud Picavet for inspiring discussions and literature.

## 1. INTRODUCTION

Small enterprises typically make a large contribution to manufacturing employment in poor countries. However, the developmental contribution of the great majority of these manufacturing companies is limited to generating subsistence employment 'of last resort'. Hence, in the face of fast labour force growth and limited employment absorption in other sectors, developing country governments have mounted efforts to improve productivity and earnings in these enterprises. This has spawned a plethora of policies and programmes, and an almost boundless literature documenting these.

This write-up is a review of one specific subset of that literature, namely studies that shed light on measures aimed at improving small producers' *technological performance*. Compared to other forms of assistance, this type of support has received less attention recently. Although much is being written about so-called Business Development Services (BDS) for small manufacturing firms, of which technology support is a component, most of the BDS literature tends to have a broader focus, dealing with issues such as management, organisation, sales, employment, income and general quality. Few publications contain technical details about upgrading of products, processes and production organisation, the types of support needed to bring about such improvements, and a discussion about the effectiveness of the support delivery mechanisms.

Yet, technological competence is an especially important determinant of small manufacturers' ability to hold their own in a context of liberalisation and increasing integration of developing countries' manufacturing activities into global networks. Many of their markets, even traditional ones, are undergoing fast change. In this situation, a lack of capability to produce efficiently, meet deadlines, upgrade product quality and involve in design spells defeat, while firms that are capable of keeping up with, or even initiate

improvements in products, processes and production organization will be able to take advantage of new opportunities and have an edge over competitors.

The main objective of the paper is to identify important common factors behind success and failure of technology assistance projects.<sup>1</sup> Insight into the question as to what constitutes 'best practice' in this field is still sorely lacking, and many are looking for conceptual clarity with respect to these issues. The paper starts by drawing some lessons from past debates and assistance interventions in section 2. Section 3 discusses some important recent developments in the debate about small industry promotion more broadly, as these hold some important lessons for current technical assistance practices. This sets the scene for the discussion of recent practical approaches to project design and implementation in section 4, focusing on important principles behind success of new approaches that are likely to have more general validity. A few case studies from promising technical assistance projects are given in section 5 to illustrate these general principles. Conclusions are given in section 6.

The emphasis of this review is on small-scale 'workshops'. Workshops are very common throughout the developing world. They typically employ, say, between five and 50 people, including some hired labour. They have some division of labour and use basic machinery, but their managerial practices and technological characteristics are worlds removed from those of modern large companies. They tend to be engaged in well-established or even traditional activities, making basic wooden furniture, processed foodstuffs such as tofu and pasta, simple metal products such as tractor trailers, ploughs and window frames, leather goods, local construction materials, and so on. Their customer base usually includes large numbers of poor and lower middle class people. Except in some of the Asian NICs, few workshops are in the forefront in new high-tech sectors, and only a small minority engages in formal R&D.<sup>2</sup> Self-employed workers such as traditional blacksmiths, potters and weavers, and very small family-run 'micro-enterprises' operating in the informal sector are not part of

this review. The support programmes mounted for them are more focused on poverty alleviation than on business growth, and a discussion of these programmes raises different issues.<sup>3</sup>

## **2. EARLY PROGRAMMES**

The small enterprise sector was firmly put on the mental map of LDC policy makers in the early 1970s, as part of a general disenchantment with industrialisation strategies favouring top-down modernisation through concentration of investment and expansion of the modern large-scale sector that had been pursued in the 1950s and 60s. As the benefits of ‘trickle-down’ were apparently limited, income-creation approaches based on direct targeting of poorer sections of the population gained widespread favour. The International Labour Organisation took the lead in documenting the precarious position of those working in small enterprises, and the serious constraints faced by them (e.g., Sethuraman, 1981).

Early technology support programmes predominantly adopted a ‘supply-push’ approach (UNDP *et al.*, 1988). It was thought that the availability of a variety of services would help overcome small producers' resource constraints and thereby help them to strengthen their competitiveness. Many countries set up state-run small and medium industry development organisations (SMIDOs) that were charged with the task of providing these services. They covered such aspects as technical and management training, marketing assistance, advice about technology choice, assistance with technology procurement and provision of subsidised financen. The scope of these programmes was generally broader than technological upgrading alone. However, there were also a number of bodies, both state and NGO, that focused specifically on technology support. There have been some good results from these programmes, but they were also beset with a large number of problems. Here, we only discuss some issues that bear closely on *technological* support specifically. Inevitably,

we have to employ a very broad brush approach which does not do justice to the specificities associated with particular programmes and variations in conditions across different countries.

## **2.1 Underlying conceptual problems**

In the early years of small enterprise promotion, the precarious existence of many workshops was thought to be largely due to the fact that larger firms could be expected to be more efficient as a result of economies of scale and the use of more modern and productive techniques of production. The question whether small enterprises would be able to operate efficiently at all was hotly debated. A number of studies were conducted that attempted to find evidence in favour of the small firm, or vice versa, depending on the ideological bent of the researchers (e.g., Little *et al.*, 1987; Goldar, 1988).

On hindsight, the scope of this debate appears to be somewhat limited. The technological problem of small producers was predominantly seen to be one of lack of suitable machinery and equipment, in line with the prevailing literature about technology and development in the 1970s (e.g., Sethuraman, 1977; Harper, 1984). Thus, their competitiveness problem was viewed primarily in terms of their high relative unit cost of production emanating from lack of appropriate hardware. There was as yet not much attention for the fact that humanware, i.e., skills and knowledge to efficiently use, adapt and improve the hardware, might also be in short supply and might constitute an equally crucial constraint on the competitiveness of these enterprises. Moreover, the focus was on a comparison of cost levels in *individual* small firms versus those of larger firms, i.e., there was no recognition of potential competitive advantages that might accrue through exploitation of cluster or network synergies involving groups of small firms. Meanwhile, the preoccupation with the problematic horizontal (competitive) relations of small producers with their larger counterparts prevented many researchers and policy makers to explore growth possibilities

through development of *complementary* (vertical) relations, although some notable exceptions did exist.<sup>4</sup>

To sum up, the main aim of the programmes at that time can be seen as bolstering the competitive position of individual small firms relative to larger ones through the adoption of more efficient 'hardware', with which they should be able to lower their cost of production and/or improve the quality of their products. Presumably, a one-time injection with better equipment would be sufficient to strengthen their competitive position in the economy. Needless to say, such a one-time injection is useful, but it is inadequate by itself. Competitiveness should derive from small producers' capacity to absorb and improve process and product technology on an *ongoing* basis. Yet, some useful lessons can be drawn from these early programmes, which are discussed briefly below.

## **2.2 Lessons learnt**

### *'Appropriate' technologies and their limitations*

The question as to how technology for small firms (as defined above) could be improved in the best way led to a big debate. Some claimed that efficient technologies suited to small-scales of operation did not exist.<sup>5</sup> Others tried to show that such technologies did indeed exist in several industries, but that there were serious disincentives to their adoption, emanating from unfavourable macro-economic policies favouring the use of large-scale modern techniques and boosting demand for products made with such technologies (Stewart, 1987; Bhalla, 1985; Stewart and Ranis, 1990; Haggblade *et al.*, 1990).

Both arguments carried some weight. The first one led policy makers to promote research in science and technology institutes aimed at the development of small-scale efficient technologies. Different strategies were identified that could be adopted for achieving

this (Bhalla *et al.*, 1984; James, 1989). Foreign donors were much involved in these types of projects. This was the golden age of the Appropriate Technology movement.

