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IN-DEPTH EVALUATION OF SELECTED UNIDO ACTIVITIES ON DEVELOPMENT AND TRANSFER OF TECHNOLOGY

Component 2

Technology Centers
An analysis of UNIDO's Experience

Prepared by*

United Nations Industrial Development Organization

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Abstract

Technology Centers (TCs), in principle, constitute an important instrument for the development and transfer of industrial technology (DTT) either in a specific subsector or a theme (e.g. environment, maintenance and repair, tools and dies) or in the whole of the industrial sector.

Technology centers have normally been a good choice as an instrument for the development and transfer of technology to enterprises. Where there were failures, and there are a few, it was more a question of management and operations rather than of concept.

Out of over 350 in-depth evaluations undertaken since 1986 of projects/programmes executed by or with the involvement of UNIDO, 84 or 24% refer to the establishment/development of TCs. This also shows the weight that TCs have had in the UNIDO technical cooperation delivery. The reports of these evaluations constitute the main basis for the present analysis, in view of the breath of coverage in regional and substantive terms.

This evaluation will try to prove that the concept of TCs is still a valid one, provided that the conditions of applicability and operations indicated in this report are met. Important issues affecting the effectiveness of the institution are its ownership, the adequate mix of income from services and subsidies and an appropriate and continuously updated staff and facilities.

Governments have pulled out or limited their participation and management of TCs, whose management and financing is now supposed to be increasingly taken over by the private sector: the end users. In some cases there was a sudden and drastic change, from total public to private management and financing, with little time for adaptation. The private sector is often not willing or capable to take over the management and funding, particularly of centers having considerable amounts of staff and equipment, which is expensive to depreciate. As a consequence most of the TCs face an uncertain future. This is particularly true of those centers supposed to attend smaller enterprises, which sometimes do not even see the need for the services. In such cases the centers are supposed to provide an important “social” function that justify a subsidy.

Despite the apparent good prospects for twining and networking of TCs, neither has worked satisfactorily nor has proven sustainable.

The issues which the TCs face point to constraints but also to opportunities, the decrease or disappearance of public funding remaining the most significant issue to be tackled. Response of TCs to these issues is far from homogeneous, ranging from institutions which could not meet the challenge and were obliged to close down, to those who were privatized and are successful commercial operations while diversifying continuously the range of services provided in response to market needs.

TCs can play an important role in the transfer of technology to enterprises but it is difficult to quantify benefits. The only actual test on the usefulness of the center to its end user is the ability of the center to get paid for its services which however are not exclusive to transfers of technology.

Due to the fast changing nature of industrial technology, it is obvious that TCs should seek a position of dynamic sustainability. That is, the knowledge accumulated at the end of the technical cooperation project in terms of personnel, facilities and equipment has to continue to develop in line with the related technology advancements. An important ingredient of sustainability is the continuing financial soundness of the institution.

Finally, the report derives some conclusions and lessons on the following main issues:

- The relevance of TCs as an instrument of development and Transfer of Technology
- Good practices for technical cooperation to support the revitalization of TCs
- Orientation of operations to market needs and the need to subsidize operations in favor of the smaller enterprises
- Sustainability

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Acronyms

ARAI	- The Automotive Research Association of India
CESMEC	- Centro de Estudios, Medición y Certificación de Calidad
DTT	- Development and transfer of industrial technology
IRSI	- Industrial Research and Service Institutes
ITRO	- Industrial and Technological Research Organization
MIRA	- Motor Industry Research Association, UK
TAC	- Technical advisory center
TC	- Technology Centers
WAITRO	- World Association of Industrial and Technological Research Organization

Introduction

1. Institutions have frequently been established as means to create or improve national capabilities in a particular field. Technology Centers are among such institutions to be found both in developed and developing countries. Usually they have a mandate to perform one or a combination of the following core functions related to development and transfer of technology: monitoring of technology development (and dissemination of related information), applied research and product development, training, testing, and technology advisory services to enterprises. Not included in this category are centers dealing with management extension services, training and standardization stand alone activities (therefore not including certification, testing or quality control services), subcontracting and partnership promotion exchanges and pilot and experimental plants.

2. In principle, Technology Centers (TCs) constitute an important instrument for the development and transfer of industrial technology (DTT) either in a specific subsector or a theme (e.g. environment, maintenance and repair, tools and dies) or in the whole of the industrial sector.

3. Although the relative importance of TCs in the development and transfer of technology to enterprises have diminished over the years, they have played an important role in developed market economies (e.g. Institut du Pétrole and Institut du Cuir in France and the Motor Industry Research Association, MIRA in the UK), in previous centrally planned economies (Technology sub-sector R&D centers normally attached to the respective "Kombinats" or large public conglomerates) and in developing countries, where they were established mostly under technical cooperation projects, multilaterally or bilaterally sponsored.

4. Their designation can differ: *Industrial Research and Service Institutes (IRSIs)* as called by a UNDP/UNIDO evaluation on the subject undertaken 20 years ago[1], *Industrial and Technological Research Organizations (ITROs)* as called by the World Association of Industrial and Technological Research Organization - WAITRO[2], and *Technical advisory centers (TACs)* as referred to by a study undertaken in 1996 by UNDP, UNDO and OAS[3]. There are some minor differences behind these designations but basically all these relate to institutions which deal from various angles with industrial technology issues .

5. Technology centers have normally been a good choice as an instrument for the development and transfer of technology to enterprises as this evaluation will try to show. Where there were failures it was more a question of management and operation rather than of concept. This evaluation will obviously focus on the DTT component of such centers but cannot ignore other important issues such as their sustainability and income generation.

6. Out of over 350 in-depth evaluations undertaken since 1986 of projects/programmes executed by or with the involvement of UNIDO, 84 or 24% refer to the establishment/development of TCs (19 in Africa,

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[1]Joint UNDP/UNIDO evaluation of Industrial Research and Service Institutes, UNIDO/EX.79, UNIDO 19 April 1979.

[2]WAITRO is a international non-governmental association of 200 institutions in 85 countries, many developing. It does not have a permanent secretariat and its headquarters rotates among its members organizations which have the capacity to do so. Presently is headquartered at the Danish Technological Institute.

[3]Business Incubators in Economic Development, R. Lalkaka, J. Bishop. UNDP, UNIDO and OAS. New York.1996

10 in Arab countries, 44 in Asia, 1 in Europe, 9 in Latin America and the Caribbean and 1 Global)[4]. This also shows the weight that TCs have had in the UNIDO technical cooperation delivery. The main author of this report participated in 10 of these evaluations and was involved in the creation of three centers. The bulk of the related technical cooperation projects were UNDP financed. The reports of these evaluations constitute the main basis for the present analysis, in view of the breath of coverage in regional and substantive terms. Also useful were other evaluations and studies carried out on the subject as indicated under 1.6. Case studies on the activities of UNIDO in DTT undertaken in Brazil, Kenya and Sri Lanka were also useful.

7. UNIDO has sponsored the establishment of the so called International Technology Centers[5] which "focus on industrial application and commercialization of new technologies and innovations" thus having the scope to "become an important bridge between the research community and the commercialization of technologies at the industrial scale". (Both quotations from the URL indicated in the footnote). The mandate and status of these centers are indicated in Annex 2. The centers are normally financed by contributions from the Government of the host country. The evaluators could not visit any of these centers. Furthermore, in the lack of objective and independent information material on the centers, they do not form part of this evaluation.

