Technology Support for Small-scale Industry in Developing Countries: A Review of Concepts and Project Practices

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ABSTRACT The paper is a review of approaches towards institutional technology support for small-scale manufacturing enterprises in developing countries since the early 1970s. Early programmes tended to suffer from a number of weaknesses, stemming from a limited conceptualization 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 advances 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 different 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 organize themselves in collective bodies that can evolve into self-help institutions; and (d) include appropriate incentive structures based on market principles.

1. Introduction

Small enterprises typically make a large contribution to manufacturing employment in poor countries. However, the developmental contribution of most of them 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 firms. This has spawned a plethora of policies and programmes, and an almost boundless literature documenting them.

This article is a review of one specific subset of that literature, namely studies that shed light on measures aimed at improving technological performance. This aspect has recently received less attention than other forms of assistance. Although much is being written about so-called business development services (BDS), of which technology support is a component, most of that literature has a broader focus, dealing with management, organization, sales, employment, income and general quality issues. Few
publications contain technical details about upgrading of products, processes and organization, the support needed to bring about such improvements and the effectiveness of delivery mechanisms.

Yet technological competence is an especially important determinant of small manufacturers’ ability to hold their own in a context of liberalization and increasing integration of manufacturing into global networks. Many of their markets, even traditional ones, are changing rapidly. In this situation, a lack of capability to produce efficiently, meet deadlines, or upgrade product quality and design spells defeat.

The main objective is to identify important common factors behind the success and failure of technology assistance projects of public agencies and non-governmental organizations (NGOs). Insight into the question of what constitutes “best practice” in this field is still sorely lacking. The rationale for technology support for small firms is elaborated in Section 2. Lessons from past debates and interventions are drawn in Section 3. Section 4 treats recent developments in the debate about small industry promotion more broadly, as these hold important lessons for current technical assistance practices. This sets the scene for the discussion of recent approaches to project design and implementation in Section 5, focusing on key principles behind the success of new approaches that are likely to have more general validity. These are illustrated with project case studies in Section 6. Conclusions are given in Section 7.

The emphasis of this review is on small-scale “workshops”, so common throughout the developing world. They typically employ 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; simple metal products such as tractor-trailers, ploughs and window frames; leather goods; local construction materials; or processed foodstuffs such as tofu and pasta. The customer base usually includes large numbers of the poor and lower middle class. Except in some Asian newly industrialized countries (NICs), few are in the forefront in new high-tech sectors and successful exporters. Only a small minority engages in formal R&D. 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 focused more on poverty alleviation than on business growth, and a discussion of these programmes raises different issues.

2. The Importance of Technology Support

The importance of institutional (i.e. public and NGO) technology support to industry in general derives from the argument that investments in technological upgrading and learning are subject to widespread market failure. Without corrective intervention, private companies will under-invest in technological effort relative to the social optimum (Stoneman, 1995; Dasgupta, 1987). First, new knowledge created by a company tends to leak out to competitors, reducing its incentive to innovate. Second, investments in technological upgrading are subject to risk due to uncertainty. Third, new knowledge often becomes substantially useful only in fairly large amounts, so that the required minimum investment outlay and risk will sometimes exceed the capacity of individual investors. Scale advantages also occur in the form of benefits from interactive technological learning, which creates positive externalities by sparking new knowledge and ideas. Co-ordinated action can: balance innovators’ and imitators’ interests; help decide which industries and projects should receive priority in the national research
effort; help mobilize sufficient resources to that end; get private actors to co-operate towards the achievement of those goals; and reduce risk through improved access to information and knowledge.

Support policies are particularly vital in less-developed countries (LDCs), where problems of appropriability, co-ordination and information are especially severe. The financial, research and human capital base of firms tends to be weak. Most of their technological efforts are relatively easy to copy because they are, for the most part, adaptive and incremental, not amenable to patenting. Inter-firm communication and co-operation are cumbersome because of poorly developed physical infrastructure, and risk is high in an information-poor environment. Even relatively easy tasks become difficult, costly and risky (Lall & Teubal, 1998, p. 1371).

