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IT Diffusion Policies for SMEs

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INFORMATION TECHNOLOGY (IT) DIFFUSION POLICIES FOR SMALL AND MEDIUM-SIZED ENTERPRISES (SMES)

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris 1995

FOREWORD

This document contains the synthesis report of the *ad hoc* Meeting of Experts on Information Technology (IT) Diffusion Policies for Small and Medium-sized Enterprises (SMEs) held at the OECD on 24-25 June 1993, together with seven national contributions to the meeting. The synthesis report was prepared by Mr. Wolfgang Polt and Mr. Fritz Ohler, Austrian Research Centre, Seibersdorf (Austria) and the Secretariat. It was presented at the eleventh meeting of the ICCP Committee's Group of Experts on Economic Implications of Information Technologies, held at the OECD on 18-19 October 1993.

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*Country Reports**

These country reports were submitted by national delegations to the meeting on 24-25 June 1993. The Canadian contribution was prepared by Mr. Martin Mudd. The two reports on the Netherlands were prepared by Dr. W.E. Tostmann and Dr. W.J.P. Vogelsang, respectively. The report on Norway was prepared by Mr. Erik Skaug. The Swedish contribution was prepared by Mr. Björn Näsvall, and the report on the United Kingdom by Mr. Trevor Fraser.

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Part I

Information Technology (IT) Diffusion Policies for Small and Medium-sized Enterprises (SMEs)

EXECUTIVE SUMMARY

The main findings of the project on "IT Diffusion Policies for SMEs" can be summarised as follows.

Among Member countries there are widely differing definitions and concepts of SMEs, both statistical and functional. These differences reflect the important differences between large enterprises (LEs) and SMEs, and even among SMEs, in the extent to which they adopt IT and the problems associated with the implementation of these new technologies in the manufacturing process.

Irrespective of definition, the shares of SMEs in employment and output are increasing. This seeming reversal of a secular trend towards concentration into ever-larger business units, together with the proliferation of IT applications in manufacturing in the recent decade, has given rise to speculation about the advent of a new manufacturing paradigm ("flexible specialisation"), especially favourable for SMEs.

Such speculation notwithstanding, it appears that SMEs are currently lagging behind in their adoption of IT, and they may lose their comparative advantage of flexibility in the course of introducing these new technologies if their introduction is not part of a well-defined business strategy.

Unfortunately, SMEs face resource problems (managerial, organisational, financial, access to outside sources of knowledge, etc.) that hamper the formulation of a well-defined IT strategy. It is here that state support can help SMEs circumvent these barriers and exploit their flexibility potential.

In tackling specific problems related to IT diffusion among SMEs, governments have responded in various ways and with various rationales. A comparison of ten OECD Member countries and two non-member countries provides information on how to design and implement IT diffusion policies among SMEs.

All the countries studied are confronted with multiple problems and barriers regarding IT diffusion among SMEs. They typically react not with a single measure but with a set of instruments ranging from reconstruction of the institutional infrastructure through implementation of telecommunication network services to the provision of consultancy services to overcome specific gaps in managerial and technical skills.

Very few countries have developed policies which explicitly target IT, diffusion and SMEs at the same time. Most countries, on the contrary, use "embedded" policies, which are restricted to one or two of these areas, but do not cover all three. Regarding the question of whether countries rely more on hands-off policies (with a focus on infrastructure) or more on hands-on rationales (with direct intervention at the enterprise level), no sharp distinction could be found. Almost all countries use both types of measures. However, some prefer more direct intervention, typically with "soft" measures, while others have a stronger focus on hands-off, "hard", measures, notably telecommunication network services. In general, a shift away from "hard" towards "soft" intervention measures was observed.

1. Introduction

This report deals with the role and specific problems of small and medium-sized enterprises (SMEs) in implementing information technologies (IT), and the possibilities for public policy to support SMEs in their efforts to modernise and adapt to technical change.

The focus is on the application of IT in small and medium-sized manufacturing firms. IT in manufacturing covers a vast range of technologies from Management Information Systems (MIS) that try to utilise the growing flows of information as a useful resource for management, to Advanced Manufacturing Technologies (AMT) that are used to cope with the growing information content of shop-floor processes. While the emphasis of the report is placed on AMT, other IT applications will also be touched upon, especially the possibilities of improving corporate management by the application of IT.

AMT covers a broad range of technologies. It is defined as "computer-controlled or microelectronics-based equipment used to design, manufacture or handle a product. This includes design and development, materials and components handling, monitoring and/or control of fabrication and process equipment, quality control, packaging and storage".[1] Different types of AMT include for example Computer Aided Design (CAD), Computer Aided Engineering (CAE), Computer Aided Planning (CAP), MRP (Material Requirement Planning), Numerically Controlled/Computerised Numerically Controlled Machine Tools (NC/CNC-MTs), Industrial Robots (IR), Flexible Manufacturing Cells (FMC), Flexible Manufacturing Systems (FMS), Automated Guided Vehicles (AGVs), Automated Storage and Retrieval Systems (AS/RS), which can be connected internally [e.g. *via* Local Area Networks (LANs)] to form systems of Computer Integrated Manufacturing (CIM), and externally *via* Electronic Data Interchange (EDI)].

There are two reasons for the special focus on manufacturing applications of IT:

i) The diffusion and implementation of AMT is crucial to the development of productivity, and hence competitiveness, with many services more or less directly linked to the performance of the manufacturing sector (or, as Cohen and Zysman put it: "manufacturing matters").

ii) The diffusion of AMT is in general better documented than IT applications in services. The growing number of diffusion surveys of these technologies[2] thus provides a better empirical basis from which policy conclusions can be drawn.

This work draws on studies carried out in the OECD over the past few years on the subjects of diffusion policy in general[3] and on several aspects affecting the economic performance of SMEs.[4] It attempts to blend these analyses and focus on the question of IT diffusion in SMEs. Far from being solely a special sub-topic of technology policy, this question lies at the heart of current technological and structural changes.

2. The difficulties of defining SMEs

2.1 Different statistical concepts of SMEs

The question of finding a workable definition of SMEs is far from being solely a matter of international statistical comparability. The various national definitions reflect the place of firms of smaller size (however defined) in the respective "national systems of innovation (NSI)"[5] as well as size distribution within different industrial sectors.

There is general agreement among economists that no unique definition of an SME exists which is applicable to all sectors of the economy. This is obvious when one compares, for example, retail trade and manufacturing, where a comparison based on employees is unlikely to produce a meaningful picture. For example, the Small and Medium Enterprise Agency of the Ministry of International Trade and Industry (MITI, Japan), defines an SME as having 50-299 employees in manufacturing, 20-99 in wholesale, 20-49 in retail sales and services, and 50-299 in other non-manufacturing.[6]

Even within manufacturing, the different capital intensities (fixed capital per employee) will make a large enterprise (LE) in one industry look like an SME in another. To further complicate matters, different countries compile their statistics with different classifications of firm size. In the Netherlands, Norway, Turkey and Canada, the borderline between LEs and SMEs is drawn at 100 employees, while it is 200 for Sweden, and 300 for the Czech Republic. In line with the OECD definition, Hungary, Austria, Denmark, Finland and Germany define SMEs as enterprises with fewer than 500 employees (compare Table 1).

For many issues concerning differences in levels of IT diffusion, business behaviour and potential to adopt new technologies such as IT, these categories are too broad. For example, in their study on SMEs in Ireland, Scotland, Wales and South-East England, O'Farrell and Hitchens[7] used a "matched pair" method for a grouped comparison of enterprises, and found that splitting the sample into size classes of 0-10, 11-20, 21-50, 51-100 and 101-200 respectively gave sufficient detail to ensure that the firms within these size classes are structurally quite similar. In other words, a broader categorisation would have altered the results of the analysis, pointing to the fact that even firms in the different size classes of this grouping of SMEs differ substantially from one another.