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[4]Complete list in Annex 1.

[5]Http://www.unido.org/doc/502522.html

1. BACKGROUND INFORMATION

1.1 Evolution of the concept

8. As indicated in the introduction, the concept of TCs has various origins, all of them based on the alleged need for government to support, to provide or to start up technological services to enterprises, either because of market imperfections, or to plan and concentrate R&D in central institutions (as was the case in planned economies) or to provide R&D services to (usually) public companies. Because of previous heavy public (often mis-) handling of such TCs, of the push of globalization to increased and faster competitiveness of enterprises, and of the dismantling of centrally planned economies, many of these institutions have fallen behind the needs of enterprises and as a consequence, in disrepute. An example of this assessment is provided by R. Lalkaka, et al, in 1996: "Technical advisory centers have been established by some governments but these are usually inadequate in numbers and dispersion to service more than a fraction of small enterprises in need of assistance; also they often become bureaucratic and politicized and their staff mediocre or worse because they cannot compete with private employers". It is true that many TCs in developing countries and in economies of transition have closed down or lead a precarious existence. WAITRO pictures the present situation in very clear terms [6]: "In today's world there are two kinds of ITROs... the quick and the dead. Those quick enough to change will survive, those that don't, will die".

9. However, one should differentiate between the validity of the concept, its applicability/relevance to the conditions of the country and the effectiveness of their efforts. In fact the criticism is frequently aimed at the *modus operandi* and not at the concept. This evaluation will try to prove that the concept of TCs is still a valid one, provided that the conditions of applicability and operations indicated under Chapter 3 of this report are met. Important issues affecting the effectiveness of the institution are its ownership, the adequate mix of income from services and subsidies and an appropriate and continuously updated staff and facilities.

1.2 Scope of the UNIDO programme

10. Although the activities of UNIDO in support of TCs should have been considered as a programme benefitting from the accumulated knowledge and feedback from experience, such activities have been undertaken in an isolated manner by various organizational units. No advantage has been derived from the replication of good practices. Many of these projects were donor or recipient country originated. It was therefore not handled as a programme. The recent decreased emphasis given by UNIDO to sub-sectoral issues (apart from agro-industries) and the move of UNDP away from project related, institution building efforts, have considerably diminished the size and scope of the programme and no change for this trend is expected. At present in UNIDO, the most recent technical cooperation projects related to TCs regard almost exclusively National Cleaner Production Centers. Bilateral funds funneled through multilateral agencies also have supported TCs. An example is the project financed by the government of Germany which, through UNIDO, has established a Lignite Research and Development Center in India.

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[6] Best Practices for the Management for the Management of Research and Technology Organizations. WAITRO. Denmark 1999

1.3 Scope of other agencies/countries' programmes

11. TCs constituted an important component of the UNDP country programmes and those centers which were industrial related were traditionally executed by UNIDO. Bilateral programmes have also supported their establishment/development. An example could be found recently in India where German bilateral assistance continues to support an important central tool room facility serving the industry around Ludhiana. Swedish bilateral assistance established an important center to service the truck and earthmoving equipment park of a South East Asian country, thus building up a local technical and logistic capacity to service such equipment. Even the World Bank in the past supported the development of TCs. An example can be found within a large credit line established in Mexico in the early 1980s which *inter alia* supported the strengthening of institutions performing R&D work respectively for the heavy mechanical and electrical machinery Industry. The former institution was also supported by UNDP. The situation has dramatically changed. The multilateral technical projects in support of TCs still in existence are the continuation of past projects and are reaching their end.

1.4 Institutional setting and financing

12. TCs have been mostly established and financed by governments. In some cases funds have a private origin but they are mandatorily levied on exports/imports or payrolls (cases of Brazil, Uruguay and Paraguay) of enterprises. Therefore this type of financing should also be considered as public since it is not based on voluntary payments. Also this practice is not recommendable from the fiscal viewpoint nor it guarantees that there is a significant private sector involvement in the running of the TC. Traditionally, income from sale of services has been usually low since these services were provided by the TCs free or at marginal costs. Even in those cases where the Institution was established at the initiative of the end users (such as the ARAI in India[7]), the important initial investment and running costs were provided by the Government and external cooperation. These institutions fell usually under the supervision of a particular ministry, usually the one providing the financing. End users (that is industrial enterprises, not always private) were present in the managing boards with various degrees of influence. In centrally planned economies these centers were established, funded and managed by the "Kombinats" to which they were attached. In developed countries the centers although public, (sometimes they are established as a limited liability company whose shares were still publicly owned) derived a higher percentage of their budget from sales of services and end users had a stronger say in its management.

13. Another observation that can be made refers to the need of these centers to be positioned in relation to a national framework of technology and institutional development. In some cases this positioning was not clear, in other cases, it was the framework that was not clear or did not exist.

14. The situation has dramatically changed in the 1990s. Governments have sold most of their assets in manufacturing, limited their intervention in industrial conduction to a facilitating role and usually provide incentives and support measures only where situations of market imperfections occur. In the same line, governments have pulled out or limited their participation and management of TCs, whose management and financing is now supposed to be increasingly taken over by the private sector: the end users. In some cases there was a sudden and drastic change, from total public to private management and financing, with little time for adaptation. The private sector is often not willing or capable to take over the management and funding, particularly of centers having considerable amounts of staff and equipment, which is expensive to depreciate.

15. This is particular true of those centers supposed to attend smaller enterprises, who sometimes do

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[7] The Automotive Research Association of India, An analysis a quarter of a century afterwards, FOA/R.8 , 8 March 1999, UNIDO

not even see the need for the services. In such cases the centers are supposed to provide an important "social" function that justify a subsidy. Even in developed countries such institutions often provide the first service free of charge to enter the enterprise and gain future business. Further services, at least in the EU, in support of SMEs continue to have a degree of subsidy. There are however successful cases of full privatization of TCs albeit in centers dealing with "easier" and sometimes mandatory type of services, such as testing, quality control and certification. One notable case is CESMEC established in 1969 in Chile under UNDP/UNIDO technical assistance[8]. The Center started to provide testing and quality services to the metalworking industry on a cost free basis. In line with the drastic deregulation and privatization measures taken by the Government in the middle 1970s, the Center was privatized in 1978. In fact, it was bought by its management and employees who subscribed the equity and purchased the assets from the State using a commercial loan. The Center has expanded its activities in the quality field to the whole of manufacturing sector as well as to fisheries and agricultural products and is today a thriving operation.

1.5 Twining and networking

16. These are two separate mechanisms often included in technical cooperation projects in support of TCs. **Twinning**, somewhat of a misnomer, consists of preferential cooperation arrangements made between a recipient institution and a similar but more advanced institution. The developing country often prefers a twin institution in a developed country rather than one in a more advanced developing country, so that the gap is not so large. There was the case of an institution in Sri Lanka which UNIDO tried to twin with an Indian institution but this was resisted because preference was given to a far more developed institution in the U.K. At the end, no twinning was achieved. The present evaluation could not identify cases of successful twinning except in the case of NCPCs, where it works.