This approach gained a degree of success, but there have also been many failures. Many so-called 'appropriate' technologies failed at the commercialisation stage. One big lesson had to be that technology development in the public domain and its subsequent diffusion to the private sector in top-down, 'supply-push' fashion was not an effective model.<sup>6</sup> Many scientists of the technology institutes were competent engineers, but they knew little about the requirements of poor producers and communities, were usually located far away from them, and had little awareness about social, economic and cultural contextual issues. Even where that was not the case, significant communication barriers between developers and prospective users tended to preclude effective exchange of information.

The success cases (which were mainly situated in East Asian countries such as Japan and China) highlighted that technologies have to be developed in close collaboration with the prospective users through a process in which these users can take significant control over the direction of the project and in effect assume ownership of the technology. Another essential condition for success is that equipment producers (i.e. local capital goods makers) have to be involved at an early stage of development, since these actors (rather than the users or the technology institutes) have to take care of repair, maintenance, replication, and modification in the light of practical experience by the users. Technologies are rarely perfect when they come 'off-the-shelf'. Often, several rounds of forward and backward feedback of information between developers and users are needed to improve and adapt them in iterative fashion. For this reason, the best technology development model appears to be one which involves close and ongoing interaction between users, institutes and producers as equal partners with complementary knowledge and skills.<sup>7</sup>

*Lack of incentives and competitive pressures*



There were other major design and implementation flaws associated with many of these early programmes. Supplying crucial missing ingredients to small companies is a good thing in underdeveloped economies where well-functioning markets for essential services rarely exist, but in practice it has all too often bred complacency among the recipients. There were cases where small entrepreneurs took the assistance for granted simply because they belonged to the underprivileged class of small entrepreneurs. This has been especially the case when projects providing assistance with product design and quality simultaneously provided an assured public outlet for the produce, leading to the removal of competitive pressure.

There have also been problems with the incentive structures in the institutions providing the assistance. Providing support for small companies is not as rewarding and glamorous as assistance to bigger business. It is less visible, it does not bring political influence or important contacts, and much effort has to be put in to achieve good results. Not surprisingly, the most successful technology support projects have involved highly committed individuals who were not primarily driven by high monetary rewards.<sup>8</sup> In addition to lacking incentives, many programmes have lacked effective sanctions on inadequate performance of assistance agencies. State-run or parastatal organisations were functioning with ‘soft budget constraints’ and did not have to rely on commercial sources of revenue for their continued existence. The technological assistance under the SMIDO programmes have had even more modest results than the programmes run by specialised technology development institutes and NGOs, and it is not worthwhile to dwell much on their role and functioning.<sup>9</sup>

### *An uncondusive macro-environment*

The 'macro-incentives approach' to technology improvement mentioned earlier gained considerable influence in the early 1980s, a bit later than the appropriate technology approach. A series of studies were undertaken which linked inappropriate technology choices to biased incentive structures emanating from adverse macro- and 'meso'-level policies that were commonly pursued in developing economies. Its arguments shed much light on why the effectiveness of the early programmes remained so limited. It is probably true that the lack of success of these programmes can be traced as much to problems in the general economic and institutional environment in which they had to function as to flaws in conception, design and implementation at the micro-level.

In particular, the problem of lack of market opportunities faced by small enterprises referred to above, was at least partly caused by the general economic malaise and the lack of growth possibilities for small companies in many economies pursuing import-substitution strategies that favoured modern, large-scale forms of production. Highly overvalued local currencies and cheap credit for large import-substituting companies made it attractive for them to establish highly integrated production facilities with a high import content. There was little incentive to establish backward linkages to local companies. The impact of policies such as tax and financial incentives and local content regulations has generally been very modest.<sup>10</sup>

To the extent that the approach advocated 'to get the prices right', it tied in well with the sort of reforms that countries had to introduce when they embarked on structural adjustment. However, the approach went well beyond pointing towards biased factor prices. It also drew attention to major institutional, legal and structural constraints that prevented the small industry sector from flourishing, and that could not be remedied quite so easily.

### *Lack of integration of small enterprise programmes with national industrialisation strategies*

The macro-incentives approach was particularly useful because it began to raise awareness about how the small industry sector was linked to, and affected by what was happening in the economy in general. Curiously, the studies about small-scale enterprises and the informal sector that were generated in the 1970s never made any mention of the modern industrial sector, while studies about countries' industrialisation in general in turn tended to disregard the small industry sector. This lack of integration in research had its effect on the policy level. Policy makers generally did not properly integrate the promotion of their small industry sector within their broader industrialisation strategies and objectives, almost as if it was existing in a vacuum. Many countries still suffer from such legacies, even those that have made a serious effort at reforming their industrial policies to incorporate the small enterprise sector (see, e.g., King, 1996; and Oladeji, 1998).

### **3. THE 1990S: NEW DIRECTIONS IN CONCEPTS AND PRACTICES**

The practice of technology support interventions has moved forward in recent years, especially since the early 1990s. Partly, this reflects some major changes in the broader debate about small industry development and its role in industrialisation in general. In this section, therefore, we highlight some important lessons which are emerging from this debate for the way in which technology support projects could best be designed and implemented in practice. Sections 4 and 5 focus on recent innovative approaches at the project level that have begun to absorb these lessons, along with the findings from earlier project practices discussed above.

The small industry debate has clearly been influenced by the major changes in the economic policy climate that have occurred since the late 1970s. The ascent of neo-liberal

thinking which de-emphasised state involvement in the economy, spelled the demise of inward-looking approaches to industrialisation, and advocated increased openness to trade and foreign investment. The effects of these policies on local industrialisation have been varied. Some of the relatively advanced developing countries in East and Southeast Asia and Latin America are increasingly being integrated in large regional and/or global trade and production networks that are steadily growing in importance. In contrast, in many of the truly low-income economies, where liberalisation took place in the context of heavy structural adjustment programmes, industrial development has suffered (Lall, 1999). Sub-Saharan Africa's share in global manufacturing, already very low with 0.4 percent in 1985, declined to 0.3 percent ten years later (UNIDO, 1996, p.22).<sup>11</sup>

In either case, however, the old notion that economic prospects for small industries would derive mainly from their ability to achieve competitive cost levels with appropriate equipment proved increasingly inadequate in the context of the big shift in countries' macro-economic climate and the forces pushing for global integration and marginalisation. One can notice important common elements of change in the literature about small industry development across major regions. In particular, the old view that small producers could improve their competitiveness by absorbing technical improvements designed elsewhere by other actors is beginning to be replaced by a more dynamic notion of competitiveness, one that depends on small firms' *own internal* capacity to make an independent and unique contribution to local technical progress on an ongoing basis. This is happening in Asia, Latin America and Africa alike, although inter-regional variations exist, as the following discussion highlights.