The results of an Austrian survey[8] point in the same direction. The intensity of adoption (as measured by the number of different IT components in use) in medium-sized firms (100-499 employees) is far more similar to that of larger firms (more than 500 employees) than to that of small firms (up to 100 employees), and therefore ME developments and problems in MEs are different from those in SEs or VSEs (very small enterprises, often called "micro-enterprises", with fewer than 20 employees).

As the discussion contained in the country reports demonstrates, SMEs should be (and to some extent already are) treated differently with regard to policy measures.

Table 1. **Definitions of SMEs by country**

		Very small (VSEs)	Small (SEs)	Medium (MEs)	Large (LEs)
Austria			<100	100-499	500+
Canada					
	Manufacturing		<100		
	All other businesses		<50		
Czech Republic			<25	<300	300+
Denmark				<500	500+
EC				<250	
Finland			1-99	100-499	500+
	All businesses				
	Manufacturing				
France					
Germany				<500	500+
Hungary		1-20	21-50	51-300	300+
Japan					
	Manufacturing			<300	300+
	Wholesale trade			<100	100+
	Retail trade/services			<50	50+
Netherlands			<10	10-100	100+
	Manufacturing				
	All businesses				
Norway				<100	
Sweden				<199	200+
Turkey					
	SIS (State Institute of Statistics)		10-49	50-99	100+
	SMIDO (Small and Medium Industry Development Organisation)		<49	50-149	150+
OECD			<100	100-499	500+

Source: Country reports and various national sources

2.2 Different functional types of SMEs

SMEs play very different roles in the economy (see Rothwell[9]). They may be traditional small firms with no formal R&D, and their technology exogenously supplied by materials and equipment suppliers, or they may be sub-contractors to large firms that receive their major technology in-flow from customers while, as modern niche-strategy firms, they are likely to utilise product-embodied technologies, very often have formal in-house R&D and "very frequently need technical inputs from external sources to complement their often limited in-house R&D resources".[10] The new technology-based firms (NTBFs), business start-ups which are at the forefront of technological change, constitute another type of SME.[11] While, in the past, policy approaches concentrated mainly on the development of new technologies, thus giving NTBFs a more prominent role since the 1960s and 1970s, the shift in attention to the diffusion aspect (and the associated economic exploitation of the inventions) is more recent.

Given the very different forms of SME, it seems justified to conclude that "small enterprises" and "small and medium-sized enterprises" are elusive concepts. They hide a wide heterogeneity in types of firms.[12] If policy formualtion is to be sufficiently selective, these functional differences must be borne in mind.

3. Is there a "new manufacturing paradigm" which favours SMEs?[13]

3.1 The revival of SMEs

The 1980s (and in some cases the late 1970s) were the decade of the reversal of a long-term historical trend: the number of SMEs as well as their share in employment (see Table 2) and value added had been rising, and this development was due not only to the growing share of services in the economy, but could also be seen in the manufacturing sector. For instance, according to Acs and Audretsch (1992), in the period 1976-86 US enterprises with fewer than 500 employees increased their share in turnover in the manufacturing sector from roughly 20 to about 25 per cent.[14]

Table 2. **Growth rates of employment by size of firm or establishment in some OECD countries**
Percentage change over period

Belgium						
Number of employees	1 to 4	1 to 49	50 to 99	>100		
1978-86						
	6.4	-1.6	-19.3	-11.2		
Canada						
Number of employees	0 to 19	20 to 49	50 to 99	100 to 199	200 to 499	>500
1976-84						
	42.1	4.1	-11.2	-23.3	-22.2	-1.0
United States						
Number of employees	0 to 19		20 to 99		100 to 499	>500
1976-82						
	29.3		13.1		10.7	12.2
1982-86					0 to 499	>500
					11.8	8.3
France						
Number of employees	0 to 9	10 to 49			50 to 499	>500
1981-86						
1988-91	16.3	6.5			-1.9	-9.7
	7.7	10.1			8.0	-1.2

Source: OECD: adapted from various sources.

Table 3 is compiled from national sources and statistics recording employment shares of SMEs, and should be interpreted with some caution as the data are not strictly comparable. Nevertheless, it clearly shows that SMEs now account for a large, if not the major, part of employment in OECD economies.

Table 3. **Share of enterprises by size**

	Year of reference	Employment						Total SMEs	
		<5	*5-19*	*20-49*	*50-99*	*100-499*	*500+*	(A)	(B)
Austria	1989	0.6	3.4	7.8	10.3	36.9	41.1	59.0	
Canada	1992	9.9	15.1	11.8	8.1	15.8	39.3	44.9	60.7
Finland									
All businesses	1990				45	17	38	62	
Manufacturing	1991				33	23	44	56	
			<20		*20-99*				
France	1985		25.8		20.4	18.3	35.5		64.5
			<20		*20-99*				
Germany	1987		35		22.4	21.7	20.9		79.1
			<20		*20-99*				
Italy	1981		50.7		21.7	14.9	12.7	87.3	
Japan	1989					*<300*			
Manufacturing						80.6		80.6	
Netherlands					*1-100*				
Manufacturing	1991				41			41	
All businesses	1991				52			52	
Norway	1991				50			50	
Sweden	1990	5.3	9.8	9.7	18.4		56.8		43.2
Turkey	1990				21	79			
UK	1989	23.3	12.3	7.7	5.8	17.8	34.2	66.9	

Sources: Country reports and various other national sources; for Turkey, State Institute of Statistics data.

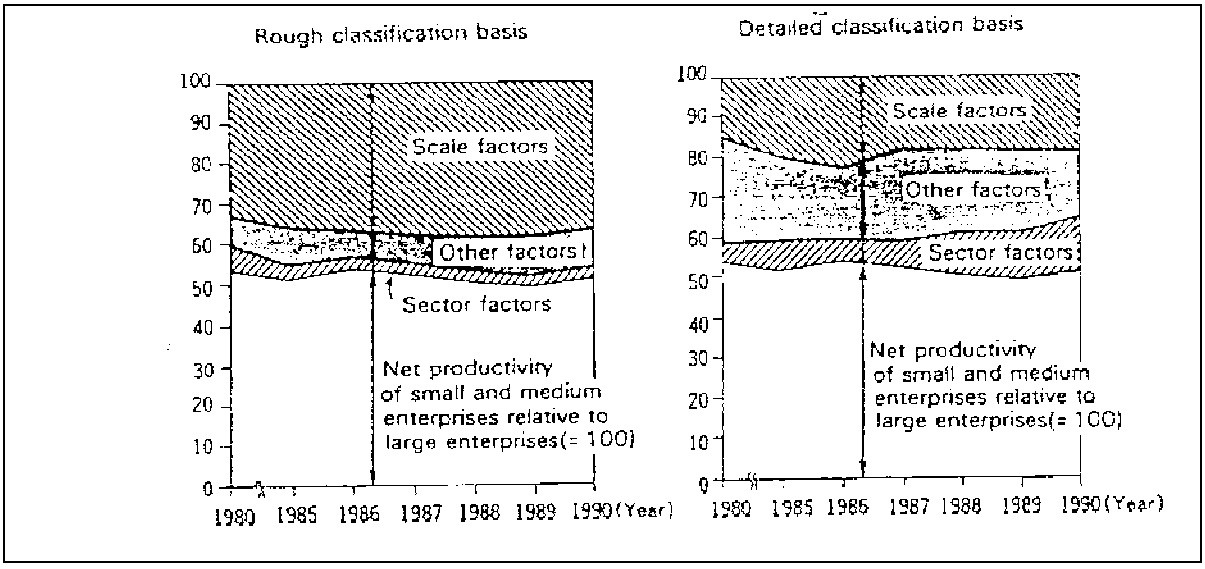
(A)...according to national definition, (B)...according to OECD definition, where different from national definition.