17. **Networking** between similar institutions, today facilitated by electronic mail, is a mechanism that allows primarily for exchange of information and experiences. This can be achieved by periodic meetings or mail. Presently interactive web pages or electronic platforms of discussion (a moderator is needed to keep a minimum of order) can be used where issues are introduced and commented upon by its participants. Comments on networking of NCPCs are provided in the related report. The evaluation could not ascertain cases of significant networking between TCs. What can be considered a variation of networking is practiced by the UNIDO Leather Programme, whereby a panel of peers reviews trends and provide direction to the centers established with UNIDO help in various regions. This process derives from the now defunct UNIDO system of consultations. It is essentially financed by technical cooperation funds and despite its apparent usefulness we wonder whether this system is sustainable once the external funding is no longer available.

18. In short, despite the apparent good prospects for twining and networking of TCs, neither has worked satisfactorily nor has proven sustainable.

1.6 Other evaluations/studies

19. The subject of TCs has been studied and/or evaluated by several multi- and bilateral bodies.

20. The first evaluations was undertaken by UNIDO exactly twenty years ago. In those days, the financing of the institutions was publicly funded, so issues of financial sustainability did not seem to be important, at least they were not mentioned by the evaluation. Recommendations were essentially in the line of improved efficiency and effectiveness and increased cooperation of TCs under the umbrella of the UNIDO sponsored organization WAITRO. Already then recommended was the support that TCs could

[8] CESMEC, Centro de Estudios, Medición y Certificación de Calidad- CHILE. An exercise in sustainability , FMD. 2 (Spec) dated 23 October 1995, UNIDO

provide to national R&D policies, a recommendation which is repeated by this evaluation. A word of caution was made on the proliferation of TCs in many fields and it was recommended to look into alternative ways to intervene in support of technology upgrading, in particular by assisting existing TCs in preference to the establishment of new ones. This evaluation developed some methodological tools for institution building projects which were often used by UNIDO in the design and evaluation of TC related technical cooperation.

21. Another significant evaluation was prepared in May 1991 by Ludwig Rudell[9]. Despite its title, it covers exclusively UNDP funded assistance provided to the establishment of TCs, 10 in India and 5 in China, most of them industry related. The evaluation concluded that R&D institutions played an important role in those two countries to pursuit indigenous capabilities and their establishment was warranted. The main issue at that time referred to the different modalities for the establishment of the institutions in an efficient manner.

22. Furthermore it acknowledged that UNDP response to the countries needs was made on an ad-hoc basis and did not follow programmatic considerations. For instance, UNDP's efforts could have been focused on fewer sectors where central and state governments had more leverage so as to gain more synergy. Sustainability of the institutions was considered a weak point. For instance, the change from a closed to a more open economy in the two countries, led to the need to promote a two way flow of technology, not only inward but also outward. It was also recommended that UNDP shift its emphasis from institution building to linkage building, meaning increased attention to the utilization of R&D results and the related financing. Also these two countries should not continue to pursue an autarchic view of the so called dependence on foreign technology and not bias the "buy or make" decision process. In China the abrupt change of policy in the early 1990s to reduce or eliminate direct government funding for R&D institutions led to an uncertain future for many of the covered institutions. Some were forced to close down, others to move away from their original R&D mandate and enter into more commercial type of operations like using equipment initially intended for research, for commercial productions. Alternative modalities to institution building in order to acquire new technologies were recommended, such as technology contracts, foreign direct investment, licensing and joint ventures. In other words, in some cases it would have been more convenient to get the technology from abroad rather than develop it.

23. The report makes some recommendations to UNDP on how to approach institution building in these two countries which somehow are no longer applicable or applied since UNDP has not entered since into new institution building commitments in these two countries.

24. The subject of TCs was further studied by UNIDO in cooperation with ICS. A workshop on Managing Changes and Technology Innovations for Industrial Research Institutions in developing countries was sponsored by these two organizations in Trieste in December 1995 and had as the main background paper "The Guidelines[10] for the Revitalization of Industrial Technology Research Institutes". The author of these guidelines culminated in this publication considerable research he undertook in a number of case studies of TCs in Latin America. These guidelines reiterate the good practices established in other studies, also by the present evaluation, but remain not sufficiently known and applied.

25. WAITRO organizes regularly regional seminars to discuss trends and common problems of what they call Industrial and Technological R&D Institutions. Their experience has been compiled in a recent

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[9] Thematic Review of High Technology Assistance in India and China, International Science and Technology Institute, Washington, D.C. 1991

[10] The revitalization of Industrial Technology Research Institutes in developing countries, Alberto Araoz, UNIDO, ITPD.12 (SPEC) dated 30 December 1994

report[11]. The report is based on a study of best practices in 60 TCs, out of which 38 in developing countries. In accordance with the WAITRO Best Practice model, 10 processes (governance, financial management, services provided, business development, organizational management, project management, capability building, personnel management, networking and policy and programs) and 57 subprocesses were benchmarked. This model can be of use to other TCs to benchmark their own processes.

26. Among the other studies on this subject which the evaluator consulted we cite the following:

- Utilization and Commercialization of United Nations System funded R&D Results, UNCTAD/ITP/TEC/20 17 October 1991.

- Technology Transfer Manual for Research Institutes in developing countries, UNIDO, IPCT.187(SPEC.) 16 November 1993

27. There is no dearth of literature on the subject. They all recognize the importance of TCs in the development and transfer of technology but also that there are alternative possibilities to do so, such as licensing and local consultancy, which not always are exploited. Furthermore, the literature offers similar avenues for the changes needed by TCs much in line with what is said in this report. In the context of increased globalization, many of these institutions need to radically change their orientation and *modus operandi* in order to take into consideration alternatives to DTT and find their market niches.

2. RESULTS OF TECHNICAL COOPERATION

2.1 Overview of activities

28. This overview of UNIDO technical cooperation on this theme is based on the 84 in-depth evaluations mentioned above. In such evaluations the issues of relevance, impact and sustainability are normally covered. Visits to end users by the evaluators constitute usually the main instrument to verify the impact and usefulness of the center's activities. The list of such evaluations is included in Annex 1. However we could not undertake a rigorous cross analysis on these reports in terms of relevance, sustainability and impact at the level of end users because a number of difficulties was encountered, as follows:

- The reports span a period of around fifteen years. Results are not entirely comparable: for instance sustainability in 1986 was not an issue and in 1990 was different from what is today.

- There is no follow up to such in-depth evaluations. The follow up system established by UNDP and adopted by UNIDO as of 1987, to be checked respectively six months and one year after the evaluation, never really functioned. So it is difficult to pierce beyond the date of the evaluation.

- There are very few ex-post evaluations carried out. It is only at this level of evaluation that impact, sustainability and continuing relevance can be really determined.

- Some of the centers have folded down but the reasons behind these closures are far from complete and are obtained by hearsay. Some of the centers officially still exist in name but may have ceased or changed completely the nature of their operations. While it would be interesting to know exactly the causes for such closures, it is rather difficult to do so. Once the public funding diminishes or ceases they cannot sustain themselves. Why some centers have folded and others not? Experience shows that lack of market orientation and outdated capabilities (staff and equipment) lie at the basis of such closures.

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[11] WAITRO. Op.cit.

29. Therefore we found it preferable for this evaluation to use the qualitative information from the in-depth evaluation reports rather than use quantitative aggregated results.