Small firms generally find it more difficult to cope than medium and large ones. Their technological capabilities are weaker, and they are usually not in a position to get funding for innovation on reasonable terms through the regular financial system. Owing to resource constraints, their information search efforts and investments in training and education tend to be quite restricted. Lack of finance, skill and expertise combined with high uncertainty also lead to risk-averse behaviour, depressing investments in technological effort. In some industries, modern, efficient techniques of production suitable for a small scale of operation are also lacking. Moreover, problems associated with economies of scale affect small firms worse than large ones. While the latter can to some extent overcome scale problems and capture externalities from inter-personal interaction within the confines of their own walls, small firms can create critical mass only through inter-firm co-operation and market exchange, which is often precluded by intense competitive rivalry, lack of trust, poorly functioning factor markets and under-developed private-sector services. The large majority of the workshops that are the subject of this paper are caught in a vicious circle of low-tech, low-productivity production, unable to embark on substantial technological upgrading efforts without help.

Potential benefits of institutional support to small firms are large. By improving access to information, finance and suitable technologies, support can help fill the “missing middle” observed in the manufacturing size structure in poor countries. Dynamic small firms could also contribute significantly to national exports. Moreover, clusters of geographically close producers may create significant positive dynamic externalities (Levy et al., 1999).

3. 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 industrialization strategies favouring top-down modernization through expansion of the modern large-scale sector that had been pursued in the 1950s and 1960s. 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 Organization took the lead in documenting the precariousness of those working in small enterprises, and the serious constraints they faced (e.g. Sethuraman, 1981).

Early technology support programmes predominantly adopted a “supply-push” approach (UNDP et al., 1988). It was thought that the provision of a variety of services could overcome producers’ resource constraints and thereby foster competitiveness. Many countries set up state-run small and medium industry development organizations (SMIDOs) charged with providing services such as technical and management training,
marketing assistance, advice about technology choice, assistance with technology procurement and provision of subsidized finance. The scope of the programmes was generally broader than technological upgrading alone. However, there were also a number of bodies, both state and NGO, focusing specifically on technology. These programmes achieved some good results, but they were also beset with a large number of problems. Here, we only discuss some issues that bear specifically on technological support. It is inevitably a broad-brush approach that does not do justice to the specificities associated with particular programmes across different countries.

3.1 Underlying Conceptual Problems

In the early years of enterprise promotion, the precarious existence of many workshops was thought to stem from larger firms being more efficient as a result of economies of scale and the use of more productive techniques. The question of whether small enterprises would be able to operate efficiently at all was hotly debated (e.g., Little et al., 1987; Goldar, 1988).

With hindsight, the scope of this debate appears 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 literature about technology and development in the 1970s (e.g., Sethuraman, 1977; Harper, 1984). Thus, their lack of competitiveness was attributed to high relative unit cost stemming from lack of appropriate hardware. Little attention was paid to the possibility that human skills, knowledge and organizational capacity to use, adapt and improve the hardware efficiently might also be in short supply and might constitute an equally crucial constraint on competitiveness. Moreover, the focus was on cost levels in individual small units versus those in larger firms, i.e. there was no recognition of potential competitive advantages that might accrue through exploitation of cluster or network synergies involving groups. Meanwhile, the preoccupation with the problematic horizontal (competitive) relations of small firms with their larger counterparts prevented most researchers and policy-makers from exploring growth possibilities through development of complementary (vertical) relations.4

3.2 Lessons Learned

3.2.1 ‘Appropriate’ technologies and their limitations. In the debate on aid for small firms, some claimed that efficient technologies suited to small-scale operation did not exist.5 Others suggested that such technologies did indeed exist in several industries, but that there were serious disincentives to their adoption due to unfavourable macroeconomic policies favouring use of large-scale modern techniques and boosting demand for their products (Stewart, 1987; Bhalla, 1985; Stewart & Ranis, 1990; Haggblade et al., 1990).

Both arguments carried some weight. The first led policy-makers to promote research in institutes aimed at the development of small-scale efficient technologies. Various strategies were identified (Bhalla et al., 1984; James, 1989). Foreign donors were much involved in such projects; it was the golden age of the appropriate technology movement.

This approach achieved a degree of success, though many so-called “appropriate” technologies failed at the commercialization stage. One big lesson was that technology development in the public domain and its subsequent diffusion in top-down, “supply-push” fashion was not an effective model.6 Technology institutes often had competent engineers, but they knew little about the requirements of poor producers and communi-
ties, were usually located far from them and had little awareness about social, economic and cultural issues. Even where that was not the case, significant communication barriers between developers and prospective users tended to preclude effective information exchange.