Another "robust" result of the analysis is that the recent growth of SMEs' share in the economy is not merely a statistical artifact, the result of structural change towards services, the business cycle, or a phenomenon to be seen in just a few countries. A study from the United States (of the manufacturing sector for the period 1969-84) regressing employment shares against cyclical variables, finds counter-cyclical movements of SMEs' share along a positive trend in contrast to pro-cyclical movements around a negative trend for LEs.[15]

Furthermore, the "V-pattern" of the development of SMEs' share (decline until the late 1960s, subsequent halt and reversal of the trend in the 1970s and 1980s) can be observed in many different countries, irrespective of the differing roles SMEs play in the respective national systems of innovation. The very different weights of SMEs clearly emerge when the United States, where enterprises with fewer than 20 employees account for a mere 7.4 per cent of the labour force, are compared to Japan and Italy, where the corresponding shares are 35.0 per cent and 35.5 per cent respectively.[16]

The growing importance of SMEs is also mirrored in their comparatively higher rates of innovation. Studies by the National Science Foundation (NSF, United States) in the mid-1970s, the Small Business Administration (SBA, United States) at the beginning of the 1980s, and the Science Policy Research Unit (SPRU, United Kingdom) in the mid 1980s, using different methodological approaches and measures for "innovation intensity" (e.g. patents per innovation expenditure, basic innovations per number of employees or per turnover, etc.) revealed good and, in many instances, better innovative performance of SMEs in comparison to their larger counterparts (see Figure 1).

Figure 1. **Productivity gap between large enterprises and SMEs and its determining factors in Japanese manufacturing**

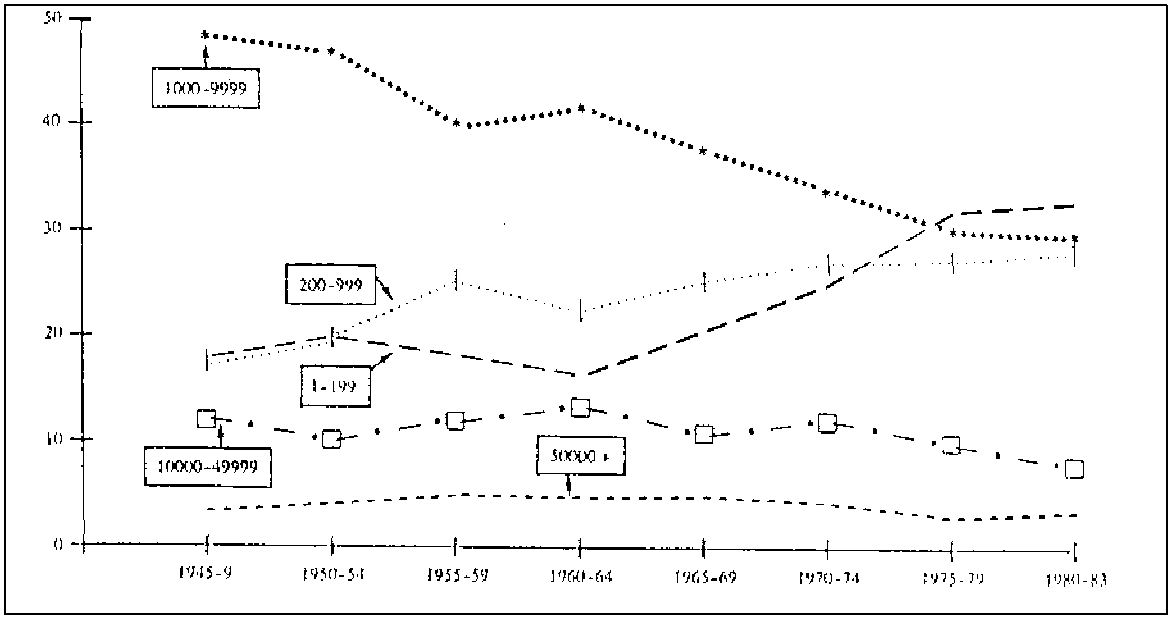


Source: MITI -- Japan (1992), p. 85.

This development has been labelled the "re-emergence of the small enterprise"[17] and was ascribed to the flexibility of SMEs, allowing them to keep abreast of the rapid changes in economic environment occurring since the mid-1970s, especially to changes in the volume and structure of demand, which LEs found difficult to cope with.

The other side of the coin is the prevailing backwardness of SMEs with respect to many other indicators. One of the most decisive is, of course, productivity performance, where the advantage is still clearly with larger enterprises. Studies from Japan, the United Kingdom, and several other countries indicate that there is still a gap between SMEs and LEs, and that this gap has even been growing in the second half of the 1980s (see Figure 2 for the Japanese case). Because of the growing share of SMEs in value added and because of their decisive role as suppliers of components to LEs, their productivity development is crucial for overall economic performance.

Figure 2. **Trends in the size distribution of innovating firms (%) between 1945 and 1983**



Source: Rothwell (1991), p. 94.

SMEs have other disadvantages, including lower labour compensation (wages, and even more so fringe benefits, increasing with firm size), longer working hours for employees, who also face substantially higher risks of closure and consequently of job loss in SMEs, and -- with respect to competitiveness -- higher unit wage costs (the lower wage rates of SMEs cannot compensate totally for their lower labour productivity).[18]

The observation of parallel growth of the share of SMEs in the economy and the diffusion of IT has given rise to speculation about the advent of a new manufacturing paradigm based on a blending of the inherent flexibility of both SMEs and information technologies. This "flexible specialisation hypothesis" (see Diwan, 1989) assumes that the current change in the technological regime is most favourable for SMEs[19] or, *vice versa*, among the possible reasons for SMEs' growing importance. "The 'flexible specialisation' hypothesis is rated as the most pervasive and persuasive" in the country reports of an ILO study on SMEs.[20] Hence, the question arises as to whether the processes of integration of tasks, re-qualification of labour, re-formulation of labour relations, or, in short, the spread of "new production concepts"[21] can be found in the rationalisation and modernisation patterns of SMEs.

3.2 The pros and cons of small-scale production

The advantages and disadvantages of SMEs compared to their larger counterparts have often been described in the literature (see Table 4 for a comprehensive comparison). Empirical studies have elaborated the main competitive advantages of SMEs as follows:

Table 4. **Advantages and disadvantages of small and large firms in innovation**[1]

	Small firms	Large firms
Marketing	Ability to react quickly to keep abreast of fast-changing market requirements. (Market start-up abroad can be prohibitively costly.)	Comprehensive distribution and servicing facilities. High degree of market power with existing products.
Management	Lack of bureaucracy. Dynamic, entrepreneurial managers react quickly to take advantage of new opportunities and are willing to accept risk.	Professional managers able to control complex organisations and to establish corporate strategies. (Can suffer an excess of bureaucracy. Often controlled by accountants who can be averse to risk. Managers can become mere "administrators" who lack dynamism with respect to new long-term opportunities.
Internal communications	Efficient and informal internal communication networks. Affords a fast response to internal problem-solving: provides ability to reorganise rapidly to adapt to change in the external environment.	(Internal communications often cumbersome: this can lead to slow reaction to external threats and opportunities.)
Qualified technical manpower	(Frequent lack of suitably qualified technical specialists. Often unable to support a formal R&D effort on an appreciable scale.)	Ability to attract highly-skilled technical specialists. Can support the establishment of a large R&D laboratory.
External communications	(Frequent lack of time or ressources to identify and use important external sources of scientific and technological expertise.)	Ability to "plug in" to external sources of scientific and technological expertise. Can afford library and information services. Can sub-contract R&D to specialist centres of expertise. Can buy crucial technical information and technology.
Finance	(Can experience great difficulty in attracting capital, especially risk capital. Innovation can represent a disproportionately large financial risk. Inability to spread risk over a portfolio of projects.)	Ability to borrow on capital market. Ability to spread risk over a portfolio of projects. Better able to fund diversification into new technologies and new markets.
Economies of scale and the systems approach	(In some areas, scale economies form substantial entry barriers to small firms. Inability to offer integrated product lines or systems.)	Ability to gain scale economies in R&D, production and marketing. Ability to offer a range of complementary products. Ability to bid for large turnkey projects.
Growth	(Can experience difficulty in acquiring external capital necessary for rapid growth. Entrepreneurial managers sometimes unable to cope with increasingly complex organisation.)	Ability to finance expansion of production base. Ability to fund growth *via* diversification and acquisition.
Patents	(Can experience problems in coping with the patent system. Cannot afford time or costs involved in patent litigation.)	Ability to employ patent specialists. Can afford to litigate to defend patents against infringement.
Government regulations	(Often cannot cope with complex regulations. Unit costs of compliance for small firms often high.)	Ability to fund legal services to cope with complex regulatory requirements. Can spread regulatory costs. Able to fund R&D necessary for compliance.