2.2 Performance or success indicators

30. Despite repeated recommendations made in connection with project appraisal, most of the project documents do not include quantified performance indicators at the development objective, purpose and output levels, nor the means to verify them. At most, quantification of outputs is provided, such as: "so many people trained in X and Y fields".

31. As mentioned in the report dealing with NCPCs, a standard set of indicators at the three levels is being prepared to suit the needs of these institutions. This will clarify expectations from the technical cooperation efforts, facilitate evaluation and allow for aggregation to determine programme results. Despite the heteroxity of TCs, standard indicators can also be prepared for these centers to facilitate inclusion in project documents.

3. SELECTED ISSUES

3.1 Demand for services

32. Practically all in-depth evaluations of TCs, based on visits to end users, acknowledge that a demand exist for their services. However, in project documentation this demand is often implicit rather than explicit. As a matter of fact quantification and specification of services is rarely done at the project preparation or at the outset of the institution. As a consequence the real delivery of services to end users often differs from what is foreseen in project documents. In the presently more open economies, the difference in type between the planned and actual supply of services has increased. The easier or mandatory type of services such as testing and certification have a higher demand. One type of services which is also in high demand are jobbing operations needing expensive production machinery like jig borers and high precision wire cutters. While these machines are purchased for an intended "research and development" purpose, they are being used to give complementary machining facilities to enterprises. The entrepreneurs are willing to pay for such services but the payment rarely covers its full cost including the important machinery depreciation component. The problem with income generation is increased in servicing the very small enterprises who initially do not even allow visits by the center's personnel nor feel the need for the services. Here an intensive market promotion is needed. In some of the evaluations where the author participated, it should be acknowledged that the centers management are aware of this problem and because of their "social" among other missions, feel the need to reach the small enterprises. Several techniques are used like promotion campaigns, meetings, free services, and differential billing according to the size of the enterprises. Success is mixed. This is a problem which is not exclusive to developing countries. A similar situation is found in services aimed at small entrepreneurs in the advanced economies of the EU. At any rate the lesson here is that such services should be considered from their social angle and there is no way that they can be financially self sustained since they need considerable promotion and the entrepreneur is not willing to pay the full cost.

33. Research activities of TCs are seldom carried out at the request and with the participation, including financial, of end users and are usually supply driven.

3.2 Policy level

34. The amount of information collected by the TCs regarding the field they cover can be impressive. Issues affecting the particular subsector, problems that the entrepreneurs face on labor, availability of raw materials, competition, often disloyal, from imports are among those which we would believe would be useful to policy makers when taking decisions which affect the particular set of enterprises. However, it is felt that such advice is rarely requested. It is true that often the reputation of TCs is worse that their actual

worth and therefore that is not much appeal in going to them for advice.

3.3 Company level

35. The days are gone, we hope, when TCs operated in a vacuum away from end users. We recall two institutions, one in Central Africa (in the 1980s), the other in South America (in the late 1960s) that were completely unknown by enterprises even located in their vicinity, enterprises which they were supposed to serve. The push to become self or more sufficient in funding obliges them to go to the market and seek customers. End user companies are now invariably sitting in the boards of the institutions and have an increased say in their management and operations. Financing of the institutions is increasingly coming from affiliation fees and sales of services but full self financing is rarely achieved. In the area of enterprise use and participation in the management of TCs, a notable improvement over the past three decades can be observed.

3.4 Response of the TCs

36. The above issues point to constraints but also to opportunities for the TCs, the decrease or disappearance of public funding remaining the most significant issue to be tackled. Response of TCs to these issues is far from homogeneous, ranging from institutions which could not meet the challenge and were obliged to close down, to those who were privatized and are successful commercial operations while diversifying continuously the range of services provided in response to market needs. While there cannot be a standard set of recipes for their response, the following approaches have been tried by the TCs evaluated. Its applicability to other TCs has to be considered on a case by case basis.

37. Capacity building: Capacity building has to be considered in relation to the staff of the centers and to the staff of end users. Number of staff of the centers varies from ten to hundreds. A relatively high proportion of non-technical staff is still observed, caused essentially by the low level of salaries and the usual over staffing of public entities. Two recently evaluated TCs in Punjab, India have been careful in this respect and stand out successfully of the usual practice in this country. First of all staff has been admitted as business in the particular area grows and not according to the planned manning tables. Technical staff admission is given priority over non technical staff. Despite their public character, the centers have their own salary scales, slightly above the market (private sector) and thus are able to attract experienced staff which is respected by end users. The attraction is increased by a good work atmosphere, varied and challenging tasks, away from the routine and pressure of normal production tasks. Some centers use recent graduates, thus providing an opportunity for them to practice their recently acquired knowledge although this is not necessarily an asset from end users viewpoint because these do not have the required experience.

38. Training of the TC staff is mostly provided under the technical cooperation phase. To achieve dynamic sustainability this training should continue beyond that phase. Few institutions do that, so their technical competence stabilizes or better stagnates at the time of the technical cooperation completion. Sustainability also implies that the technical competence of the centers' staff continues to be furthered beyond the project's end.

39. Training of end users is also often confined to the technical cooperation phase by mean of courses undertaken by visiting international experts or recently trained center's staff. Training in developing countries rarely recovers its full cost since it is regarded as a duty to be provided by the state. As a consequence we observed that some centers are often reluctant to provide courses or training to their users because of its relatively low income generation. Training services, particularly those who belong to the category of social services, merit financial support from the State.

40. Research: In most designations of TCs, particularly the older ones, the magic letter R for Research appears. In addition to the supposed prestige that the word implies, there is a whole philosophy regarding self-sufficiency in terms of knowledge (self-reliance) which predominated in the development theory and practice until recently. The idea was to become independent of foreign technology. In those cases where imports were needed these would be only temporary to bring the knowledge up to the required level and the doors would be again shut. Therefore TCs were supposed to be heavily involved in Research. However research results were of not much use. Research was mostly supply based and found few takers. Four cases of research can be quoted which led to nothing. In one case in South America a kind of a vehicle was to be conceived and designed to move in the desert. Research was never completed and was doomed to fail from the beginning because of the technical and economic impossibility to meet specifications and the absence of any taker for the technology. Two cases in Asia regard a motorized and a pedal operated rickshaw. The final products were too heavy and not practical enough and also found no takers. Finally in Africa a research institute developed a simple press which was produced and sold in a few units but then it turned out that these presses were not absorbed by the market but purchased under the budget of other technical cooperation projects.

41. Research results of TCs in developing countries have consequently been little used in production. Therefore a trend away from Research in TCs operations can presently be observed. One example relates an important Institution in India which in the past regarded Research as the only way to have technology in the particular subsector it was serving. This was to be complemented by imports via technical cooperation in terms of equipment, training abroad and foreign expertise. After completion of the technical cooperation, the research results of the center would be the main source of technology in that particular subject. What happened is that the Indian economy was liberalized, imports of technology were facilitated and multinationals, with their important R&D facilities in their base countries, established green field projects or purchased controlling interests in Indian companies. The obtention of proprietary technologies from abroad has been greatly facilitated. Multinationals are less likely to require Research services from the center than 'easier"services such as testing and certification. While, for purists, this implies an increased dependency on imported technology, prospects for the particular subsector are much brighter since it will become more competitive to imports and in export markets, which was not the case in the past. This trend has been observed in many TCs which thus are moving from research to development and testing activities. It is felt that research by TCs should be undertaken only upon close consultation with end users (prospective purchasers) and with the prospective producer(s) which should take also a financial stake in the research project. This becomes particularly necessary for R&D projects involving large financial outlays, such as those related to the development and production of prototypes.