The successes (mainly in East Asian countries, especially Japan, Taiwan and China) demonstrated that technologies have to be developed in close collaboration with the prospective users through a process in which the users can take significant control over the direction of the project and, in effect, assume ownership of the technology. Another essential condition is that equipment producers (i.e. local capital goods makers) have to be involved at an early stage of development, since they (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 feedback between developers and users are needed to improve and adapt them in iterative fashion. For this reason, the best technology development model involves close and ongoing interaction between users, institutes and producers as equal partners with complementary knowledge and skills.

3.2.2 Lack of incentives and competitive pressures. Early programmes had major design and implementation flaws. 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 often bred complacency among recipients. Sometimes small entrepreneurs took the assistance for granted simply because they belonged to an “underprivileged class”. This was 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 were other incentive problems. Supporting small companies is not as rewarding and glamorous as assistance to bigger business. It is less visible, does not bring political influence or important contacts and needs much effort to achieve good results. Not surprisingly, the most successful projects involved committed individuals who were not primarily driven by high monetary rewards. In addition to weak incentives, many programmes lacked effective sanctions for inadequate performance of assistance agencies. State-run or parastatal organizations functioning with “soft budget constraints” did not have to rely on commercial sources of revenue for their continued existence. The technological assistance of the SMIDOs has had even more modest results than the programmes run by specialized technology development institutes and NGOs, and it is not worth dwelling much on it.

3.2.3 An unconducive 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 movement. Studies were undertaken that linked inappropriate technology choices to biased incentive structures caused by adverse macro-level and “meso”-level policies commonly pursued in developing economies. Much light was shed on why the effectiveness of the early programmes was so limited. It is probably true that their lack of success 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
was at least partly caused by the general economic malaise and the lack of growth possibilities for small companies in many countries pursuing import-substitution strategies that favoured modern, large-scale forms of production. Overvalued local currencies and cheap credit for large import-substituting companies led them to establish import-intensive integrated production facilities. 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 was generally modest.¹⁰

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

3.2.4 Lack of integration of small firm aid with national industrialization strategies

The macro-incentives approach was particularly useful in raising awareness about how small industries were linked to, and affected by, what was happening in the wider economy. Curiously, the studies about small-scale enterprises and the informal sector generated in the 1970s largely ignored wider industrialization strategy issues, while studies about countries’ industrialization in general tended to disregard the small industry sector. This lack of integration in research had its effect at the policy level. Policy-makers generally did not properly integrate the promotion of their small industry sector within broader industrialization strategies and objectives, almost as if it existed in a vacuum. Many countries still suffer from such legacies, even those that have made a serious effort at industrial policy reform (see, e.g. King, 1996; Oladeji, 1998).

4. The 1990s: New Directions in Concepts and Practices

The practice of technology support has moved forward in recent years, especially in the 1990s. This partly reflects changes in the broader debate about small industry development and its role in industrialization in general. This section highlights some important emerging lessons for the design and implementation of technology support projects. Sections 5 and 6 focus on innovative project approaches that have absorbed these lessons, along with the findings from earlier project practices discussed above.

The debate has clearly been influenced by the major changes in the policy climate since the late 1970s. The rise of neo-liberal thinking de-emphasized state involvement in the economy, spelled the demise of inward-looking approaches to industrialization and advocated increased openness to trade and foreign investment. The effects of these policies on local industrialization have varied. Some of the relatively advanced developing countries in East and Southeast Asia and Latin America are increasingly being integrated into 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 liberalization 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 at 0.4% in 1985, declined to 0.3% 10 years later (UNIDO, 1996, p. 22).¹¹

In both cases, however, the old notion that economic prospects for small industries
would derive mainly from their ability to achieve competitive cost levels with occasional injections of appropriate equipment proved increasingly inadequate in the context of the big shift in the macroeconomic climate and the forces pushing for global integration and marginalization. There are important common elements in the changing literature about small industry development across major regions. In particular, the old view that producers could improve their competitiveness by absorbing technical improvements designed elsewhere 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.