1. Statements in brackets represent areas of potential disadvantage. Abstracted from Rothwell and Zegveld (1982).

Source: Rothwell, R. (1983), "Innovation and Firm Size: A Case for Dynamic Complementarity", *General Management*, Vol. 8, No. 3, Spring.

-- fewer bureaucratic decision procedures;
-- co-operative management style;
-- more highly motivated workers; and
-- closer personal labour relations.

For example, Kotthoff and Reindl[22] confirm the existence of these competitive advantages in about two-thirds of their sample of SMEs. Other studies from Germany[23] and France[24] also partly support the hypothesis, but also point out some of the disadvantages inherent in SMEs (high dependency on personal relations, etc.).

Kleinknecht, in his comparison of barriers to innovation, found differences according to size class in nearly all aspects of innovative behaviour, not all of which were statistically significant (see Table 5). The most significant differences between SMEs and LEs at this general level can be seen:

-- in the ability to raise the necessary funds for innovation;
-- in monitoring technological developments; and
-- in gaining access to outside sources of technological information.

Table 5. **Relative significance of the problems encountered by firms in innovation**
Per cent

	Size by number of employees:						
Problems	10 to 19 n= 75	20 to 49 n= 294	50 to 99 n= 330	100 to 199 n= 264	200 to 499 n= 176	>500 n= 112	Stat. Sign.[1]
Lack of capital	58.7	47.3	38.8	33.7	29.0	26.8	++
Difficulties in predicting demand	57.3	47.6	49.7	59.1	48.3	50.9	•
Apparent costs of developing innovation	37.3	36.1	32.7	33.3	35.8	30.4	•
Problem of adapting the marketing function	25.3	25.5	27.6	26.5	25.0	25.9	•
Costs of monitoring future applications	29.3	26.9	27.9	20.5	19.3	11.6	+
Difficulties in finding technological information	24.0	20.4	26.1	18.2	22.2	8.9	+
Employee skills	24.0	20.7	21.2	20.1	12.5	12.5	•
Government standards	13.3	8.8	11.2	10.6	13.6	13.4	•

1. Stat. Sign. = level of statistical significance: • = insignificant; + = 90% significant; ++ = 99% significant.

Source: Kleinknecht, A. (1989), "Firm Size and Innovation", *Small Business Economics*, No. 2, pp. 215-222.

However, it should be kept in mind that the latter two problems are not ranked among the most important barriers to innovation, but as ones where SMEs and LEs differ significantly. Thus policy measures addressing these problems might especially favour SMEs, but are no guarantee *per se* of significantly raising overall innovativeness.

A more general analysis of the potential barriers to the diffusion of IT in SMEs reveals the following results:

-- A lack of internal financial resources and a failure of capital markets that makes access to outside financial resources difficult for SMEs. Loans are more easily given to larger firms which can offer securities, while more risky SME projects are less likely to be funded

because financial institutions are often unable to properly judge the potential benefits. This barrier is eased somewhat for more mature types of IT, such as NC/CNC machine tools, because of the rapid decline in the costs of the system controls and the increasing supply of standardised low-cost CNCs, but is still high for more advanced forms of IT, such as FMC/FMS or CIM.

Further, financial constraints are not felt equally, but differ from country to country, as comparative studies on SMEs in Ireland, Scotland, Wales and South-East England have revealed[25] (see Table 6). For neither the (less subsidised) English nor for the (heavily subsidised) Irish firms was a lack of investment capital an impediment to investment in new equipment. Instead, scarcity of working capital turned out to be a significant barrier because of lack of securities. Again, this is an indication that there are no generally-applicable rules for appropriate policies. In any case, problems specific to SMEs operating in the environments of very different national systems of innovation have to be carefully analysed and addressed by policy.

Table 6. **Major constraints on SME growth**

	Ireland	England
Engineering & injection moulding		
lack of cost competitiveness	40	
finance/shortage of capital	16	15
lack of demand	20	
lack of skilled labour	20	65
Clothing & knitware		
lack of working capital	50	
lack of investment capital	50	
lack of demand	10	
lack of skilled labour	14	60

Source: O'Farrell and Hitchens (1989), pp. 70.

-- A lack of awareness regarding the developments and the economic potential of ITs, mainly due to limited access to scientific and technical information, and to information about government programmes, etc. Although ITs were developed in the 1960s, and entered a phase of rapid diffusion almost ten years ago, there may still be a problem of awareness of the potential use of IT, especially among SMEs. An Italian study of the Lombardy region, one of the most developed industrial regions in Europe, found that a large share of enterprises was totally unaware of this potential. On the other hand, as can be seen from Part 2 of this report, countries with a long-standing tradition of technology programmes such as Canada or the United Kingdom no longer rank the awareness problem as a serious barrier. The awareness problem seems to be felt more intensely in countries where the diffusion of IT is at a lower level in general (Turkey, the Czech Republic, Hungary).

-- Limited availability of skilled personnel and, at the same time, limited resources for in-house training. Skill shortage as a barrier to technical change does not seem to be a problem for small firms alone. Despite their disadvantages in attracting skilled labour from the labour market and their reluctance to train in house, several studies indicate a comparably high skill level for SMEs. In France (for the observation period 1979-83), SEs were found to employ roughly the same proportion of skilled workers as LEs, but with more white-collar and fewer unskilled workers.[26] In the United Kingdom, small engineering firms (25-99 employees) have a higher than average share of skilled workers, with the difference increasing since the 1970s.[27] Empirical evidence from a German study supports the French results.[28]

-- Lack of managerial competence and difficulties in being able to afford the help of outside consultancy and technical services. The last two points above are crucial especially for the implementation of IT, which drastically changes the organisation of the firm as well as the qualification requirements. A very conscientious and strategic approach to this problem has been shown to be a necessary prerequisite for exploiting the full potential of IT to raise productivity and enhance competitiveness. SMEs are more dependent than other firms on access to outside resources and information, because of the lack of in-house-competence. This is especially true for technical and scientific information, on the one hand, and for managerial skills, on the other. One way to ease these barriers could entail consultancy services support. This has proven to be a very successful tool in some programmes, *e.g.* the Canadian Advanced Manufacturing Technology Application Programme (AMTAP), the Danish Technology Development Programme (DTP), or the Norwegian Business Development with New Technologies (BUNT) programme, and is now a feature offered by some new programmes (*e.g.* the new Austrian FlexCIM programme).

4. Patterns of IT diffusion

4.1 General trends

The diffusion of new technologies in manufacturing was very rapid in the 1980s in many OECD countries. As Northcott and Vickery (1993) point out, "the surveys show a striking similarity in patterns of diffusion and factors affecting diffusion despite differences in survey methods and classification systems".[29] These surveys clearly reveal that the process of diffusion was very uneven between the different technologies, industrial sectors and between firms of different size.