### **3.1 Advanced LDCs: Small firms, technical capability and systemic competitiveness**

The change is perhaps most evident in the most advanced and fast-industrialising developing economies of Asia and Latin America (especially the East Asian NICs), where there is much potential for small firms to participate in their export-oriented industrialisation drive and their increasing participation in international trading and production networks. In the dynamic industrial environment of these countries, small firms' competitiveness begins to be perceived as an integral part of national industrial competitiveness. This is mainly because of the perceived *complementarity* of the activities that large and small firms undertake. The emphasis is on the need for local specialist suppliers that can supply products and services to customers downstream in the 'value chain', react quickly and flexibly to their changing requirements, and begin to play a role in the design and implementation of technological improvements. Thus, competitiveness of small companies is increasingly being perceived in terms of their *internal capabilities to choose, use, adapt and develop technology*. Such capabilities are a must in order to become, and retain competitiveness in a fast-evolving environment which continuously places new demands upon large and small firms alike (see, e.g., the studies in Meyanathan, 1994; and UNIDO, 1996, pp. 53-6)

By moving in this direction, the small enterprise literature from these relatively advanced developing countries is beginning to link up with a large body of literature about acquisition of technological capability in industrial development.<sup>12</sup> This literature largely replaced the old static choice of technique framework which underpinned the early small firm support programmes discussed earlier. Its basic point of departure is that the existence of adequate local skills and knowledge for incorporating more advanced technologies in developing countries cannot be taken for granted. Whereas technological hardware (machines, equipment, blueprints) can be transferred, the capability to make use of that hardware has to be developed through a gradual learning process, resulting from purposive

efforts to assimilate, adapt and modify the new technology. Many of these efforts take the form of small improvements ‘on the shop floor’, rather than formal R&D. In contrast to the earlier choice of technique literature, the capability literature sees technological constraints primarily in the lack of *human knowledge and skills* rather than *machines*, and it views technological progress as endogenous to firms and within developing countries more broadly. This literature holds important lessons for the design of technology support projects for small manufacturers.

The trends towards a more dynamic interpretation of small firm technological performance and competitiveness in line with this body of literature are evident even in countries like South Korea and Singapore, whose earlier policies were heavily biased towards the promotion of large-scale firms. There has been a remarkable shift in their policy-stance since the early 1980s, when they began to experience the difficulties associated with advancing into higher-technology-based manufacturing without an extensive local subcontractor network (Wong, 1994; Lee, 1992; Leipziger and Petri (1993); Chon, 1996; and Chung and Park, 1998).

### **3.2 Middle-income LDCs: Dynamism in small industry clusters**

Another important contribution to the recent debate about small industry development with implications for technology support programmes has come from a set of studies emphasizing efficiency of *groups* of SE, especially how inter-firm interactions in networked geographical clusters might contribute to their collective competitiveness (e.g., Humphrey and Schmitz, 1996; Schmitz, 1995; Nadvi, 1996; Tewari, 1996; Rabelotti, 1995; Ceglie and Dini, 1999). Much of this literature is focused on middle-income developing countries in Asia and Latin America, such as Pakistan, India, Indonesia, Brazil, and Mexico and Peru, but there

are also some contributions dealing with lower-income African countries. Their main concern is similar to the literature discussed above, namely *internal economic dynamism* of small producers, although the main emphasis is on interfirm dynamics rather than on intra-firm learning processes. Drawing on writings about flexible specialisation in dynamic industrial districts in developed countries such as Italy (e.g., Piore and Sabel, 1984; Best, 1990; Pyke and Sengenberger, 1992), these studies have generally suggested that clustering in developing countries can create effects that help sustain long-term economic competitiveness among the participating firms. Presumably then, the writers presuppose that it may also give rise to enhanced capability to initiate and diffuse technological improvements. Unfortunately, this claim has remained largely unsubstantiated. The assumption about technological dynamism remains largely implicit, and the innovation and learning effects have not been investigated systematically. Even though the term 'learning' tends to crop up in some of the studies, it is often not clear what is meant by this, or what the learning entails in practice (Albu, 1997).<sup>13</sup>

### **3.3 Poor LDCs: Technological capability building by individual producers**

A final important contribution to the recent small enterprise literature with implications for design and implementation of technology assistance programmes has come from studies focusing on the importance of internal technological capability acquisition in *individual* small industrial units. Much of this literature is set in lower-income countries with poor growth prospects, mostly but not exclusively in Africa. Here, the concept of small firm' competitiveness is evolving more under duress than as a result of emerging opportunities. These countries are increasingly feeling the crunch of international competition from more advanced economies. Their own large-scale industrial sectors have all but collapsed, and they are not being targeted in a big way by foreign investors. Hence, they are beginning to look

towards small companies as a potential force for industrial regeneration. Increased attention is being devoted to the question whether, or under what circumstances, small producers can function as an engine of industrial growth and become a source of competitive advantage in their own right. There is also a growing concern that such regeneration cannot and should not be built on low wages, dismal working conditions and paltry profits, at least not beyond the short term. Acquisition of more advanced technological capabilities is beginning to be perceived as a major requirement for escaping from the low-wage, low-skills scenario in a sustainable manner. It is also recognised that this will require a supportive policy environment, one in which the small firm sector is fully integrated in the design and implementation of industrial support programmes and technology policy (Wangwe, 1993; Oladeji, 1998; Oyelaran-Oyeyinka, 1997; King, 1996; Maldonado and Sethuraman, 1992; Massaquoi, 1995; Romijn, 1997 & 1999; Smillie, 1991; and the articles in *Appropriate Technology*, June 1997).

#### **4. INNOVATIVE APPROACHES AT THE PROJECT LEVEL**

The insights emerging from the recent conceptual debate about the role of small industries in development are beginning to be incorporated in the design of technology assistance projects, along with lessons learnt from accumulating hands-on experience with project implementation by practitioners (section 2). There is reason to believe that the success record of some of the more recent programmes is rather better than those of earlier ones.

Unfortunately, even now, only a few project studies have so far systematically pinpointed the main project features that are believed to underpin their success. In view of this, the discussion in this section cannot go much beyond identifying a few broad principles which can be distilled from the reviews in section 2 and 3 of this paper, and which at the



same time can be associated with success in technology assistance projects in practice. These success features are present more strongly in some geographical regions than in others, but quite often they do cut across regional variations.

#### **4.1 Acquisition of indigenous technological capability**

Perhaps the most important common factor that appears to be critical to improved outcomes of technical assistance projects, is an emerging convergence in much of the recent debate that a sustained improvement in the competitive position of small producers must come from their acquiring internal technological capability to initiate and pursue adaptations and improvements to products, processes and production organisation on an ongoing basis. In their well-known review of small enterprise project interventions, Humphrey and Schmitz (1996) hint at the need for this requirement when they state that competitiveness of small producers is a process rather than a state. Therefore, they argue, one-off improvements are of limited use, and projects need to aim for 'cumulative benefits' instead.

The implication of their important observation for the design of *technological* assistance projects specifically appears to be, that they must aim to initiate and facilitate a process of change which creates opportunities for small producers to engage in continuous development of their technological knowledge, skills and organisation. The Donor Committee on Small Enterprise Development, an umbrella group of big aid agencies which have organised much of the ongoing BDS discussion, refers to this approach as 'indigenous technology development' (Donor Committee on Small Enterprise Development, 1997, p.39-40).

In this approach, the ultimate project objective is not the one-off design and adoption of improved technological 'hardware'. That is not to say that the introduction of such hardware should become unimportant or redundant. Making a mechanical lathe available to a

woodworking shop, or introducing an improved cooking stove model for low-income households to local metalworkers who are to manufacture it, obviously constitute developmentally beneficial policy interventions in their own right. However, rather than viewing the supply of these deliverables as final project objectives, the process of their introduction into a local business community should also, and perhaps even primarily, be seen as a means through which small producers can master new technical and organisational skills and knowledge which will strengthen their ability to introduce other product and process innovations *on their own initiative* at a later stage.<sup>14</sup>

The adoption of this notion has obvious implications for the modalities of assistance delivery. Rather than using external experts to come up with a perfect design for a new artefact, an appropriate adaptation of a foreign artefact to local conditions, or a quick fix to a technical production bottleneck in a small workshop, projects that aim to stimulate indigenous technology development must use those experts as teachers and facilitators who will actively involve small producers in design, adaptation and problem-solving processes so that these will create possibilities for them to build their own design skills. Other ways in which projects can help producers to learn is to create, what Levy *et al.* (1994) have called, ‘an information-rich environment’ for small firms, facilitating access to knowledge and information that can form inputs into the learning process. Examples include projects sponsoring courses on selected topics, organising field trips by producers to more advanced factories, facilitating the use of specialised consultants, helping small producers to participate in trade fairs, and promoting information sharing among firms.