4.1 Advanced LDCs: Small Firms, Technical Capability and Systemic Competitiveness

The change is perhaps most evident in the most advanced and fast-industrializing economies of Asia and Latin America (especially the East Asian NICs), where there is much potential for small firms to join in export-oriented industrialization with increasing participation in international trading and production networks (Levy *et al.*, 1999). In a dynamic industrial environment, small firms’ competitiveness begins to be perceived as an integral part of national competitiveness. This is mainly due to the perceived complementarity of the activities of large and small undertakings. The emphasis is on the need for local specialized subcontractors to customers downstream in the “value chain”, who can react quickly and flexibly to their changing requirements and begin to play a role in the design and adoption of technological improvements. Thus, the competitiveness of small companies is increasingly being perceived in terms of their internal capabilities to choose, use, adapt and develop technology. Such capabilities are essential to foster competitiveness in a fast-evolving environment which continuously places new demands upon large and small firms alike (Meyanathan, 1994; UNIDO, 1996, pp. 53–56).

Consequently, the small enterprise debate in these countries is beginning to link up with the debate about acquisition of technological capability in industrial development.12 The latter has largely replaced the old static “choice of technique” framework that underpinned the early small firm support programmes already discussed. Its 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 (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 “shop-floor” improvements rather than formal R&D. Unlike the earlier choice of technique material, the capability approach sees technological constraints primarily in the lack of human knowledge, *skills and organization* rather than *machines*, and it views technological progress as endogenous to firms and within developing countries more broadly. This approach holds important lessons for the design of technology support projects for small firms.

The trend towards a more dynamic interpretation of small firm technological performance and competitiveness is evident even in countries like South Korea and Singapore, whose earlier policies were 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 & Petri, 1993; Chon, 1996; Chung & Park, 1998).
4.2 Middle-income LDCs: Dynamism in Small Industry Clusters

Another important contribution with implications for technology support has come from studies emphasizing the efficiency of groups of small firms and their interactions in networked geographical clusters which may foster collective competitiveness (e.g. Humphrey & Schmitz, 1996; Schmitz, 1995; Nadvi, 1996; Tewari, 1996; Rabellotti, 1995; Ceglie & Dini, 1999; World Development, September 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, but there are also some contributions dealing with lower-income African countries. The main concern is again the internal economic dynamism of small producers, but the emphasis is on inter-firm dynamics rather than intra-firm learning. Drawing on writings about flexible specialization in industrial districts in developed countries (e.g. Piore & Sabel, 1984; Best, 1990; Pyke & Sengenberger, 1992), the suggestion is that clustering in developing countries can help sustain long-term competitiveness among participating firms. The writers appear to presuppose that clustering may also enhance capability to initiate and diffuse technological improvements, though this claim has remained largely unsubstantiated. The innovation and learning effects have not been investigated systematically. “Learning” crops up in some studies, but what this entails in practice remains unclear (Albu, 1997).13

4.3 Poor LDCs: Technological Capability Building by Individual Producers

A final important contribution has come from studies about the importance of internal technological capability acquisition in individual small industrial units. Many are 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 because of international competition from more advanced economies. The large-scale industrial sector has all but collapsed and foreign investors have failed to fill the gap in a big way. Small companies are being seen as a potential force for industrial regeneration and increased attention is being devoted to questioning whether they can function as an engine of industrial growth and become a source of competitive advantage in their own right. There is 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-skill scenario. It is also recognized 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 (King & McGrath, 1999; Wangwe, 1993; Oladeji, 1998; Oyelaran-Oeyinka, 1997; King, 1996; Maldonado & Sethuraman, 1992; Massaquoi, 1995; Romijn, 1997, 1999; Smillie, 1991; Appropriate Technology, 1997).

5. Innovative Approaches at the Project Level

The insights emerging from the recent conceptual debate about the role of small firms in development are beginning to be incorporated into the design of technology assistance projects, along with lessons learnt from accumulating hands-on experience with project implementation by practitioners (Section 3). There is reason to believe that the
success record of some of the more recent programmes is better than those of earlier ones.

Unfortunately, even now, only a few project studies have systematically pinpointed the main features that are believed to underpin their success. Hence, the discussion cannot go much beyond identifying some broad principles which can be distilled from the reviews in Section 3 and 4, and which at the same time can be associated with success in assistance projects in practice.

5.1 Acquisition of Indigenous Technological Capability

Perhaps the most important common factor central to improved outcomes of technical assistance projects is that 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 organization on an ongoing basis. Humphrey & Schmitz (1996) hint at 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; projects need to aim for “cumulative benefits”.