IT diffusion has reached high levels for more mature technologies such as NC/CNC machine tools or simple types of pick and place robots, but is still in its infancy for more advanced forms, such as Flexible Manufacturing Systems (FMS), not to mention the linking of several IT components to form Computer Integrated Manufacturing (CIM) and Factory Automation (FA) systems.

In addition, there are differences in diffusion levels between industries, with mechanical engineering, automobile and electronics lead sectors with high levels of diffusion, while other branches of discrete part manufacturing (furniture, textiles, apparel, etc.) are only just beginning to exploit IT potential.

Table 7. **IT and its effect on SMEs -- an overview of some recent studies**

Author	Year of publication	Year of survey	Country/region	Branch/industry	Sample/type of enterprise (number/size)	Main results
ROMEO	1975	1970			152	Found that the rate of adoption of NC/CNC increased with size of the enterprise.
GLOBERMAN	1975		Canada	10 different	90	- " -
GERWIN	1983					NC/CNC machine tools are more expensive than conventional tools (which might be an adoption barrier for SMEs).
NORTHCOTT / ROGERS	1984	1983	Great Britain		1200 enterprises > 20 employees	In 1983, 23% of enterprises used CNC-MTs. In the size class from 20-199 there were 21%, from 200-499, 22% and in enterprises with more than 500 employees there were 31%.
DODGSON	1985	1983	SE - England	Machinery	40 / small	The price of an average NC machine tool was £81.000, *i.e.* 4.1% of turnover or 21.8% of the book value of installed machinery of an average SME. Cost reductions are greater for small enterprises adopting CNC-MTs than for larger ones.
TOMBAK / DE MEYER	1988	1985	US / Europe			FMS adopters were 1.92 (in Europe) or 2.67 times larger (in the US) than non-adopters.
KONING / POUTSMA	1989	1985	Netherlands		6000	In the size class from 50-199 employees 40% of the establishments used CNC, those employing more than 200 had an adoption rate of 55%.
POUTSMA / ZWAARD	1989					CNC-MT programming is decentralised in SMEs, but centralised in separate departments in LEs.
CAINARCA/COLOMBO/ MARIOTTI	1990	FLAUTO Database	Italy	metalworking industry	2927 >10 employees	Clear positve relation between firm size and the diffusion of IT/AMT.
CARLSSON	1990					Rapid diffusion (also among SMEs) did not take place before 1975, when the control system of the (then) CNC-MTs considerably decreased in price.
LINK / BOZEMAN	1991	1985	New York State	several	284 enterprises 50 to 499 employees	Rate of adoption increases even within this selected group of SMEs.
POLT/DELL´MOUR	1992	1989	Austria	engineering industries	1700/263 all sizes	Diffusion of AMT increases with size, SEs have a distinct diffusion pattern from MEs and LEs, and SMEs follow different business strategies when applying AMT.

Source: Acs and Audretsch (1992) and various other sources (see Notes and References)

Finally there is empirical evidence that SMEs are lagging behind in the adoption of IT. A clear positive relation between firm size and the use of IT was found in numerous studies, for instance in Austria,[30] Italy,[31] Japan[32] and many other countries (see Table 7 for an overview of some recent studies). This holds true for all technologies, with NC/CNC machine tools a notable exception. Acs, Audretsch and Carlsson found a positive relationship between industries with higher SME shares and the propensity to employ NC/CNC machine tools.[33] This may be due to the fact that this type of IT is already in a mature stage of its technology life cycle and the diffusion process was long enough to affect a considerable amount of SMEs. Other explanations for this deviation from the regular pattern could be found in the complexity of the production process and the variety of products in these sectors: mainly investment goods as well as some branches of consumer durables for which this mode of production is typical. Both variables were considered decisive factors in NC/CNC use in German mechanical engineering by Dreher and Lay.[34] They conclude that, in the case of mechanical engineering, it is the sector rather than the firm size that is responsible for the higher level of diffusion.

According to Link and Bozeman the probability of adoption of new production technologies increases markedly with firm size even within their sample of SMEs ranging from 50 to 499 employees (see Table 8).[35] Thus SEs, as the group of firms where adoption of IT is slowest, seem to deserve special attention in future surveys as well as in policy measures.

Table 8. **Differences between small (SEs) and medium-sized enterprises (MEs) in innovation and diffusion**

Types of innovation by category of firm size[1]

Category of size	No. of firms	TECHKNOW[2]	PROCTECH[3]	PRODINNO
< 50 employees	118	-0.207	0.525	2.71
50 to 99	48	-0.096	0.604	2.83
100 to 249	83	-0.014	0.783	2.89
250 to 499	35	0.501	0.857	2.89
Total	284			

1. Mean values reported for the variables.
2. Calculated with a factor analysis using varimax rotation.
3. Transformed to a binomial variable.

Explanations:

"TECHKNOW" indicates the importance of acquisition of technological knowledge from outside sources. The firms had to assess the importance of 8 items (consultancy, universities, licensed technology ,etc.) on a 4 digit scale. By the means of factor analysis, a single firm specific dimension was calculated. The higher the value, the more use a firm makes of these outside sources.

"PROCTECH" indicates the probability of use of new manufacturing technologies and is coded as a binary variable (0 = no use, 1 = use of new process technologies).

"PRODINNO" stands for innovativeness in products and is measured on a 4 digit scale with 1 = lagging position of the firm with respect to its competitor, 4 = leader in developing new products.

Source: Link and Bozeman (1991), pp. 180.

In contrast to the "flexible specialisation hypothesis", in the course of introduction of IT SMEs are to a certain extent sacrificing their flexibility to produce a wide range of products or parts in exchange for a higher degree of automation and productivity. This has been shown in international comparisons of the use of FMSs (see Figure 3),[36] as well as in some country studies.[37] The reason is that in order to produce the greater volumes necessary to secure a high rate of utilisation of the machinery, SMEs are obliged to re-design their products and reduce their variants to make them easy to manufacture and the manufacturing process easy to automate ("design for manufacturing").

Neither observation: *i)* a positive correlation between diffusion and firm size; nor *ii)* SMEs partly sacrificing their flexibility; supports the "flexible specialisation hypothesis". Rather, it would seem that SMEs are facing the well-known problems implicit in technological innovation described in Section 3.[38]

4.2 Patterns of IT usage in SMEs

The following findings are mainly based on an extensive survey in Austria,[39] but are confirmed by surveys in other countries. The following picture emerged with respect to the factors determining the mode of usage of IT by SMEs and their effects on company strategies:

-- The adoption of IT in SMEs is positively correlated with their presence in growing markets, while no such pattern could be observed for other classes of firm size. One might conclude that the perspective of a growing market is especially necessary for SMEs, while larger firms may try to apply IT in a stagnant market situation.

-- SMEs seem to pursue different strategies than larger firms. While for the latter there is a significant increase in small batch production and a tendency towards "flexibilisation of mass production"; for SMEs growth, cost reduction and an increase in the degree of automation are observed.

-- The problems of IT use are surprisingly similar between large and small firms, *i.e.* the ranking of problems does not much differ. All firms mention "problems in the organisational adaptation to the new technologies" as the most prominent problem. Nevertheless, statistically significant differences occur: there seem to be "economies of scale" in the use of software, which cause large firms to rank this problem much lower than SEs (because of the lack of in-house capacity for adaptation of software in SMEs). The higher ranking of flexibility problems after IT introduction in SMEs is a clear indication that they sacrifice (some types of) flexibility for cost reduction and higher automation.

-- On the other hand, SMEs showed a comparatively significant higher propensity for product innovation after IT introduction than did large firms. Many had to renew their range of products to make them fit into more highly-automated production processes, while larger firms were able to produce more variants of their products after the introduction of IT.

To briefly sum up, the Austrian study showed that SMEs:

-- were lagging behind in the adoption of ITs;
-- needed growing markets as a prerequisite for the introduction of ITs;
-- encountered massive organisational problems (although of a different kind than larger firms);

-- had special problems with the proper selection, use and adaptation of software;
-- had to sacrifice to a certain extent their flexibility (as measured in the number of different products) in order to obtain a higher degree of automation.