#### **4.2 Demand orientation**

An effective way in which assistance agencies can trigger and sustain such processes of indigenous technological capacity building in small firms is by taking a demand-led

approach. That is, project interventions have to start by identifying a new market channel for the target producers, and establishing concrete possibilities for them to establish themselves in that new market (Humphrey and Schmitz, 1996; Tendler and Amorim, 1996; Dawson, 1999). There are different ways in which this has been achieved. Most of the evidence pertains to the successful negotiation by assistance agencies to use (groups of) small producers as suppliers in public procurement schemes, but there are also some examples where assistance agencies have successfully mediated to link small producers to new private sector clients.

There are at least two major advantages of this customer-focused approach over the earlier supply-side project interventions reviewed in section 2. First, access to a dynamic market in which producers are required to deliver products with improved designs or quality, to pay attention to standardisation, to meet deadlines, to control their unit cost of production, and so on, provides a financial incentive for small firms to invest in efforts to make the improvements needed to live up to the expected standards. Second, it tends to focus the project assistance quite tightly around supplying the critical missing inputs required to overcome producer bottlenecks experienced in the process of trying to meet customer demands and responding to their complaints. The assistance can be applied at once, i.e., there is an immediate test of its practical relevance. This avoids the danger of projects supplying a broad array of services that will ultimately not be useful in practice. A particularly effective way to ensure that small producers get the right type of technical assistance has been an arrangement in which a representative of (typically large) clients will agree to engage in 'buyer-mentoring' for a while, taking small suppliers under their wing, training them up and providing technical consultancy, with the assisting agency meeting part of the costs involved (see the case studies in Dawson, 1999; and Wong, 1994).

### **4.3 Organisation of groups of clustered firms**

In most recent successful projects, the practical organisation of the type of assistance outlined above has involved targeting groups of geographically clustered producers in the same industry, rather than scattered individual small companies operating in a variety of industrial sectors (Humphrey and Schmitz, 1996). A number of advantages of collective support to clusters of small firms have been noted. First, it is simply more cost-effective and practical for agencies to concentrate their efforts on the problems faced by groups of similar producers in one or a few specific localities. This is especially important since aid projects are increasingly under pressure from donors to ensure financial sustainability of their interventions within a short period of time (Dawson and Jeans, 1997). It also allows agency personnel to develop in-depth expertise about the technical, market and other problems of one specific industry, and about the particular role played by the small producers in that industry in a particular region.<sup>15</sup> Moreover, when the assisting institutions is based close to its clients, it is in a position to develop a close working relationship with them, thereby overcoming mistrust and establishing its credibility.

The learning efforts within the small firms may also be stimulated through interaction, common problem solving, information exchange, and getting around problems associated with economies of scale (e.g., setting up of a common facility centre by the assisting agency, or joint investment by producers in expensive equipment which cannot be operated profitably by only one company). Finally, organisation in groups may provide a convenient way to overcome contractual problems with clients and to enforce compliant behaviour by the companies participating in an assistance project. It is more practical and less costly for large clients to deal with an association of small manufacturers than to share out orders among the individual members, monitor their progress and deal with problems relating to order fulfilment. Furthermore, the manufacturers association can put effective pressure on its

individual members to perform according to the agreement, e.g. by making the group jointly responsible for delivering the final outputs and honouring warranty claims.

#### **4.4 Incentives that promote sustainability**

A flawed incentive structure both for assistance providers and beneficiaries was one of the chief causes of failure in the early technology support projects discussed in section 2. In some of the recent projects, much attention has been devoted to the careful design of a more appropriate set of incentives for all project participants (see especially Tandler and Amorim, 1996). This appears to entail a combination of ‘carrots’, i.e. potential rewards that will motivate the participants to take action, and ‘sticks’, i.e. a set of sanctions that come into operation when they fail to do their best. It seems that effective incentive systems appear to be those which subject projects as much as possible to market discipline. Especially, there has to be a payment system that rewards effective services offered by support staff, and penalises those that don't work. Getting beneficiaries to pay (at least part of) the services offered is also a way to ensure that they value the support and that they will utilize it.

That is not to say that some project activities may not require initial subsidies. They do, because technological learning is subject to considerable market failure. E.g., the results from technological efforts made by an innovating firm spill over to competitors through copying and inter-firm movement of its trained labour, preventing the originator firm from appropriating the full benefits of its investments. However, market failure is not an argument for mounting interventions that have the effect of distorting or even completely replacing the market by doling out permanently subsidized services of dubious value. Linking project activities with market forces ensures that projects 'remain on track' by getting the right signals about their activities from their client base and that the project staff remains motivated. Only then will projects be able to bring about the sort of cumulative effects that Humphrey Schmitz

referred to. Some projects now go so far as to aim not merely for cumulateness in terms of sustained occurrence of benefits for small producers and their customers (i.e. innovation and improvement processes driven by ongoing learning) after project completion, but also apply the notion to the delivery of the project services themselves. Dawson and Jeans (1997) argue that projects must evolve certain institutional forms of self-help that will, over time, start to function independently from external aid agencies. Organising producers and helping them to build strong local collective institutions (already discussed above) can contribute in a major way to the achievement of this goal.

## **5. SOME ILLUSTRATIONS FROM SPECIFIC PROJECTS**

Several of the general principles outlined above have been applied in recent technical assistance projects in different developing countries. We illustrate these points with three examples, one of the industrially most advanced developing economies in East Asia, one from a middle-income country in Latin America, and one from a low-income country in Africa.

### **5.1 Upgrading local subcontractors in Singapore<sup>16</sup>**

The Singaporean experience with technical assistance to small manufacturers is perhaps not an obvious example. The country is better known for its success in attracting high-tech multinationals than boosting local small-scale industries. This image is somewhat misleading. Over the years this country has evolved a remarkably well-organised and elaborate support system for small manufacturers, in which indigenous technical upgrading takes up a central place. A local ancillary sector is considered to be crucial for Singapore's continued international competitiveness in high-tech electronics. For example, the presence of

large TNCs in the disk drive industry depends on the availability of high quality suppliers in precision engineering.

The country has been providing technological assistance to local small manufacturers ever since 1962, but the programmes acquired real momentum in 1989 when the various measures and initiatives were consolidated under the SME master plan presented by the Economic Development Board (EDB) in 1989. Fabricated metal and machinery industries receive most attention because these form the core group of supplier industries. The Local Industry Upgrading Programme (LIUP) forms the most significant component of technical assistance, a programme which clearly displays three of the four features discussed above, namely a focus on technological capacity upgrading, a demand-driven approach to the intervention, and a market-driven incentive structure. The fourth feature (group-based assistance) is also present to some extent but its advantages are not spelled out clearly in the available documentation about the programme.

- The aim of the programme is to strengthen local *manufacturers' internal technological capabilities*., involving increased operational efficiency (ability to produce according to the exacting time schedules and quality standards required by TNC clients), as well as increased ability to perform ongoing incremental improvements in products and processes. The aim is ambitious: technical standards are to be raised to a level where the small producers are able to compete successfully with leading foreign suppliers, and in this way form attractive partners to the local TNC community.
- It has been designed to forge close links between TNCs and their suppliers, taking a *demand-led approach* to assistance delivery. The EDB is achieving this essentially by playing the role of 'network broker', an idea that has also worked well in a few other countries.<sup>17</sup> TNCs are approached by the EDB to participate in the project. When agreement is reached with a TNC, an experienced engineer from the company is identified

and seconded to the EDB to assume responsibility as LIUP manager for 2-3 years, whose responsibility is to identify areas of focused assistance for the TNC's suppliers. A participating TNC takes several small firms under its wing, and is expected to provide training in areas such as management, quality control, process engineering and industrial engineering through visits, workshops, consulting activities and so on (an example of 'buyer mentoring'). The EDB meanwhile arranges access for the participating small companies to a variety of financial support schemes operated by and through it.