The implication for the design of technological assistance projects is that they must initiate and facilitate a process of change which creates opportunities for producers to engage in continuous development of their technological knowledge, skills and organization. The Donor Committee on Small Enterprise Development, an umbrella group of big aid agencies which has organized much of the ongoing discussion, refers to this as “indigenous technology development” (Donor Committee on Small Enterprise Development, 1997, pp. 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 its introduction should become unimportant or redundant. Making a mechanical lathe available to a woodworking shop, or showing local metalworkers a prototype of an improved cooking stove for low-income households, obviously constitutes a developmentally beneficial policy intervention in its own right. However, rather than viewing the supply of equipment or designs as final objectives, 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 organizational skills that will strengthen their ability to introduce other product and process innovations on their own initiative at a later stage (Jeans, 1999).

The adoption of this notion has obvious implications for the delivery of assistance. 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. Producers should participate in design, adaptation and problem-solving processes so that these will create possibilities for them to build their own design skills (Jeans, 1999).

Another way in which projects can help producers to learn is by creating an “information-rich environment”, facilitating access to knowledge and information that can form inputs into the learning process (Levy et al., 1999, p. 243). Examples include projects sponsoring courses, organizing field trips by producers to more advanced factories, facilitating the use of specialized consultants, helping producers to participate in trade fairs and promoting information-sharing among firms.
H. Romijn

5.2 Demand Orientation

An effective way in which assistance agencies can trigger and sustain indigenous technological capacity building 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 & Schmitz, 1996; Tendler & Amorim, 1996; Dawson, 1999). There are different ways in which this has been achieved. Most of the evidence concerns successful negotiation by assistance agencies to help small producers (or groups) to become suppliers in public procurement schemes, but assistance agencies have also successfully linked small producers to new private sector clients, not only at home but also abroad (Levy et al., 1999).

This customer-focused approach has at least two major advantages over the earlier supply-side project interventions reviewed in Section 3. First, access to a dynamic market in which producers are required to deliver products with improved designs and quality, to pay attention to standardization, 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 assistance quite tightly around supplying the critical missing inputs required to overcome producer bottlenecks experienced in the process of trying to meet customer demand and responding to their complaints. The assistance can be applied at once; hence 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, training small suppliers and providing technical consultancy, with the assisting agency meeting part of the costs involved (Dawson, 1999; Wong, 1994).

5.3 Organization in Groups of Clustered Firms

In recent successful projects, the practical organization 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 with varied activities (Humphrey & Schmitz, 1996). Collective support to clusters has advantages. First, it is simply more cost-effective for agencies to concentrate on the problems faced by groups of similar producers in a few specific localities. Keeping costs down is especially important since aid projects are increasingly under pressure from donors to ensure financial sustainability of projects within a short period (Dawson & Jeans, 1997). It also allows agency personnel to develop in-depth expertise about the technical, marketing and other problems of specific industries in particular regions. Moreover, an agency based close to its clients can develop a close working relationship with them, overcoming mistrust and establishing its credibility.

Joint support can also stimulate intra-firm learning through common problem-solving, information exchange and overcoming lumpiness problems (e.g. establishment 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, organization in groups can overcome contractual problems with clients and enforce complaint behaviour by the companies participating in a project. Large clients prefer to deal with an association of small manufacturers rather than to share out orders
among individual members, monitor their progress and deal with problems relating to order fulfilment. Furthermore, the manufacturers’ association can pressure its members to perform according to the contract, e.g. by making the group jointly responsible for delivering the outputs and honouring warranty claims.

5.4 Incentives that Promote Sustainability

Flawed incentives, both for assistance providers and beneficiaries, were one of the chief causes of failure in early support projects. In some of the recent projects, much attention has been devoted to the careful design of a more appropriate incentive structure (see especially Tendler & Amorim, 1996). This entails a combination of “carrots”, potential rewards that motivate the participants to act, and “sticks”, sanctions that come into operation when they fail to do their best. Effective incentive systems appear to be those that rely as much as possible on market discipline, especially a payment system that rewards effective services offered by support staff and that penalizes failure. Getting beneficiaries to pay for (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 deny that some project activities do require initial subsidies to overcome market failures commonly associated with technological learning (see Section 2). However, this is not an argument for mounting interventions that distort, or even completely replace 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 remain motivated. Only then will projects be able to bring about the cumulative effects that Humphrey and Schmitz refer to. Some projects now do not merely aim for cumulativeness in terms of sustained benefits for small producers and their customers (i.e improvement processes driven by ongoing learning); they also apply the notion to delivery of the project services themselves. Dawson & Jeans (1997) argue that projects must evolve institutional forms of self-help that will, over time, start to function independently of external aid agencies. Organizing producers and helping them to build strong local collective institutions (see above) can contribute to the achievement of this goal.