42. Transfer of technology: The transfer of technology is normally viewed as a process of stages: Assessment and selection, obtention which may involve acquisition or contracting, adaptation, implementation and eventually replication. A TC may be involved in any of these stages including the development of the technology. It should be recognized that the actual volume of transfer facilitated by TCs is not high. In today's open economies, most of transfers of technology are the result of equipment purchases, licensing, direct investment or joint ventures and procurement of expertise but even in such cases the TC can have a facilitating role. Transfer of technology from abroad is presently viewed by developing countries as one of the key mechanisms to support their industrial development. This does not facilitate the role of TCs in research. As mentioned at the start of this report, TCs are established to create or improve national capabilities, that is technology. This is done by supply of equipment, provision of training and expertise usually from abroad. Once this capacity is achieved there are usually no plans on how to proceed particularly on the choices to be made between develop or procure (from abroad or locally). This lack of policy at the TC level is compounded by a lack of synergy between themselves, the technical universities and to a lesser extent with the productive sector. Despite this lack of orientation, simply because of market pressures, TCs are shifting from basic research to applied research and further to easier services like testing and certification but educated choices on either developing a technology or procuring it outside the center are rarely done. At the same time, the end user of a TC really does not care from where the technology he needs originates, either from abroad, local or a mixture of both. TCs are well poised to provide the

technology package that the enterprise needs , a package which will be composed of imported and local components which the TC should be able to put together judiciously. It is also difficult to follow up at the enterprise level the technology changes effectively introduced as a result of the services provided by the TC. It is believed that in the case of the more dynamic centers, as a result of their work, technology changes are introduced at the enterprise level but it is rather difficult to quantify this since enterprises are reluctant to provide this kind of details particularly when the center is a public entity. Furthermore, not all services provided by the center imply a transfer of technology. Testing and certification results are not always explained to enterprises, to allow them to introduce the necessary technology changes. Jobbing operations undertaken by the centers do not transfer any technology, which does not invalidate the fact that theses services are also useful. Summing up, it is estimated that TCs can play an important role in the transfer of technology to enterprises but it is difficult to quantify benefits. The only actual test on the usefulness of the center to its end user is the ability of the center to get paid for its services which however are not exclusive to transfers of technology.

43. Information services: The role of information in the transfer of technology will be the subject of the last component of this evaluation. Therefore not much will be said here on this subject also because there is little experience yet on applying modern information systems in the TCs supported by UNIDO. In the past "information services" normally meant that the TC had a library where relevant technical books, manuals and periodicals were available. At most, a periodic newsletter was issued with abstracts or information on the TC operations. Today this system is no longer sufficient. First of all a decision has to be taken on what type of information is needed for the center's operations and its end users. The former will be particularly useful in the taking of decisions of the make/buy type. The second should be ascertained by determining the needs of such end users, possibly by a survey.

44. One's own home page and access to specialized databases are minimum requirements for a modern information department of a TC. However one should not expect too much in terms of technology transfer from information. There is more experience in NCPCs on this subject and therefore we are quoting here the paras 77 and 78 of the NCPC evaluation because we believe they also apply to TCs.

> *"Low demand for information on technologies by external clients is to a great extent understandable. Large companies have their own mechanisms, professionals and established channels to keep abreast of the state-of-the-art technologies. SMEs, on the other hand, are in most cases not aware of what information they may need and, therefore, they do not ask for it. The second dimension of the problem is that information as available in the databases on Internet and elsewhere is often of little practical use for SMEs if not accompanied by advice/expertise. Technical information is a powerful tool in the hands of the expert who knows how to interpret it and apply it in a certain context whereas information on technology accessed through a library, Internet, or a patent office in the hands of laymen is of limited value. If SMEs do need some information on technology, they usually contact somebody they know in the business and whom they trust, or a dealer or manufacturer/supplier.*
>
> *It seems that the frequently emphasized importance of information for technology change including transfer of technology needs some qualification. Simple dissemination of information on technology among SMEs would not help much. What is more effective is dissemination of information in the context of advisory services. In view of this the NCPCs need not set too ambitious goals as regards dissemination of stand-alone information on technology. Rather they should aim at developing a capability to provide expert advice (supported by updated technical information). Such expertise, however, requires continuous exposure to the specific technology area, visiting trade fairs, following up professional literature etc. As it is hardly possible to staff the NCPC with such experts covering all sectors is it necessary either to focus on a specific sector of industry or - what seems to be more practical - to establish a network with other sectoral institutions, consulting companies or free lance consultants to whom such services can be subcontracted or referred to. This is yet another reason why these groups should be targeted*

in training and awareness raising activities."

45. Competitors: There are two types of competitors related to TCs. One type is constituted by the international agencies, bilateral or multilateral which are also in the business of developing cooperation in support of TCs and the other are the competitors which TCs find in their own territory and turf. Regarding the first, the market is rather limited. The concept of TCs does not have a good reputation, no new centers are being established and UNDP, the principal multilateral source of funding in support of TCs, no longer appears to be in this business. However, some bilaterals, Germany, for instance continue to support TCs. Despite the generally positive attitude of this evaluation towards TCs we do not believe that new TCs are in much demand. However, the revitalization of many if not most of the TCs existing in developing countries is crying for help. We believe this could constitute an important market segment for UNIDO.

46. The competition that TCs face in their territory has become significant. First they have become more market oriented. Secondly there are overlaps between similar TCs. For instance in the Indian Ludhiana area, we found no less than five centers serving different areas of the metalworking sector and offering overlapping services. The lack of cooperation between them leads to an uncoordinated competition which translates into excess capacities and drives down prices for services. Another source of competition are consultants, national or foreign. Again in the area of Ludhiana, at least one foreign consultant was very active and apparently successful in providing assistance to plants mostly on process engineering on a commercial basis. This is a business which at least one of the TCs in the region could have taken.

3.5 Sustainability

47. Sustainability is defined by UNDP[12] as the "durability of positive programme or project results after the termination of the technical cooperation channeled through that programme or project; *static sustainability* - the continuous flow of the same benefits, set in motion by the completed programme or project, to the same target groups; *dynamic sustainability* - the use or adaptation of programme or project results to a different context or changing environment by the original target groups and/or other groups."

48. Due to the fast changing nature of industrial technology, it obvious that TCs should seek a position of dynamic sustainability. That is, the knowledge accumulated at the end of the project in terms of personnel, facilities and equipment has to continue to develop in line with the related technology advancements. An important ingredient of sustainability is the continuing financial soundness of the institution. In-depth evaluations, being mostly conducted during the project life, cannot verify actual sustainability but only the likelihood of its occurring. However, some ex-post evaluations or visits to completed projects indicate that a few TCs do reach a stage of dynamic sustainability. CESMEC in Chile and ARAI in India are amongst such institutions but even the latter is presently facing important challenges.