- The *incentive structure* is such that the participating TNCs benefit from their efforts to upgrade the operational efficiency of their client enterprises, while they also receive considerable subsidies for providing their inputs in the project, up to 90 per cent of the costs involved. These are partly borne by the EDB, but also partly by the participating small producers themselves, which in turn helps to ensure their continued support and commitment to the project. The programme is apparently effective because '... the benefits are mutual, and *market forces* rather than administrative exhortation or compulsion motivate the transfer of technology...' (Wong, 1994, p.82).

As far as results go, it has been reported that various significant forms of technological learning have been taking place, including learning through direct know-how transfers; learning through feedback provided by stringent quality / performance control by the TNCs; learning through exposure to information resources provided by the TNCs; and learning through, and as a result of, investments in capital equipment and other forms of new technology by the small firms that they would not have made in the absence of their relationship with the supporting TNC.



## 5.2 Technical upgrading through public procurement in Brazil<sup>18</sup>

One project that clearly displays all four features discussed above is a public procurement scheme for school furniture in the Brazilian State of Ceará. The scheme was organised by the Industry and Commerce Department (SIC) of the state government, together with SEBRAE, the Brazilian SMIDO, after the central government decided to seek out alternative, small-scale suppliers of wood products in regions that had been badly hit by a drought, as a sort of alternative to a public works programme.

- The scheme was very clearly *demand-driven*, in the sense that the project itself was triggered off with the opening up of public procurement of basic manufactured products by SIC to small-scale manufacturers. This created a potential new market outlet for them.
- It was clear that technical assistance by SEBRAE would be needed to enable the small woodworkers to ‘pull themselves up technologically’ in order to reach the required production standards. The objective of the assistance was squarely to *help raise the internal technological capacity* of local producers by providing them with technical assistance and consulting services over a period of time. The customer-driven approach led to a well-focused and efficient form of that assistance in which producers could learn in incremental fashion: Producers participating in the project would hit up against technical bottlenecks in the course of trying to fulfill SIC's requirements, and they would call on SEBRAE engineers to provide help when they had identified the specific problems they needed to solve in order to deliver the required quality at the agreed price at the right time.
- The support was narrowly targeted to *a small collective of clustered small producers in one particular locality operating in one particular activity (woodworking)*. This set-up had a number of advantages. First, in view of the large orders from SIC, which exceeded the production capacity of any one of the individual producers, it was only practical to

contract the small producers as a group. A producer association was formed for the purpose, with encouragement from SEBRAE. The association was responsible for ensuring product quality and honouring product warranties, and had to coordinate the activities of the individual members. In case of default of one of the association members, the association was responsible for honouring orders and warranty claims. By making the association the one focal point in the transactions, it was in the interest of members to monitor each others' performance. Meanwhile the existence of the association lowered the transaction costs involved in dealing with SIC and SEBRAE. Moreover, group formation enabled the producers to engage in collective learning because they had to communicate and collaborate to solve common problems, and coordinate their activities in order to meet large orders. SEBRAE engineers would typically come in only after the producers had discussed their problems together and identified their assistance priorities.

- However, the fact that technological upgrading actually did occur also had a lot to do with the clever way in which the *incentives* of the scheme were designed. *Two important features mimicked the way in which a private market works*, and they set up tremendous *pressures* on the assistance deliverers and the beneficiaries to perform: Firstly, while a new potential market opportunity was created, the customer was not obliged to proceed with the procurement from the small producers if the quality of the products remained below that of the regular (large-scale) suppliers. Hence, rather than creating a protected market, the scheme created competition between large and small. Secondly, by linking the commission received by SEBRAE to the successful securing of orders by the producers, SEBRAE's financial position became to some extent dependent upon the effectiveness with which they delivered their assistance, thus creating a clear incentive to perform well.

The success of this project is evident from upgraded skills, knowledge and management capabilities of the participating enterprises, as well as substantial investments

made in power tools, expanded production capacity, creation of many backward and forward linkages, and vastly increased employment in the industry locally. The most powerful evidence of project sustainability is the fact that the producers were able to use their sales to SIC as a starting point to enter new markets and diversify their customer base considerably. Five years after the start of the project, 70 per cent of their output was already going to the private sector. The association has become an important institution locally, initiating many developmental activities without help from the original assistance agencies.

### **5.3 Technological capability building in small metal workshops in Kenya<sup>19</sup>**

The Farm Implements and Tools (FIT) programme implemented in Kenya and Ghana by the International Labour Organisation and TOOL, a Dutch NGO specialising in technological assistance projects, is an example of a tightly focused, dynamic user-driven approach to group-based technical assistance with a strong market-based incentive structure, which is designed to operate under quite hostile economic conditions and in economies at a low stage of economic, technological and infrastructural development. The focus here is on the Kenyan component since this is the best-documented part of the programme. The programme targets small manufacturers of metal farm equipment and food processing equipment.

- The aim is to *strengthen their local capacity to undertake activities that can spark technological upgrading of their products*, ultimately contributing to higher productivity and incomes of the technology users (i.e. farmers and people running home industries, predominantly poor women). Technological learning by and among the participating enterprises is central to the success of the programme. The programme essentially functions as a facilitator for these learning processes, initiating activities and embedding them institutionally in such a way that they become self-sustaining over time. Several

services have been developed according to this philosophy which help to create an *information-rich environment*. By broadening producers' access to information, the producers are in a better position to analyse their own strengths and weaknesses in relation to others, learn more about the needs of their users, and in what ways the performance of their products falls short of user' expectations. It also gives them new ideas for product improvements and for the introduction of new products, and so on. One activity is the organisation of group visits by small producers to bigger enterprises elsewhere in the country or abroad, which has strong demonstration effects. Another is the facilitation of direct communication with the users of farm implements. 'Brokering workshops' for groups of entrepreneurs, initially designed to evaluate the impact of these two activities, became an independent activity in itself because the informal information exchange that took place in these fora obviously filled a need among the participants. Finally, help to small producers in identifying new markets through teaching them a simple form of market research dubbed 'rapid market appraisal' has also been offered.

- FIT is strongly *demand-driven*. According to the project organizers, '...the demand by MSEs (micro-and small-scale enterprises, red.) for services is ultimately financed by sales to their customers, and it is the demand and perceptions of these customers which are therefore the origin of all sustainable activities with MSEs.' (Tanburn, 1996, p.47). For that reason, the activities undertaken by the project must translate into substantial and reasonably quick improvements in products which benefit the customers. In contrast to the other two projects discussed earlier, the FIT programme has not used public procurement, but has mounted initiatives to stimulate demand from the private sector by linking up producers with their customer base and helping to create a demand for innovations. The project was able to do this because the end-users of the firms' products (farmers) demonstrated a strong interest in interacting with the manufacturers, providing

them with feedback about their performance and suggesting improvements and innovations, to the point where they were willing to pay for their own transportation costs to participate in user-producer meetings where improved farm equipment developed by project participants was displayed.