6. Some Illustrations from Specific Projects

We illustrate the above points with some examples ranging from projects in advanced developing economies in East Asia to schemes in low-income countries in Africa.

Among the higher-income industrializing countries in East and Southeast Asia and Latin America, Singapore, Korea and Taiwan have the most elaborate technical support systems for small manufacturers. These appear to be used quite intensively, although most of the support is aimed at more advanced “small/medium” firms rather than the small workshops that are the central focus of this article. The usefulness of institutional schemes in other higher-income developing countries appears to be more limited. For example, interactions with private parties, especially buyers and suppliers, were much more important for technological upgrading among small exporters in Indonesia and Colombia (Levy et al., 1999).

Here we focus mainly on an East Asian programme with a more “workshop-like” focus, drawing on other NIC schemes where relevant. Singapore’s Local Industry Upgrading Programme (LIUP) was designed in 1989 by the Economic Development Board (EDB) as part of its Small and Medium Enterprise Master Plan, to strengthen
the technological capacity of suppliers to transnational corporations (TNCs) in precision engineering, which is crucial for the country’s competitiveness in high-tech electronics.\textsuperscript{16} It has been reported that various significant forms of technological learning have taken 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 corporation.

An example of a project in a less prosperous setting is a public procurement scheme for school furniture in the backward Brazilian State of Ceará.\textsuperscript{17} It was organized 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 scale suppliers of wood products in regions that had been badly hit by drought, as a sort of alternative to a public works programme. The success of this project is evident from the upgraded skills, knowledge and management capabilities of the participating enterprises, as well as substantial investments made in power tools, expanded capacity, creation of many backward and forward linkages, and vastly increased employment in local industry. 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. Five years after the start of the project, 70% of their output was already going to the private sector. The association had become an important institution locally, initiating many developmental activities without help from the original assistance agencies.

We also draw on the experience of the Farm Implements and Tools (FIT) programme implemented in Kenya by the International Labour Organization and a Dutch NGO called TOOL.\textsuperscript{18} It targets (among others) small manufacturers of farm equipment. Conditions are hostile: Kenya is currently a stagnant economy at a low stage of economic, technological and infrastructure development. Indications of success in this project have been that the participating small firms have continued within the programme over a period of time and that they are paying at least part of the cost of the services. They are also suggesting the introduction of new project activities, such as help with establishing facilities for equipment testing and with resolving teething problems encountered when new or improved farm implements are used in practice.

\subsection*{6.1 Demand Creation}

Of the three projects, the SEBRAE scheme has been the most explicitly demand-driven. The project was itself a response to the opening up of public procurement of basic manufactured products by SIC to small-scale manufacturers, which created a potential new market outlet that could be readily exploited. After the success of this project, public procurement has begun to be more widely used as a vehicle for small firm support, but the scope for such public sector initiatives is inevitably somewhat limited. Therefore, the experience of the other two projects is more instructive. They show that demand-driven projects can also come about as a result of special efforts to build demand from private agents into the project design. The LIUP scheme has achieved this by forging close links between TNCs and their suppliers, focusing the support around practical problems that crop up as the suppliers try to meet the demand from their customers. The EDB assumes the role of “network broker”, an idea that has also worked well in assistance projects in other countries.\textsuperscript{19} 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 act as LIUP manager for 2–3 years, identifying 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, a clear example of the practice of “buyer-mentoring” discussed in Section 5. The EDB, meanwhile, arranges access for the participating small companies to a variety of financial support schemes operated by and through it.

FIT, too, is strongly demand-driven. According to the project organizers, “... the demand by micro- and small-scale enterprises 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” (Tanburn, 1996, p. 47). For that reason, project activities must translate into substantial and reasonably quick improvements in products that benefit the customers. Unlike in the cases of SEBRAE and LIUP, ensuring customer co-operation for technological upgrading of suppliers has been difficult in a situation where the farmers whose demand for innovations is to be stimulated are just as resource-poor as the entrepreneurs who make their ploughs and hoes. Yet the project has had some success with the organization of regional user-producer meetings where improved farm equipment developed by project participants is displayed. Through these “innovation fairs”, farmers developed a keen interest in interacting with the producers, providing them with feedback on the performance of their improved products and suggesting further improvements.