4.3 The unexploited flexibility potential of SMEs

The main competitive advantages of SMEs are their ability to react quickly to changing market conditions, their short internal means of communication, and their non-bureaucratic internal structure giving incentives to innovative behaviour.

These characteristics seem especially relevant in the context of IT diffusion, given the largely un-unexploited potential of ITs to "flexibilise" formerly rigid forms of automation. Nevertheless, there is some evidence that the implementation of IT in SMEs will not lead to the broad-scale introduction of "new production concepts", but will exercise some pressure towards "standard automatisation paths" (*e.g.* deeper division of labour, more formalised labour relations, and centralised decision structures).

The sources of this pressure are:

-- The *necessity for systemic rationalisation*. Rationalisation using IT will yield the highest results with respect to productivity and profitability when applied in a "systemic" way. This means that IT is not confined to the rationalisation of a single task or operation, but rather applied to the restructuring of the whole production and information chain within and across the borders of the enterprise. IT usage of this kind will profoundly alter not only the way in which manufacturing operations are performed, but also the whole structure of the enterprise. If SMEs are confronted with this necessity, in the absence of a coherent plan for implementation (see below for the "strategy deficit" of SMEs), they often resort to typical "tayloristic" rationalisation patterns.

-- *LEs*, which very often force their sub-contracting SMEs into types of linkages which do not leave much space for "new production concepts", dictate to a certain extent the way in which technology is applied.

-- *Suppliers* of technology. IT applications in SMEs are still to a great extent "supply driven", that is, they are dominated by the available technical solutions of machine tool vendors, software firms, etc. Manz argues that most IT vendors do not tailor their systems for use in SMEs, but try to sell technical solutions most suited to LEs, with Production Planning and Scheduling Systems (PPSs) being a notable exception,[40] having been scaled-down in order to meet the specific needs of SMEs.

As Manz found in his study on the German machine tool industry, the main field of IT application is in administration, although the machine tool industry also holds the record for using IT more than other branches on the shop floor. Even in this industry, IT diffusion is positively correlated with enterprise size, although the difference has recently narrowed due to the proliferation of IT in the size class of 50-500 employees.

Very different approaches toward IT use can be found even within this rather homogeneous industry where the overwhelming majority of enterprises is of small and medium size. Roughly two-fifths

pursue a typical tayloristic rationalisation path, characterised by growing division of labour, narrowing of job description, separation of planning tasks and decision competencies from the shop floor, and introduction of additional hierarchical layers. Only one-fifth of enterprises could be described as implementing "new production concepts" as described above, and the remainder seem to follow no definite path, but to combine elements of both.[41]

One of the most important shortcomings of SMEs is their lack of strategic planning. For example, SMEs are found to have introduced ITs in a "reactive", rather than in a "proactive" manner. IT is very often seen as an immediate answer to pressing technical or business problems, as Manz has shown in his study on the German machine tool industry.[42] Too little attention is paid to organisational questions or to the necessity of retraining the workforce. The prevailing attitude of SMEs in the IT process is a "techno-centric" one, leaving unexploited many of the potential advantages of flexible organisational adjustment. This deficiency is especially problematic as IT introduction changes the way in which business is performed. *Ad hoc* efforts are doomed to fail, as the bulk of cases studies has demonstrated.[43]

Thus, on the one hand, SMEs must evolve from an "incremental-reactive" to a "strategic-proactive" approach but, on the other hand, they are often prevented from doing so by their insufficient personal, financial and organisational resources. Under these constraints, SMEs often miss the opportunity of implementing IT in a "social innovative" manner,[44] and resort to old, tayloristic rationalisation patterns.

The predominance of these patterns is confirmed by many empirical studies: *e.g.* Cavestro found a predominance of central programming instead of shop floor programming of machine tools in his study of French SMEs;[45] a similar tendency was observed by Mendius[46] among small German sub-contractors. The increasing use of CNC machine tools was accompanied by a shift from decentral to central programming. Both Politsch[47] and Poutsma[48] were unable to find a clear relationship between enterprise size and location of programming, and were thus unable to support the hypothesis that SMEs could handle IT in a more innovative way than LEs. Manz, in his study comprising seven in-depth case studies, discovered that in all enterprises there was an increase in indirect labour[49] and in levels of hierarchy.

Mendius[50] claims to have found what he calls a "typical pattern" of innovation behaviour in small enterprises:

- -- a restriction of qualification measures to the minimum required level and to very short-term forms of training and education;
- -- a dependency on training programmes supplied by the machine vendor;
- -- little awareness and little use of (other) external training opportunities. A reluctance that might also be caused by the lack of training programmes tailored to the needs of SMEs.

To briefly summarise the above diagnosis: the innovation potential of SMEs is not realised due to several constraints, in particular the resource barriers faced by SMEs.

"Networking" offers one solution to circumvent these barriers. SMEs might reduce the obstacles *via* some form of close co-operation with other firms (large or small) or with research institutes and universities (or other potential sources of technological knowledge). A phenomenon that has attracted much research interest in recent years was networking between mainly small firms in regional concentrations (the so-called "industrial districts"). Prototype examples of such districts are Northern Italy and Baden-Wurttemberg in Germany.

Brusco describes main features of technology diffusion in the institutional setting of industrial districts: "The climate is such that the new technology has to be understood and accepted by those who will be using it. It is therefore essential to encourage entrepreneurs and employees to work with the new technology, to tailor it to their needs and to improve it, and also to design the new techniques in such a way that they can be introduced without causing upheavals in the workforce. The real service (*servizi reali*)[51] centre needs to deploy experimental expertise to ensure that the new technologies are introduced in the most painless way possible".[52]

SMEs rely more heavily on scientific and technological information from outside the enterprise than do LEs (Table 5). One important source of this type of information is the user-producer relationship between enterprises. While these relations could also be a source of capability enhancement for SMEs, Poutsma found in a survey on Dutch enterprises[53] that SMEs in general do not actively use or create these relations, but are more or less passively integrated into these networks by LEs. The study of Rothwell provides contradicting evidence: "the great majority of firms in the UK survey played an active role in initiating external R&D collaboration and had an active policy of seeking external ideas".[54]

Thus SME behaviour towards external sources of information and knowledge seems to differ substantially from country to country, reflecting the traditions of the institutional settings in which SMEs are operating (attitude of LEs towards SMEs, existence of easily-accessible science infrastructure or efficient "bridging institutions" to facilitate technology transfer). Policy must reflect these different circumstances by taking a highly selective approach when choosing instruments and target groups.

5. Information systems and SMEs

5.1 General outline

IT-based information systems comprise an important part of IT use which is potentially useful for SMEs. In this case, IT use is invisible. Use of information, not technology itself, helped by computers in production processes (including both office and factory works), is the major theme of this section, rather than the direct use of microchips in products and automated manufacturing systems.

SMEs need information for their management and development. This includes both in-house information and information obtained from outside. Examples of the former include sales, inventory, purchase and client orders, and of the latter, information on new products and technologies, market price of competing products and financial opportunities.

Computer-based information systems are potentially useful for SMEs. The importance of information is increasingly recognised by policy-makers. Countries such as Finland, Japan, Norway, Sweden and the United Kingdom have public programmes that were explicitly or implicitly intended to promote the use of information-using computers.

Computer-based information systems may potentially be useful for the promotion of SME development where stimulus for take-off of industrial development has high priority. It was reported that the wide provision of information (such as technology, grant opportunities and business opportunities) was a major means of government support to SMEs in Turkey, Hungary and the Czech Republic.

Mixed feelings are, however, observed amongst policy-makers involved in the promotion of SME development. Although the potential usefulness of information systems is widely recognised, this recognition is yet to be supported by many concrete examples. While many success cases have been observed, difficulty in take-off in the use of the systems is an experience commonly shared by policy-makers.