4. CONCLUSIONS AND LESSONS LEARNED

From this evaluation the following conclusions and lessons are derived**:**

Relevance of TCs as an instrument of development and transfer of industrial technology

49. Summing up the results of this evaluation, TCs, if established in line with the conclusions/findings below, in particular with a strong private sector participation, including financial, can play an important role in the transfer of industrial technology to enterprises, less so in the development of technology. The effectiveness of a TC depend also on the sound economic framework of the particular country which should

[12] Results-oriented Monitoring and Evaluation, UNDP, NY 1997.

enable the enterprise to choose the most adequate sources and mechanisms to obtain the technology it needs for its modernization and growth. A TC should operate in a market with explicit needs in terms of technology. In turn, the TC should have a strong market orientation.

Establishment of TCs - technical cooperation in support of TCs

50. Analysis of the concept by UNIDO. If UNIDO is to keep a leading role in support of TCs it is of importance to maintain a minimum of analytical work to refine the concepts of intervention in support of such centers. In such a way, value added to technical cooperation projects will be enhanced. At the same time, under the principles of the learning organization, field experience has to be continuously kept under review to determine best practices and avoid the repetition of errors.

51. Demand assessment. Often, not enough consideration to the determination of the effective demand for services of the center is paid at the design stage. Furthermore, the demand assessment is not adequate if it is limited to a review of the potential needs of target beneficiaries without consideration of their capacity to pay in whole or part for the services. In fact higher needs by end users does not necessarily translates into a higher demand for services. In situations of depression, enterprises in developing countries often are reluctant to request external services, particularly if they have to be paid, despite this being the situation when they need them most. Markets have to be kept under continuous review by TCs also to enable them carry out an adequate promotion and marketing of services.

52. In other words, the issue of sustainability should be already considered at the design phase. This has become increasingly important in view of the recent emphasis on privatization and the reduction of government subsidies to TCs.

53. Location as a factor of demand. Physical proximity of the target beneficiaries (industrial enterprises) to such an institution can be a key factor of effective demand, as the experience of the Center for Electronics Design and Technology in India suggests. The location of the Center was chosen with the objective to support regional development (with the Center to act as a catalyst towards industrial development of the region). However, the absence in its vicinity of many industrial firms using process control instrumentation turned out to be an impeding factor for the Center. Similarly, regional centers, i.e. centers expected to serve clients in several countries, usually tend to mostly reach out clients in the country where the center is located, as the experience of ICAITI in Central America seems to corroborate, or become agencies for “regional professional tourism”.

54. Elements of design. Each specific function/service of the TC should be defined in terms of its estimated use (number of jobs, revenue, etc.) and in terms of the inputs required to develop such a service: professional staff to be trained, methodologies/manuals to be prepared, management information services to be developed, equipment and software to be procured, physical facilities to be made available/ constructed. Estimates of use (revenue) and input requirements for each function/service could go a long way towards avoiding the acquisition of expensive equipment for which there is hardly any use, as was the case in a Flexible Manufacturing System laboratory of one center. In fact, projects tend to overestimate the importance of equipment and underestimate other components of institution building. While the role of training in establishing an institution is usually well recognized, in practice not enough allocation of resources is made for this purpose and the elaboration and establishment of working methods, standards and other methodological tools is often overlooked.

55. Duration of technical cooperation intervention. Institution building projects in support of the establishment of TCs need a longer involvement of donors than the typical three-four year UN project. Overruns of the project duration established in project documents is the rule. In the case of ARAI in India, the total involvement of UNDP/UNIDO assistance amounted to seventeen years which we do not find excessive in this particular case. While this project dealt with relatively sophisticated and fast developing

technologies, the present level of technology and sustainability of this institution can be partly attributed to this long involvement.

Operations of TCs

56. Marketing. Technical cooperation projects often focus on the technology supply side and do not aim at influencing the demand side (looking for or developing a market). This may contribute to the fact that even good development or research capabilities developed in the institution does not always find its way into private enterprises. To promote use of its services a determined marketing effort by the centers is required. Experience suggests that personal contacts are more effective in establishing confidence, and generating demand than the mailing of promotional materials. Furthermore the marketing function should be done or coordinated by marketing specialists.

57. Targeting SMEs. Creating a market for technology-related services among SMEs is particularly difficult. Their problems are compounded by the fact that SMEs generally cannot afford an internal division of labor to support specialized personnel capable of absorbing/implementing technical advice provided to the company by external consultants. This fact may seriously constrain the client population of a technology center. Thus SMEs are often not aware of the benefits they can derive from advisory services, so that awareness raising visits to such companies may be a prerequisite to the establishment of a client-center relationship. For the awareness raising campaigns, senior consultants capable of providing practical and tailor-made advice and information on the spot are more likely to raise interest of the company owners/managers than junior staff. Furthermore and as a consequence of the above, services to SMEs are less likely to derive income, thus needing a comparatively higher level of subsidy.

58. Feedback to policy level. Often the technology centers operate in isolation from national policy bodies even though policy decisions influence the market for technology services and the diffusion of technology in general. Feedback to policy formulation can be channeled through personal contacts, industrial associations utilizing the center's services, the presence of representatives of policy bodies (ministries of industry, science, finance, planning ...) in the governing body of the center, among other means. A prerequisite for this function is obviously that the center has the capability to formulate and substantiate policy proposals.

59. Stability of staff. Qualified staff is the single most important asset of a well established institution. To be able to recruit and retain qualified staff, the center must be able to offer not only job satisfaction (resulting from the relevance of services and working environment) and career development but also motivating salaries and other benefits. In most cases, the latter is hardly possible in the public sector with its fixed and generally low salary scales. If established in the public sector, autonomy in personnel management, income generation and budgeting, is required. Even in relatively advanced countries like Argentina, public or quasi-public technology institutes cannot raise revenues and have to result to subterfuges such as the creation of parallel institutions or foundations. Equally important for the stability of staff and their morale is the appointment of committed and qualified directors in the top management positions which is not often the case.

Sustainability

60. Financial sustainability. Only in a few cases, such as CESMEC in Chile, are technology centers able to fully operate on a private commercial basis. Recovering 50-70% of operating costs and depreciation by income from sales of services is often considered a success. A certain level of budgetary support is justified by the fact that the activities of the center often contribute to broader national social objectives such as human resource development, employment, etc. If centers are only motivated by commercial interests, they tend to target large companies and to restrict their services to those which bring about an immediate

commercial result.

61. Different sustainability of different services**.** Ex-post evaluations suggest that testing and certification constitute the easiest service to sustain after public project support is discontinued (provided working practices and standards are well established, demand is stabilized and particularly if certification is mandatory). Training and the monitoring of technology development (complemented by information dissemination) can be sustained in more advanced environments, even though a deterioration of quality may be noticed after technical cooperation ceases. In high demand are services requiring the use of expensive pieces of equipment (such as jig boring machines and wire cutting machines) which companies are unable to purchase on their own. However such services, despite their high demand, are difficult to be self financed since the fee leveled usually does not cover the high depreciation of such equipment. Most difficult to sustain and further develop seem to be the research and technology advisory services functions. These functions require continuous upgrading of equipment and staff qualifications and rarely fully recover costs.

62. Adaptation to new policies. Some of the centers were established under regimes with import substitution and protective regimes. Subsequently under more market oriented policies the countries opened up but the centers could not adapt to the new conditions. Paradoxically, in some cases where the institutions had access to foreign assistance this only helped to maintain the status quo and delayed the adoption of radically new policies and procedures by the centers.