6.2 Capability Building

Upgrading of small producers’ technological capacity has been essential to satisfying customer demand for new or improved products in all three programmes. LIUP strengthens suppliers’ capabilities through a focus on increased operational efficiency (ability to produce according to the exacting time schedules and quality standards required by clients) and increased ability to perform ongoing incremental improvements in products and processes. It aims to raise technical standards to a level where the producers can compete successfully with leading foreign suppliers, forming attractive partners for the local TNC community.

In the SEBRAE project, too, small woodworkers had to advance technologically in order to reach the production standards called for by the public sector tenders. To this end, the local woodworkers were provided with technical assistance and consulting services over a period of time. The customer-driven approach led to a well-focused and efficient form of assistance in which producers could learn incrementally: participants in the project who encountered technical bottlenecks in the course of trying to fulfil requirements could call on SEBRAE engineers to help them identify the specific problems which needed to be solved to deliver the required quality at the agreed price at the right time.

Likewise, FIT’s objective has been to strengthen producers’ internal capacity to undertake technological upgrading of their products, ultimately contributing to higher productivity and incomes of farmers as well. The programme essentially functions as a facilitator for technological learning in the participating enterprises. Several services helping to create an information-rich environment (see Section 5) have been developed. For example, by broadening access to market and product information, 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 understand why the performance of their products can fall short of user expectations. It also gives them new ideas for improvements and for the introduction of new products. One activity is the organization 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 initiatives, became an independent activity in itself because the informal information exchange obviously met participants’ needs. Finally, help has also been offered to producers to identify new markets through teaching a simple “rapid market appraisal”.

*Inter alia*, provision of an information-rich environment has been a successful assistance instrument for more advanced small and medium enterprises in higher-income developing countries, too. Research about assistance to export-oriented small and medium-sized manufacturers in Colombia, Indonesia and Korea (as well as Japan) found that such “broad-based support”, which leaves firms to decide what information sources might be most useful, was particularly valued by the firms. A key precondition for its success, however, is that the macroeconomic environment should not be grossly distorted through overvalued exchange rates, rationed credit and foreign exchange, and so on (Section 3). Such distortions have created unfair advantages for large firms in the past, which no amount of information can offset (Levy et al., 1999).

An advantage of information provision through mechanisms such as trade fairs, specialized consultants, data banks, catalogues and so on, is that the institutional requirements for this kind of assistance are relatively modest compared with “high-intensity” specialized technical support, which places high demands on the technological and organizational capabilities of the supporting institutions. Few developing countries can deliver such assistance effectively. An exception appears to be Korea, where the central support providers have good procedures for evaluating the impact of their programmes, distributing resources between and within agencies, matching supply and demand of services, and hiring competent staff. But this is hard to replicate in poorer countries with weaker governance structures. In any case, the Korean case shows that demand for such specialized services becomes significant only when industries reach relatively high levels of technological complexity (Levy et al., 1999).

### 6.3 Organization in Groups

Advantages of group-based support are illustrated by the SEBRAE and FIT projects. The SEBRAE project has been narrowly targeted at a small collective of small producers in one particular locality operating in one particular activity (woodworking). This had a number of advantages. First, in view of the large orders from SIC, which exceeded the capacity of any one of the individual producers, it was practical to contract with a group. A producer association was formed with encouragement from SEBRAE, which assumed responsibility for ensuring product quality and honouring product warranties, and co-ordinated the activities of the individual members. In case of default by one of them, 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 other’s 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 co-ordinate their activities in order to meet large orders. SEBRAE
engineers would typically come in only after the producers had collectively discussed their problems and identified their assistance priorities.

The FIT project also targets groups of metalworking producers operating in the same area, although it does not seem to involve tightly-knit geographically confined clusters as in the case of SEBRAE. This concept is in any case not so relevant in many African rural areas where the volume of production is simply too low for such clusters to form. Advantages of group-based assistance include a tight focus on common areas of interest and concern, including specialized technical issues, which contributes to informal information exchange and has sparked interactive learning among the producers. It has also been a means to develop collective self-help institutions which can in due course take over the project activities.