The above discussion suggests the following questions:

-- What are obstacles preventing SMEs from taking advantage of IT-based information systems?

-- What are the success factors? and

-- What role should governments play in order to promote the use of information systems among SMEs?

5.2 Typology of information network systems

There are two different categories of IT-based (or computerised) information systems, *i.e.* in-house systems and those interconnected with other firms. An example of the former is an office automation system for the computerisation of pay-roll calculation; and of the latter, an order-entry system between a large automobile manufacturer and many small components providers. These two types of information systems may be considered to be at different stages of evolution in computerised information systems, in which in-house systems will be developed into inter-firm systems. SMEs may be users of either or both.

IT-based information systems connected with other firms again fall into two different categories, *i.e.* vertical or horizontal networks. The former refers to networks composed of SMEs and large firms (sub-contracting relationships), and the latter, networks composed of members with equal status, such as those for co-operation between SMEs (for example, SMEs and retail shops, exchange of information between SMEs in different businesses), and between SMEs and R&D institutions.

In Japan, from the above (rather theoretical) categorisation of inter-firm information systems, networks connecting an SME to its parent firm (a large firm) are most popular in practice. This empirical observation is supported by a UK report stating that the inclusion of large firms was efficient for the promotion of Open Systems amongst SMEs.

The same was reported with respect to electronic data interchange (EDI) systems by the United Kingdom. EDI is already well integrated in information transactions in the retail and automobile sectors of the country. In the retail sector, for example, Marks & Spencers has dominant control over SMEs. SMEs in these sectors are obliged to take part in EDI systems. This constraint drove them to rearrange their manufacturing resource planning systems.[55]

A "chain reaction" between large firms and SMEs should not be overlooked in the analysis of the use of information systems by SMEs. Large firms may be an interesting source of information for SMEs to obtain business opportunities and knowledge on new technologies and products.

The need for an exchange of information must exist in order for IT-based information systems to be successfully used by SMEs. Information systems are useful for SMEs only when they can gain

benefits from their communication partners. This characteristic is peculiar to information systems, unlike automated manufacturing systems, most of which operate on a stand-alone basis.

5.3 For what purposes do SMEs use computers?

A survey report on personal computers (PCs)[56] in Japan contained some data on the use of computers by SMEs. Although this data is not representative of all Member countries, it nevertheless contains many facts which are more or less internationally shared.

It is estimated that at least 20 to 30 per cent of Japanese SMEs own a PC. Among these, each firm uses on average 4.9 PCs. 28.4 per cent of SMEs use one unit, and 27.2 per cent, two units. In terms of the purpose of use, computers are still not used to any great extent for strategic purposes, such as management information systems. An increase in the use of point-of-sale (POS) systems in the retail sector and PC-based order-entry systems in various other sectors indicates the current development of strategic use.

The major purposes of PC use are:

-- shorter time spent on clerical work (76.7 per cent);
-- simplification of office work (46.7 per cent);
-- promotion of sales activities (41.7 per cent);
-- development of business (35.0 per cent); and
-- compensation for shortage of labour (26.7 per cent).

This result indicates that SMEs tend to use computers to undertake both routine ("shorter time spent on clerical work", etc.) and non-routine work ("promotion of sales activities"). Those SMEs interested in PC-use wish to achieve both static and dynamic economies.

The main decision-maker with respect to the purchase of PCs is the president of a firm (69 per cent). This is not surprising, given the rather simple decision-making process prevalent in SMEs.

Major promoters of the introduction of PCs, such as the board members and section chiefs, are, however, not necessarily those who are experienced in their use. On average 62.3 per cent of promoters have no experience of PCs. Even if promoters do not have experience in PC use, they believe that PCs are useful. The necessity of using PCs in corporate management is widely recognised by SMEs.

Evaluations of PC systems by users are positive. About 70 per cent of respondents answered that the first two priority objectives of PC introduction (as indicated above) were achieved. Qualitative improvement of a firm, such as "better corporate image to clients", "improvement of customer services" and "shorter time in decision-making", were also widely recognised.

Reasons for non-use of PCs partially reveal problems widely shared by SMEs in the use of computer-based information systems. 49.1 per cent of SMEs surveyed responded that the volume of work was too small to necessitate a PC. When limited to small firms (with a turnover of less than Y 300 million or approximately US$155 thousand), as many as 80 per cent responded in this way. 18.9 per cent of respondents indicated that they did not use PCs because they did not know how to make use of them. This implies that a substantial number of SMEs handle jobs that are not yet standardised or routinised.

Psychological rejection of computers by SME managers, such as "PCs look difficult to handle" (18.9 per cent) and "no one can handle a PC in our firm" (15.1 per cent), was also observed.

These results support the original observation on the use of computer-based information systems by SMEs. While many successful cases exist, various obstacles have still to be overcome before wide diffusion of computer use in SMEs will be possible.

Several countries provide public support for the promotion of information use by using computer systems. These countries include Finland, Japan, Norway, Turkey and the United Kingdom. In Finland, for example, the government provides, *via* TED, electronic database systems containing various data needed for sales in international markets, such as international market prices of goods competing with those exported by Finnish producers. The government also promotes information exchange between SMEs (Synergy exchange programme), in which computers interconnected by telecommunication networks are expected to play a substantial role. Promotion of the use of information for the improvement of management is undertaken as part of the BUNT programme in Norway. In a series of "BUNT-technique notes" issued for the education of SMEs, four out of fifty notes are on the smart use of information systems. In Turkey, a government agency in charge of SMEs, Small and Medium Industry Development Organisation (SMIDO), is building infrastructure for the promotion of information use by SMEs, such as an electronic database, a distribution system for CDs and newsletters. SMIDO also facilitates access for domestic SMEs to databases in foreign countries (OECD, EC, commercial databases, Euro Business Information Centres, etc.).

An approach taken by the United Kingdom in the Open Systems Technology Transfer programme (OSTT) deserves attention. While this programme is targeted to those SMEs interested in the automation of manufacturing systems, use of information generated through IT-based manufacturing systems interconnected with computer systems is envisaged. Inventory information (such as the number of components used in the manufacturing process), for example, may be automatically inputted to an inventory system database installed in a PC. This is where Open Systems are most useful, allowing the interconnection of manufacturing systems on the factory floor and computers in the office. Although the use of information is only part of the Open System, an approach that links manufacturing systems to the use of information systems would be most appropriate for SMEs in the manufacturing sector.

5.4 Factors of success or failure

There seem to be a number of common factors regarding success or failure in the use of computer-based information systems. The major factors drawn from case studies and reports by private sector representatives and professionals are listed below:

Success factors:

i) For both in-house and outside information:

-- the use of computer-based information systems is successful only with a strong business motivation (*e.g.* the United Kingdom reported that SMEs eager to reduce lead times achieved success in EDI);

-- information systems are best used when their use brings profits;

-- a large firm with frequent transactions with an SME takes a role in the introduction of an information network in the SME;

-- consent of workers is needed;

-- start with small systems;

-- it is better to start with the development (or reorganisation) of a company; and

-- IT should be one part of the whole development process.

ii) For in-house information:

-- an information system must be well integrated in daily work; and

-- skill in work rationalisation, but not necessarily knowledge of computers, is needed.

iii) For outside information:

-- pre-existence of stable relationships with partners of communication, that often include non-market elements (such as friendship, familiarity, etc.);

-- access to information is a major obstacle to SMEs. Such information should be made available at low cost in both time and money terms.

The above observation indicates that information systems are best used when associated with some organisational or managerial changes initiated by SMEs themselves. Information systems are tools to achieve corporate objectives. In this sense, the systems may be used as a powerful means in many of the government programmes in which consultation services are made available to SMEs for the improvement of management. AMTAP (Canada), BUNT (Norway) and Technology Cheques (Sweden) are examples of those programmes that provide management consultation services to SMEs.