63. Ownership. There is no magic formula to the success of a TC. Each case has to be analyzed to determine the market to be covered and the best mix of private ownership and financing and degree of public subsidy. However, ownership of a center by an association of industry (target beneficiaries) seems to be a good arrangement. As observed in project evaluations, this is rarely the case. More frequently the centers remain in the public domain where they were originally established thanks to the State's initiative. In that case, however, a high degree of autonomy is needed and active participation of industry in the governing bodies is required. Experience of one case in Sri Lanka shows that the taking over a sectoral R&D center by a large private company did not exclude other companies from the use of their services. In order to increase revenue the center was motivated to offer its services to a broad range of companies. However, the experience seems to indicate that this applies primarily to the easier services. The product development function serves primarily the "parent company". There are however other aspects which may be considered disadvantages if the institution is fully private. The institution will normally be occupied with revenue producing activities leaving aside others which are not so profitable but may make considerable contributions to economic development or have a public interest. In such cases the governments should make funds available to the end user or to the center depending on the case, to finance such activities fully or partially.

64. A TC should not be seen as a technical cooperation project but as a nationally owned project where technical cooperation plays only a complementary role. A ownership and commitment of the institute's management to its goals is needed.

Integration in UNIDO's new Service Modules[13]

65. UNIDO technical cooperation projects in support of TCs normally constituted stand alone interventions. UNIDO present policy is to intervene in a more integrated manner through a set of technical cooperation service modules. Revitalization of TCs easily fits under the main service "Capacity building for institutional development" of the module "Investment and Technology Promotion" where it is mentioned *inter alia* "assistance is ..offered in the .....strengthening of technology centers and in the creation of linkages to Industry..." even if the relation of TCs to investment promotion is not evident. Revitalization of TCs related to metrology, quality control and certification can fall under the module "Metrology, Standardization, Certification and Accreditation" even if institution building actions are there not explicitly

[13]The Service Modules, UNIDO, undated.

mentioned. The integration of interventions in favor of revitalizing TCs with other type of interventions related for instance to policy and private sector development is indeed beneficial since it increases the synergy between these related fields.

Annex 1

In-Depth Evaluation Reports of Projects Dealing with the Establishment/ Development of Technology Centers

Status as of 30 June 1999

A f r i c a

Ser.no	Region/Cty	Project no.	Project title	Date of report	Language
1	ANGOLA	DP/ANG/82/020	Maintenance & repair centre EMIN	October 1986	E
2	ETHIOPIA	DP/ETH/79/003	National quality control and testing centre	May 1985	E
3	ETHIOPIA	DP/ETH/84/006	National metrology centre	March 1989	E
4	ETHIOPIA	DP/ETH/83/024	Engineering design & tool centre	May 1992	E
5	ETHIOPIA	DP/ETH/88/011	Establishment of an electrical & electronics institute	September 1993	E
6	GUINEA	DP/GUI/82/009	Assistance au renforcement du centre d'entretien et de reparation des équipements industriels - Conakry	September 1989	F
7	KENYA	US/KEN/84/163	Leather development centre	August 1988	E
8	NIGERIA	DP/NIR/73/014 DP/NIR/75/012	Industrial dev. centre (IDC), Oshogbo, Nigeria Ind. Management Dev. Service, Ife, Nigeria	December 1983	E
9	NIGERIA	DP/NIR/73/014	Preparatory assist. for the establishment of the industrial development centre, Oshogbo	April 1984	E
10	NIGERIA	DP/NIR/88/009	Assistance to the standards organisation of Nigeria	December 1994	E
11	CONGO	DP/PRC/83/007	Assistance à la mise en place du CEPI	May 1988	F
12	SÉNÉGAL	DP/SEN/82/028	Assistance à la saed pour l'établissement d'un systeme de maintenance de pompes d'irrigation (II)	June 1985	F
13	TANZANIA	UC/URT/84/062	Assistance to the Tanzania institute of leather technology, Mwanza	January 1985	E
14	TANZANIA	DP/URT/81/037	Tanzania industrial research & development organization Phase II	September 1986	E
15	TANZANIA	US/URT/94/015	Assistance to enhance technical & entrepreneurial skills of business women in textile & related products	October 1997	E
16	ZIMBABWE	US/ZIM/84/232	Strengthening of the standards association of Central Africa	August 1989	E
17	REGIONAL AFRICA	DP/RAF/81/015	Institut sous-regional, multisectoriel, de technologie appliquée de planification et d'evaluation de projets	May 1985	F
18	REGIONAL AFRICA	US/RAF/88/100 US/RAF/88/102	Regional hides & skins, leather & leather products improvement scheme	December 1991	E
19	REGIONAL AFRICA	US/RAF/92/200	Regional Africa Leather and Footwear Industry Programme (Programme)	February 1997	E

Ser.no	Region/Cty	Project no.	Project title	Date of report	Language
			A r a b		
20	ALGERIA	DP/ALG/90/018	Développement des capacités nationales de maîtrise de la qualité des produits industriels	March 99	F
21	IRAQ	DP/IRQ/77/003	Specialized institute for engineering industries	April 87	E
22	LIBYAN ARAB JAMAHIRIYA	DP/LIB/77/001	Industrial research centre, II	May 83	E
23	LIBYAN ARAB JAMAHIRIYA	DP/LIB/82/003	Assistance to the industrial research centre	June 86	E
24	SAUDI ARABIA	DP/SAU/88/003	Establishment of the national metrology centre	November 92	E
25	SYRIA	DP/SYR/77/004 DP/SYR/86/010	Strengthening of the industrial, testing, research & Development Centre Industrial Quality Assurance	September 92	E
26	SYRIA	DP/SYR/86/011	Strengthening of the capability of the Syrian scientific studies & research center in the field of optical technology	May 93	E
27	TUNISIA	DP/TUN/84/007 DP/TUN/86/003	Assistance au centre technique des industries mecaniques et electriques	June 89	F
28	YEMEN	DP/YEM/87/003	Dev of Yemeni institute for standardization, quality assurance & metrology	January 94	E
29	REGIONAL ARAB	DP/RAB/83/020	Establishment of the Arab regional packaging centre	86	E
			A s i a		
30	BANGLADESH	DP/BGD/75/013	Jute products research	June 84	E
31	BANGLADESH	DP/BGD/85/162	Strengthening of the college of textile technology project	February 95	E
32	CHINA	DG/CPR/82/004	Synthetic fibre research centre	January 90	E
33	CHINA	CPR/85/087	Qualification & surveillance laboratory for consumer electronic products	May 93	E
34	CHINA	US/CPR/85/130	Assistance to the leather technology centre, Shanghai	July 93	E
35	INDIA	DP/IND/79/027	Sewing machine development centre	85	E
36	INDIA	DP/IND/79/046	Instruments design development and facilities centre Ambala	February 86	E
37	INDIA	DP/IND/82/007	Improvement of testing & evaluation facilities	June 87	E
38	INDIA	DP/IND/83/011	Fluid control research institute	February 89	E
39	INDIA	IND/83/017	Fatigue laboratory for the automotive industry	February 90	E