- The assistance is *tightly targeted at groups of metalworking producers operating in the same area*, although it does not seem to involve tightly-knit geographically-confined clusters as in the Brazilian project. This concept is in any case not so relevant in many rural areas of Africa where the volume of production is simply too low for such clusters to form. Three clear advantages of group-based assistance could be identified from the available documentation about the project. First, the assistance can be focused specifically on common areas of interest and concern, including specialised technical issues. Second, it leads to informal information exchange and helps spark interactive learning among the producers. Third, organising producers in groups is a means to form collective self-help institutions which can in due course take over the running the project activities.
- The design of a *market-based incentive structure* has played a crucial role in achieving sustainability of project benefits, as well as project services themselves. Project financing of the activities is always temporary, and even right at the start of a new initiative the participating producers as well as their customers must show a willingness to pay at least part of the costs. Moreover, producers and other involved parties must show a willingness to take over the organisation of the activity after the external input has come to an end. When it is clear that an activity does not meet these requirements, the project discontinues it quite quickly. One could argue that improvements may take some time to materialise, and that some degree of market failure is therefore inevitable, justifying a permanent public subsidy. However, in resource-poor countries like Kenya, the likelihood of such activities attracting public money on a sustained basis is quite remote. In such conditions,

projects like FIT, which do not expect such subsidies and adhere to stringent financial viability conditions, obviously stand the best chance of success.

FIT has reported several favourable effects. Perhaps the strongest indication of success is that the participating small firms continue participating in the programme over a period of time, pay at least part of the cost of the services, and suggest the introduction of new project activities such as help with establishing facilities for equipment testing, and help with ironing out of teething problems encountered when new or improved farm implements are used in practice. The group visits to other enterprises have been an important source of ideas about new and improved farm equipment that the small firms could try to produce. Many entrepreneurs also benefited from seeing metalworking machinery, tools and measuring instruments in operation, and decided to acquire new tools such as scales, a micrometer and so on. Improved linkages with suppliers of spare parts and raw materials were also reported. Even managerial skills were apparently improved, especially in the area of customer relations, record keeping and employee relations. The trade fairs were also quite successful as a vehicle for effective user-producer interaction. Several producers started to experiment with products. Some did so after they noticed the results of the technological efforts undertaken by their competitors, afraid that they would lose custom if they did not keep up with the new developments (an example of a 'stick-type' incentive in operation).

## **6. CONCLUDING REMARKS**

The practice of technology support for small producers has evidently come a long way since the early 1970s. Firstly, and most important, the notion of 'success' in projects and programmes is evolving in a more realistic direction. It is no longer based on the idea that small producers should essentially play the role of passive recipients and beneficiaries of improved technologies that have been developed elsewhere in the economy or abroad. We are

moving towards the understanding that durable competitiveness of small manufacturers must entail an internal capability on their part to make improvements in products, processes and organisation on an ongoing basis. Only then can we expect such enterprises to make a contribution to countries' industrialisation which goes beyond mere employment generation of last resort. Truly progressive developing economies are those where firms of all sizes, including the smallest ones, are actively involved in, and contribute to, the national knowledge accumulation process (Bruton, 1985, p.81).

Secondly, there is a growing understanding among LDC government agencies and donors about the broad features associated with project success so defined. These principles appear to be common to projects and programmes across regions that are technologically and economically quite diverse. In particular, the development of producers' capability will generally need to entail a process of incremental and demand-focused technological learning and organisational and institutional capacity-building by the people involved. The literature reviewed for this paper also suggests that such learning is likely to be most effective when producers can interact with each other and with other actors, especially customers.

Effective projects are those that stimulate these processes by establishing conditions in which such learning can occur. Linking producers to new markets is an important precondition. Facilitating better access to information, especially through interactions with other parties, is another aspect. Organising them in local groups with common interests and problems and helping them to build collective self-help institutions is yet another element. Finally, there has to be an appropriate incentive structure that will spur producers' and assistance agencies' efforts (especially one that makes rewards conditional upon performance).

Of course, this does not constitute a ready blueprint for technical assistance. Even if there were many more detailed analytical case studies about successful projects than we can

draw upon at present – and we certainly do need more of them –, an ideal model is unlikely ever to emerge. The design and implementation of every new project must always entail an act of creativity to adapt and operationalise general principles in such a way as to fit well within the local context within which it is to be implemented.

## ENDNOTES

<sup>1</sup> The main focus of this review is on programmes and projects with a *direct* technological content, such as development and commercialisation of appropriate technologies, provision of technical extension services and technical training. It does not deal with financial support schemes, even though these are very common in developing countries. Financing can be given for a number of purposes, among which technological improvement is only one – and often not the most important one. Venture capital and R&D financing for high-tech small firms are exceptions, but these are not covered here because the scope of such schemes is still quite limited in most developing countries.

<sup>2</sup> This contrasts with the situation in developed economies where many small companies make significant contributions to the generation of innovations (e.g., Cosh, Hughes and Wood, 1996; Rothwell and Zegveld, 1985), and where small firms staffed by educated professionals are well represented in new, knowledge-based industries such as information technology and biotechnology.

<sup>3</sup> For an elaboration of the distinction between poverty alleviation and business growth as objectives of small enterprise support projects, see Dawson and Jeans (1997).

<sup>4</sup> See especially Watanabe's insightful studies about subcontracting linkages (e.g., Watanabe, 1983).

<sup>5</sup> This argument is based on the 'rigid factor proportions' problem, first propounded by Eckaus (1955).

<sup>6</sup> See Bongenaar and Szirmai (1998) for a detailed case study of the top-down approach in Tanzania.

<sup>7</sup> Good examples are documented in Basant (1990), Ishikawa (1975), and Francks (1979).

<sup>8</sup> See Basant (1990), Smillie (1991) and Powell (1995).

<sup>9</sup> Their activities and performance have been evaluated in many studies, including several studies commissioned by aid donors that were supporting these organisations. See, e.g., UNDP *et al.* (1988).

<sup>10</sup> Few policy makers understood that the Japanese success in establishing elaborate and dynamic subcontractor networks was first and foremost driven by an extreme capital scarcity in the economy, which affected even the largest *keiretsu* (Watanabe, 1983).

<sup>11</sup> Some writers claim that substantial de-industrialisation occurred in the region, although the evidence on this is not conclusive. See World Bank (1994), pp. 149-152, for a discussion about the de-industrialisation debate.

<sup>12</sup> See Lall (1992) and UNCTAD (1996) for good reviews of the capability literature.

<sup>13</sup> Their main sources of inspiration are the economic organisation literature (transaction costs theory) and sociological literature. The writers in this group are generally sensitive to the socio-political and institutional context within which small industry clusters function, and these variables have received more attention than 'hard' economic and technological ones.

<sup>14</sup> This view is not uncontested. There are some agencies, such as ApproTEC Kenya, that operate projects that adhere to the so-called 'corporate approach' (Havers, 1998). This approach continues to give central importance to the introduction of technological hardware. A foreign NGO designs useful technologies for the benefit of primarily poor consumers, and disseminate these as widely as possible. A few reasonably well-run small and medium-sized manufacturers are contracted to make these products according to the specifications supplied by the NGO, but any benefit they receive is primarily a means to the objective of reaching a large number of poor end-users. There is no explicit attempt to transfer any design skills. Although the corporate approach is achieving good results (in terms of its own objectives), it does not seem to make sense to view it as a full-fledged alternative to the indigenous technology development approach (as done by the Donor Committee on Small Enterprise Development, 1997) since it does not see small producers as the target beneficiaries and since it does not explicitly aim to raise their technological standards.