6.4 Appropriate Incentives

Appropriate incentive structures have been of paramount importance for the effectiveness of the three projects. In LIUP, the main incentive to the participating TNCs is that they benefit from their efforts to upgrade the operational efficiency of client enterprises, while they also receive considerable subsidies for making inputs into the project, up to 90% 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).

In the SEBRAE project too, incentives mimicked market forces and created pressures on the assistance deliverers and beneficiaries to perform. First, while a new potential market opportunity was created, the customer was not obliged to proceed with the procurement from small producers if quality remained below that of the regular (large-scale) suppliers. Hence, rather than creating a protected market, the scheme fostered competition between large and small producers. Second, by linking the commission received by SEBRAE to the successful securing of orders by producers, the agency’s financial position became partly dependent upon the effectiveness of its assistance, thus creating a clear incentive to perform well.

In FIT, too, the design of a market-based incentive structure has played a crucial role in achieving sustainability of project benefits. It is made known in advance that project financing of the activities is always temporary, and even at the start of a new initiative the participating producers, as well as their customers, must show willingness to pay at least part of the costs. Moreover, producers must show willingness to take over the organization 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 materialize; and that some degree of market failure is inevitable, justifying a long-term public subsidy. However, in resource-poor countries like Kenya, the likelihood of such activities attracting public money on a sustained basis is 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.

7. Concluding Remarks

The practice of technology support for small producers has advanced since the early 1970s. First, 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. 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 organization on an ongoing basis. Only then can we expect such enterprises to make a contribution to industrialization that 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).

Second, there is a growing understanding among LDC government agencies and donors about the broad features associated with project success so defined. Although regional and sectoral specificities exist, 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 entail a process of incremental and demand-focused technological learning and organizational 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 groups, especially customers.

Effective projects are those that stimulate these processes by establishing conditions in which learning can occur. Linking producers to new markets is an important precondition. Facilitating access to information, especially through interactions with other parties, is another aspect. Organization in local groups with common interests and building collective self-help institutions is yet another element. Finally, incentive structures should spur producers' and assistance agencies' efforts (especially ones that make 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 can be drawn upon at present—and more are certainly needed—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 operationalize general principles in such a way as to fit well within the local context within which it is to be implemented.

Notes
1. The main focus is on programmes and projects with a direct technological content, such as development and commercialization 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.
2. This contrasts with the situation in developed economies where many small companies make significant contributions to the generation of innovations (e.g. Cosh et al., 1996; Rothwell & Zegveld, 1985), and where small firms staffed by educated professionals are well represented in new, knowledge-based industries such as information technology and biotechnology.
3. For an elaboration of the distinction between poverty alleviation and business growth as objectives of small enterprise support projects, see Dawson & Jeans (1997).
4. Some notable exceptions did exist, especially Watanabe's (1983) study about subcontracting linkages.
5. This argument is based on the “rigid factor proportions” problem, first propounded by Eckaus (1955).
7. Good examples are documented in Basant (1990), Ishikawa (1975) and Francks (1979).
9. Their activities and performance have been evaluated in many studies, including several commissioned by aid donors supporting the organizations. See, e.g. UNDP et al. (1988).
10. Few understood that the Japanese success in establishing elaborate and dynamic subcontractor networks was driven by extreme capital scarcity in the economy, which affected even the largest *keiretsu* (Watanabe, 1983).
11. Some writers claim that substantial de-industrialization 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-industrialization debate.
12. See Lall (1992) and UNCTAD (1996) for good reviews of the capability literature.
13. Their main sources of inspiration are economic organization literature (transaction costs theory) and sociology. They are sensitive to the socio-political and institutional context within which small industry clusters function. These aspects have received more attention than "hard" economic and technological ones.
14. This view is not uncontested. Some agencies, such as ApproTEC Kenya, 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 disseminates these as widely as possible. A few reasonably well-run small and medium-sized manufacturers are contracted to make the products according to the specifications supplied by the NGO, but any benefit they receive is primarily a means 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.
15. 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).
16. The discussion about the Singaporean project is based on Wong (1994).
17. The discussion about the Brazilian project is based on Tendler & Amorim (1996).
18. The discussion about the Kenyan project is based on Tanburn (1996).
19. 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).

References
*Appropriate Technology* (1997) 24(1), June, various articles.