Ser.no	Region/Cty	Project no.	Project title	Date of report	Language
40	INDIA	DP/IND/86/037	Jute research & development	January 91	E
41	INDIA	IND/87/012	Sewing machine development centre Ludhiana, I+II	October 93	E
42	INDIA	IND/89/114	Assistance to non-wood based pulp & paper industry	October 93	E
43	INDIA	IND/92/400	Leather sector programme	November 94	E
44	INDIA	IND/89/130	Centre for electronics packaging technology & ergonomic design (CEPTED)	January 95	E
45	INDIA	DP/IND/88/015	Jawaharlal Nehru Aluminium Research Development and Design Centre	March 96	E
46	INDIA	DP/IND/90/037	Strengthening the handmade paper industry in India	April 97	E
47	INDIA	DP/IND/90/014	Setting up a centre for electronics design & technology in process control & instrumentation	February 98	E
48	INDIA	DP/IND/90/018	Assistance to the Centre for VLSI Design & Prototyping (CVDP)	May 98	E
49	INDIA	DP/IND/91/026	Metals & plastics industries service & training centre, Goa, India	November 98	E
50	INDIA	DG/IND/93/035	Institute for machine tool technology	January 99	E
51	INDIA	DG/IND/93/004	Institute for auto parts technology	January 99	E
52	INDIA	DG/IND/79/028 DP/IND/88/070	Bicycle research and development center, Ludhiana	January 99	E
53	INDIA	DP/IND/74/019	The Automotive Research Association of India (ARAI)	March 99	E
54	MYANMAR	DP/MYA/86/002	Development centre for rubber technology	May 92	E
55	NEPAL	DP/NEP/84/031	Assistance to Nepal bureau of standards & metrology	May 93	E
56	PAKISTAN	DP/PAK/79/022	Leather products development centre (LPDC)	January 86	E
57	PAKISTAN	DP/PAK/83/010	Fertilizer research & development institute at Faisalabad	January 92	E
58	PAKISTAN	DP/PAK/88/040	Modernization of central testing laboratories in Karachi & Lahore	November 92	E
59	PAKISTAN	US/PAK/90/294	The Ecotoxicology Research Centre in Pakistan	October 96	E
60	SRI LANKA	US/SRL/78/207	Establishment of a ceramic research & development laboratory	February 86	E
61	SRI LANKA	DP/SRL/79/054	Establishment of textile training & service centre	May 86	E
62	SRI LANKA	DP/SRL 87/012	A management services division at the textile training & services centre	February 90	E
63	SRI LANKA	DP/SRL/86/007	Development of standardization and quality control (SLSI)	February 91	E
64	SRI LANKA	DP/SRL/86/014	Establishment of a computer aided design & computer aided manufacturing centre	September 93	E
65	VIET NAM	DP/VIE/83/001	Strengthening of the national metrology centre	December 86	E

Ser.no	Region/Cty	Project no.	Project title	Date of report	Language
66	VIET NAM	DP/VIE/80/039	Electronic & optical maintenance & repair centre	June 88	E
67	VIET NAM	DP/VIE/86/014 DP/VIE/86/015	Research & development on methods of spinning short staple cotton Testing of textile raw materials, yarns & fabrics & product development	May 91	E
68	VIET NAM	DP/VIE/86/037	Assistance to the national network of standardization, metrology, quality testing & calibration services III	July 91	E
69	VIET NAM	DP/VIE/86/013	Assistance to the food industries research institute	November 91	E
70	VIET NAM	DP/VIE/85/006	Technical assistance for the establishment & operation of a laboratory for bauxite processing technology	January 92	E
71	VIET NAM	DP/VIE/87/016	Strengthening of the design institute of chemical industry	November 92	E
72	VIET NAM	DP/VIE/86/046	Packaging technology development centre	February 93	E
73	VIET NAM	DP/VIE/85/007	Improvement of the quality of castings & heat-treated products through the research institute of technology for machinery (RITM)	August 93	E
			E u r o p e		
74	TURKEY	DP/TUR/81/013	Assistance to packaging centre	October 86	E
			Latin America		
75	ARGENTINA	DP/ARG/81/010	Apoyo integral al desarrollo tecnológico de la siderurgía Argentina	June 88	S/E
76	BOLIVIA	DP/BOL/83/012 US/BOL/84/115	Establecimiento de un centro de capacitacion para las industrias de procesamiento de productos	April 89	S
77	BOLIVIA	DP/BOL/83/012	Unidad de control de calidad de alimentos de Bolivia	February 95	S
78	BRAZIL	DP/BRA/82/020	Metrology, standardization & industrial quality phase I and II	February 87	E
79	BRAZIL	SF/BRA/92/001	Application of modern technologies & management systems to improve SENAI/CETIQT & the Brazilian textile and apparel industry	Dec 95	E
80	GUYANA	GUY/86/011	Strengthening Guyana manufacturing & industrial development agency	November 91	E
81	MEXICO	DP/MEX/87/005	Apoyo al instituto mexicano de investigaciones en manufacturas metalmecanicas	89	S
82	MEXICO	MEX/87/022	Apoyo a la vinculación entre las actividades de investigación y desarrollo y las necesidades tecnológicas del sector productivo en México	December 89	S
83	TRINIDAD & TOBAGO	DP/TRI/85/007	Tool manufacturing & product development for metalworking & plastics industries	August 91	E
			G l o b a l		

Ser.no	Region/Cty	Project no.	Project title	Date of report	Language
84	GLOBAL	US/GLO/88/104 US/GLO/89/104	International centre for science & high technology	November 91	E

Annex 2

List of UNIDO sponsored International Technology Centers

- International Center for Genetic Engineering and Biotechnology
  Established by UNIDO, now independent, with installations in Trieste, Italy and New Delhi, India. Seems to be one of the few centers of this list with laboratories, the others being virtual centers, working essentially through networking.

- International Center for Science and High Technology
  Headquartered in Trieste, Italy it is "a UNIDO autonomous scientific institution concentrating on a spectrum of new technologies, namely:

  - Pure and applied Chemistry
  - Earth environment and marine sciences and technologies
  - High technology and new materials
  - Institutional management, interdisciplinary and networking activities."

- International Center for the Application of Solar Energy
  Headquartered in Perth, Australia, it is "working in the area of commercialization of new energy technologies, particularly Photovoltaics".

- International Center for Small Hydro Power
  With headquarters in Hanggzhou, China, it runs a promotional and training programme in the field of small hydro power generation.

- International Center for Hydrogen Energy Technology
  Presently under discussions with the government of Turkey where eventually it will be established.

- International Center for Materials Evaluation Technology
  Running pilot activities in the Korea Research Institute of Standards and Science," its mission is to develop international guidelines, codes of practice, standards on testing and characterization for new materials...".

- International Materials Assessment and Application Center
  Under pilot operations, the center, located in Rio de Janeiro, Brazil, in an institution of the SENAI system. It is expected to assist "with monitoring, assessing and forecasting the trends in the area of materials science and engineering" and will provide them with "..information on potential applications of their natural and raw materials resources....".

- Mediterranean Center for Marine Industrial Technologies
  The feasibility study is under way for this center which is supposed to be established in Piraeus, Greece, to "promote regional cooperation in the development and commercialization of marine technology".

- International Center for Advancement in Manufacturing Technology
  The feasibility study is under preparation for establishment in Bangalore, India.