<sup>15</sup> This is in line with the 'sub-sector approach' to small enterprise promotion, which advocates that research and assistance should concentrate on commodity-specific sub-sectors. By giving considerable weight to the study of interactions between firms of different sizes and at different stages in the supply chain, this approach can provide



a more thorough insight into the competitive context in which the target enterprises operate (Boomgard *et al.*, 1992).

<sup>16</sup> The Singapore subsection is based on Wong (1994).

<sup>17</sup> For example, in the case of Malaysia's car manufacturer Proton, small manufacturers gained access to manufacturing know-how about complex car components in a similar way. A useful review of successful and less successful policy experiences with subcontracting promotion in different developing countries is contained in Altenburg (1997).

<sup>18</sup> The Brazil subsection is based on Tendler and Amorim (1996).

<sup>19</sup> The Kenya subsection is based on Tanburn (1996).

## REFERENCES

- Albu, M. (1997) 'Technological Learning and Innovation in Industrial Clusters in the South', MSc thesis, Science Policy Review Unit, University of Sussex, Brighton.
- Altenburg, T. (1997) 'Promoting Ancillary Industries in Developing Countries', *Small Enterprise Development*, 8 (2), pp. 24-33.
- Appropriate Technology*, 24 (1), June 1997.
- Basant, R. (1990) 'Farmers, Fabricators and Formal R&D – The Pipe Frame Multipurpose Tool Bar in Gujarat, India', in: M.S. Gamser, H. Appleton and N. Carter (eds) *Tinker, Tiller, Technical Change*. Intermediate Technology Publications, London.
- Best, M.H. (1990) *The New Competition. Institutions of Industrial Restructuring*, Polity Press, Cambridge.
- Bhalla, A.S. (ed) (1985) *Technology and Employment in Industry*, International Labour Office, Geneva.
- Bhalla, A.S., D. James and Y. Stevens (1984) *Blending of New and Traditional Technologies*, Tycooly.
- Boomgard, J.J., S.P. Davies, S.J. Haggblade and D.C. Mead (1992) 'A Subsector Approach to Small Enterprise Promotion and Research', *World Development*, 20 (2), pp. 199-212.
- Bongenaar, B. and A. Szirmai (1998) 'The Role of a Research and Development Institute in the Development and Diffusion of Technology: The Case of TIRDO', Paper presented in the EADI Workshop on Innovation in Small Enterprises in the Third World, Institute of Social Studies, The Hague, 18-19 Sept.
- Bruton, H.J. (1985) 'On the Production of a National Technology', in: J. James and S. Watanabe (eds) *Technology, Institutions and Government Policies*. Macmillan (for ILO), London., pp. 81-115.
- Chon, S. (1996) 'Small and Medium-sized Enterprises in the Republic of Korea: Implications for the Development of Technology-intensive Industries', *Small Business Economics*, 8, pp. 107-20.
- Ceglie, G. and M. Dinie (1999) 'SME Cluster and Network Development in Developing Countries: The Experience of UNIDO', paper for the International Conference on Building and Modern and Effective Development Service Industry for Small Enterprises, organized by the Committee of Donor Agencies for Small Enterprise Development, Rio de Janeiro, 2-5 March 1999.
- Chung, S. and D.-H. Park (1998) 'Technological Capabilities of Korean SMEs: A Preliminary Analysis', Science and Technology Policy Institute, Seoul, mimeo.
- Cosh, A., A. Hughes and E. Wood (1996) 'Innovation in UK SMEs: Causes and the Consequences for Firm Failure and Acquisition', ESRC Centre for Business Research, Working Paper 48, University of Cambridge, Cambridge.
- Dawson (1999) 'Donor Sourcing from Pro-Poor Business', report for ActionAid, mimeo.
- Dawson, J. and A. Jeans (1997) *Looking Beyond Credit. Business Development Services and the Promotion of Innovation among Small Producers*, Intermediate Technology Publications, London.
- Donor Committee on Small Enterprise Development (1997) 'Business Development Services for SMEs: Preliminary Guidelines for Donor-Funded Interventions', <http://www.ilo.org/public/english/65entrep/bds/workshop.htm>

- Eckaus, R.S. (1955) 'The Factor Proportions Problem in Underdeveloped Areas', *American Economic Review*, 45, Sept.
- Francks, P. (1979) 'The Development of New Techniques in Agriculture: The Case of the Mechanization of Irrigation in the Saga Plain Area of Japan' *World Development*, 7, pp. 531-39.
- Goldar, B. (1988) 'Relative Efficiency of Modern Small Scale Industries in India', Chapter 5 in: K.B. Suri (ed) *Small Scale Enterprises in Industrial Development. The Indian Experience*. Sage Publications, New Delhi, pp. 95-117.
- Haggblade, S., C. Liedholm and D. C. Mead (1990) 'The Effect of Policy and Policy Reforms on Non-agricultural Enterprises and Employment in Developing Countries: A Review of Past Experiences', in: F. Stewart, H. Thomas and T. de Wilde (eds) *The Other Policy*, Intermediate Technology Publications, London.
- Harper, M. (1984) *Small Business in the Third World*, Intermediate Technology Publications, London.
- Havers, M.(1998) 'ApproTEC, Kenya: Developing Technology-Based Business Opportunities. A Case Study on Business Development Services for SMEs', The Springfield Centre for Business in Development, Durham, mimeo.
- Humphrey, J. and H. Schmitz (1996) 'The Triple C Approach to Local Industrial Policy', *World Development*, 24 (12), pp. 1259-77.
- Ishikawa, S. (1975) 'The Chinese Method of Technological Development – The Case of the Agricultural Machinery and Implements Industry', *Developing Economies*, 13 (4), pp. 430-58.
- James, J. (1989) *Improving Traditional Rural Technologies*, Macmillan, London.
- King, K. (1996) *Jua Kali Kenya*, James Currey, London.
- Lall, S. (ed) (1999) *The Technological Response to Import Liberalization in Subsaharan Africa*. Macmillan, London, on behalf of UNU-INTECH, Maastricht.
- Lall, S. (1992) 'Technological Capabilities and Industrialisation', *World Development*, 20 (2), pp. 165-86.
- Lee, K.-U. (1992) 'Industrial Organization: Issues and Recent Developments', in: V. Corbo and S.-M. Suh (eds) *Structural Adjustment in a Newly Industrialized Economy: The Korean Experience*, Johns Hopkins University Press, Washington, D.C.
- Leipziger, D. and P. Petri (1993) 'Korean Industrial Policy: Legacies of the Past and Directions for the Future', The World Bank, Washington, D.C.
- Levy, B., A. Berry, M. Ito, L. Kim, J. Nugent and S. Urata (1994) 'Successful Small and Medium Enterprises and their Technical and Marketing Support Systems: A Comparative Analysis of Four Country Studies', World Bank Policy Working Paper No. 1400, The World Bank, Washington, D.C.
- Little, I.M.D., D. Mazumdar and J.M. Page (1987) *Small Manufacturing Enterprises. A Comparative Analysis of India and Other Economies*, Oxford University Press (for the World Bank), New York.
- Maldonado, C. and S.V. Sethuraman (1992) *Technological Capability in the Informal Sector. Metal Manufacturing in Developing Countries*, International Labour Office, Geneva.
- Massaquoi, J.G.M. (1995) 'The Effect of Some Sectoral Development policies on Technology – The Case of the Informal Sector', in: R. Heeks *et al.* (eds) *Technology and Developing Countries: Practical Applications, Theoretical Issues*, Frank Cass, London.
- Meyanathan, S.D. (ed) (1994) 'Industrial Structures and the Development of Small and Medium Enterprise Linkages. Examples from East Asia', EDI Seminar Series, The World Bank, Washington, D.C.
- Nadvi, K.M. (1996) 'Small Firm Industrial Districts in Pakistan', D.Phil thesis, Institute of Development Studies, University of Sussex, Brighton.
- Oladeji, S.I. (1998) 'Technology Policy and the Development of Small and Medium Scale Enterprises in Contemporary Nigeria', *Technovation*, 18 (2), pp. 125-32.

- Oyelaran-Oyeyinka, B (1997) 'Technological Learning in African Industry: A Study of Engineering Firms in Nigeria', *Science and Public Policy*, 24 (5), pp. 309-18.
- Piore, M. and C. Sabel (1984) *The Second Industrial Divide: Possibilities for Prosperity*. Macmillan, New York.
- Powell, J. (1995) *The Survival of the Fitter. Lives of Some African Engineers*. Intermediate Technology Publications, London.
- Pyke, F. and W. Sengenberger (1992) *Industrial Districts and Local Regeneration*. Geneva: International Institute for Labour Studies.
- Rabellotti, R. (1995) 'External Economies and Cooperation in Industrial Districts: A Comparison of Italy and Mexico', D.Phil thesis, Institute of Development Studies, University of Sussex, Brighton.
- Romijn, H. (1999) *Acquisition of Technological Capabilities in Small Firms in Developing Countries*. Macmillan, London and St Martin's Press.
- Romijn, H. (1997) 'Acquisition of Technological Capabilities in Development: A Quantitative Case Study of Pakistan's Capital Goods Sector', *World Development*, 25 (3), pp. 359-377.
- Rothwell, R. and W. Zegveld (1985) *Innovation and the Small and Medium Sized Firm*, Kluwer, Boston, Mass.
- Schmitz, H. (1995) 'Small Shoemakers and Fordist Giants: Tale of a Supercluster', *World Development*, 23 (1), pp. 9-28.
- Sethuraman, S.V. (1977) 'Technology and Small Enterprise Development', Chapter 12 in: P.A. Neck and R.E. Nelson (eds) *Small Enterprise Development: Policies and Programmes*, Management Development Series No. 14, International Labour Office, Geneva, pp. 187-202.
- Sethuraman, S.V. (ed) (1981) *The Urban Informal Sector in Developing Countries: Employment, Poverty and Environment*, International Labour Office, Geneva.
- Smillie, I. (1991) 'Light Engineering and the Very Late Starters', in: I. Smillie, *Mastering the Machine. Poverty, Aid and Technology*. Intermediate Technology Publications, London.
- Stewart, F. (ed) (1987) *Macro-policies for Appropriate Technology in Developing Countries*, Westview Press, Boulder.
- Stewart, F. and G. Ranis (1990) 'Macro-policies for Appropriate Technology: A Synthesis of Findings', in: F. Stewart, H. Thomas and T. de Wilde (eds) *The Other Policy*, Intermediate Technology Publications, London.
- Tanburn, J. (1996) 'Towards Success: Impact and Sustainability in the FIT Programme', *Small Enterprise Development*, 7(1), pp. 42-51.
- Tendler, J. and M. Amorim (1996) 'Small Firms and Their Helpers: Lessons in Demand', *World Development*, 24 (3), pp. 407-26.
- Tewari, M. (1996) 'When the Marginal Becomes Mainstream: Lessons from Half-century of Dynamic Small-firm Growth in Ludhiana, India', PhD thesis, Massachusetts Institute of Technology, Boston.
- UNCTAD (1996) 'Fostering Technological Dynamism: Evolution of Thought on technological Development Processes and Competitiveness. A Review of the Literature', United Nations, New York and Geneva.
- UNDP, UNIDO and Government of the Netherlands (1988) *Development of Rural Small Industrial Enterprises*, UNIDO, Vienna.
- UNIDO (1996) *Industrial Development Global Report 1996*, Oxford University Press, Oxford.
- Wangwe, S. (1993) 'Small and Microenterprise Promotion and Technological Policy Implications', in: A.H.J. Helmsing and Th. Kolstee (eds) *Small Enterprises and Changing Policies; Structural Adjustment, Financial Policy and Assistance Programmes in Africa*, Intermediate Technology Publications, London.
- Watanabe, S. (ed) (1983) *Technology, Marketing and Industrialisation. Linkages Between Large and Small Enterprises*, Macmillan (for ILO), Delhi.

- Wong, S.T. (1994) 'Singapore', in: S.D. Meyanathan (ed) *Industrial Structures and the Development of Small and Medium Enterprise Linkages. Examples from East Asia*, EDI Seminar Series, The World Bank, Washington, D.C.
- World Bank (1994) *Adjustment in Africa. Reforms, Results and the Road Ahead*, Oxford University Press (for the World Bank), Oxford.

WORKING PAPERS



ECIS working papers (May 2000):

- 98.1: Per Botolf Maurseth & Bart Verspagen:  
*Knowledge spillovers in Europe and its consequences for systems of innovation*
- 98.2: Jan Fagerberg & Bart Verspagen:  
*Productivity, R&D spillovers and trade*
- 98.3: Leon A.G. Oerlemans, Marius T.H. Meeus & Frans W.M. Boekema:  
*Learning, innovation and proximity*
- 99.1: Marius T.H. Meeus, Leon A.G. Oerlemans & Jules J.J. van Dijck:  
*Regional systems of innovation from within*
- 99.2: Marcel P. Timmer: Climbing the technology ladder too fast?:  
*An international comparison of productivity in south and east- asian manufacturing, 1963-1993*
- 99.3: Leon A.G. Oerlemans, Marius T.H. Meeus, Frans W.M. Boekema:  
*Innovation and space: theoretical perspectives*
- 99.4: A. Mukherjee & N. Balasubramanian:  
*Technology transfer in a horizontally differentiated product-market*
- 99.5: Marius T.H. Meeus, Leon A.G. Oerlemans & J. Hage:  
*Sectoral patterns of interactive learning*
- 99.6: Bart Verspagen:  
*The role of large multinationals in the dutch technology infrastructure*
- 99.7: Leon A.G. Oerlemans & Marius T.H. Meeus:

***R&D cooperation in a transaction cost perspective***

- 99.8: Gerald Silverberg & Bart Verspagen:  
***Long memory in time series of economic growth and convergence***
- 99.9: B. Bongenaar & A. Szirmai:  
***The role of a research and development institute in the development and diffusion of technology***
- 99.10: M.C.J. Caniëls & B. Verspagen:  
***Spatial distance in a technology gap model***
- 99.11: J.I.M. Halman, J.A. Keizer & X.M. Song:  
***Perceived risks in product innovation projects: development of a risk skeleton***
- 99.12: A. Mukherjee:  
***Subsidy and entry: role of licensing***
- 99.13: M.C.J. Caniëls & B. Verspagen:  
***The effects of economic integration on regional growth, an evolutionary model***
- 00.01: O. Lint:  
***The primary assessment tool at Philips Electronics:  
Capturing real options and organizational risk in technology portfolio management***
- 00.02: O. Lint & E. Pennings:  
***The recently chosen digital video standard: playing the game within the game***
- 00.03: A. Mukherjee & E. Pennings:  
***Imitation, patent protection and welfare***
- 00.04: J. Hagedoorn & G. Duysters  
***The effect of mergers and acquisitions on the technological performance of companies in a high-tech environment***
- 00.05: O. Lint & E. Pennings:  
***The V-shaped value evolution of R&D projects***
- 00.06: H. Romijn:  
***Technology support for small industries in developing countries:  
A review of concepts and project practices***

These papers can be downloaded from the ECIS website : <http://www.tm.tue.nl/ecis>.  
On request hardcopies can be sent. Please contact ECIS.