Reported factors for failure are listed below. Many of the reasons for failure were already evident in the introductory phase:

-- an SME asked a vendor to do everything, but did not think through what the firm needed;
-- lack of management ability to use computers;
-- lack of management commitment and leadership;
-- analysis of business performance was undertaken in the wrong direction; and
-- system engineers (SEs) were not familiar with SME data needs.

As information systems must be closely integrated in a firm's organisation and management, careful evaluation of the usefulness of systems should be made. Perhaps it is most reasonable to examine the usefulness of networks on a case-by-case basis. There exists a minimum firm size for which IT-based networks may operate successfully.

5.5 Lessons for policy-makers

The peculiarity of computer-based information systems is that they require a higher level of user involvement in designing and operation than does IT use in manufacturing process and products. It is a well recognised fact that IT is a generic technology. A high level of flexibility in the designing of information systems necessitates well-defined programmes of system development. Both users and SEs need to know the content and purpose of the computer system.

IT is infrastructure when used as an instrument to handle information, in the sense that such IT use is potentially useful in all sectors of the economy. This feature makes IT different from other technologies and necessitates government intervention that is adjusted to this peculiarity.

Decisions as to whether or not to use computer-based information systems should be made in support of SME business development. Governments should at the very least help to raise SME awareness of the effectiveness of information use in management. Computer-based information systems are one means of information use.

The provision of educational opportunities is another role for governments. Symposia, seminars and other training opportunities should be made available to SMEs.

Public education of the workforce has employment implications. New skill requirements are increasingly associated with the increase in the use of computer-based information systems. A workforce with basic skills in, and familiarity with, computerised information systems is needed for SME management. Despite the recent economic recession, there are job opportunities for those who have computer skills. Such skills are, in addition, needed in all economic sectors. Governments must work to improve computer literacy.

Another important role that governments may play is to formulate opportunities for SMEs to develop contacts with business partners, such as other SMEs, large firms and R&D institutions. Networks of computer-based information systems interconnected *via* telecommunication networks may serve this purpose.

6. An outline for successful government diffusion policies for SMEs

Given the circumstances described above (several types of IT still in their infancy; some industries just beginning to employ IT on a larger scale; many SMEs that have not yet adopted IT), there seems to be ample room for further IT diffusion (and for its encouragement by public policy). But, as the last two decades have shown, rapid technological development can co-exist with productivity performance that is rather poor in historical comparison. Productivity growth rates have been rising over the last few years, but are still below those of the 1960s and 1970s in almost all OECD countries.

Behind this "productivity puzzle"[57] (*i.e.* the co-existence of rapid diffusion of new technologies and poor productivity performance) lie the difficulties involved in using IT properly. It is important to ensure a mode of use of new technologies that is able to capture their full economic potential. Tidd has elaborated the existence of numerous flexibility problems accompanying the introduction of "flexible automation".[58] These range from problems of reprogramming software, technical barriers in sensors and control devices, missing linkages between existing "islands of automation", to rigidity of organisations and internal hierarchies within factories.[59]

With respect to the main limitations of SMEs (primarily problems of finance, especially when the general economic climate is bad), their situation is eased somewhat as regards IT because of the declining price of computing power. It may not, therefore, be necessary to further subsidise purchases of mature types of IT such as CNC machine tools as these machines have become sufficiently cheap as to be affordable by a larger number of SMEs. The issue is somewhat different for the more advanced forms of IT, such as FMS and CIM.

In addition to the well-documented problems faced by SMEs in capital markets,[60] recent research has pointed to the crucial importance of organisational change in SMEs[61] in the process of IT adoption. In particular, SMEs benefited to a large extent from measures such as the support of (technical or managerial) consultancy in several technology promotion programmes (*e.g.* the Danish TDP, the Canadian AMTAP and the Austrian Flex-CIM programme).[62]

According to some evaluations, the efficiency of financial subsidies (as measured by the degree of "additionality")[63] seems to be higher in SMEs because of the possibility for larger firms to "enshrine" projects that are seen as vital for the core competence of the firm, while getting other (less important) projects funded publicly.

Therefore, efficient policy mechanisms for IT diffusion among SMEs should increasingly take into account the organisational aspect. This aspect not only includes the "internal" adaptation of organisational structures and behaviour, but also the re-positioning of SMEs within networks of "external" co-operation. The degree of innovativeness (and the level of IT adoption) seems to be dependent on the type of external networking, whether SMEs are forced to increase their IT use by larger firms in order to keep their position as sub-contractors in just-in-time (JIT)-networks, or whether they form a more interdependent network as is the case for firms in some Italian and German regions (Northern Italy, Baden-Wurttemberg).

As has been pointed out before, the comprehensiveness of policy measures is one prerequisite for successful policies in support of SMEs. Addressing only one point in the innovation chain (for example by subsidising R&D or the purchase of equipment) is likely to miss the point of SME problems.

Recent policy developments in many European OECD countries have put more weight on the promotion of R&D and -- moderately -- on support for SMEs.[64] This can be seen from the development of industrial support programmes in the late 1980s, where such traditional defensive measures as "crisis aid" or "general investment promotion" lost in importance, while more offensive instruments, such as the promotion of R&D and support for education and training, were the channel for increasing shares of government funding (see Table 9). Another indication of the increased weight is the broad range of policy tools that have been successively developed and deployed since the late 1970s (see Table 10).

Table 9. **Industrial support programmes in the OECD, 1986-89**

				NCG* (in current US$ billion)					Distribution of NCG				
Policy objectives	Number	NCG available	Average NCG	1986	1987	1988	1989	Total	1986	1987	1988	1989	Total
Sectoral programmes	130	118	44	4.4	6.3	5.8	4.1	20.6	5.9	9.3	8.7	7.7	7.9
Crisis aid	37	29	45	1.8	2	0.7	0.7	5.2	2.4	2.9	1.0	1.3	2.0
R&D support	159	144	46	6.7	7.4	6.2	6.1	26.4	9.0	10.9	9.3	11.5	10.1
Regional development	162	136	84	10.2	11.7	11.9	11.8	45.6	13.7	17.2	17.8	22.2	17.4
General investment aid	123	91	290	40.9	25.2	24.4	15	105.5	54.8	37.0	36.5	28.2	40.2
SME programmes	117	87	33	2.5	3.1	3.2	2.8	11.6	3.4	4.6	4.8	5.3	4.4
Employment/training support	60	54	44	1.9	2	3.6	2	9.5	2.5	2.9	5.4	3.8	3.6
Export-related aids	91	80	119	6.3	10.3	10.9	10.5	38	8.4	15.1	16.3	19.8	14.5
Total	879	739	89	74.6	68.1	66.9	53.1	262.4	100	100	100	100	100

1. NCG = Net Cost to Government.

Source: OECD (1992), "Industrial Support Policies in OECD Countries 1986-89", OCDE/GD(92)126, Paris.

Table 10. **SME production measures by central government**

		AUT	BEL	CYP	CS	DEN	FIN	FRA	GER	GRC	HUN	ITA	LIC	NLD	NOR	POL	PORT	ESP	SWE	CH	TURK	UK
1	Definition* by Employees:	M 500			S 25 M 300	M 500	M 500		M 500	M ?				M 100	M 100	M 300	M 500		M 200		MfgM 150	
	by Financial indicators:	10 bn As assets							DM 100m	350m Drs	S<500m, M< 2500m HUF						2.2b Esc					
2	Cent Govt dept resp	E	S	I	E	I	I	X	E	I	I:SBA	I & Others	E	E	I & Others	I & Others	I/APME	I/[MP]	I	I	I & Others	Emplmt (Ind)
3	Govt burden unit		•		None but under review	None but under review		•	•		None but under review		None but under review	•	None but under review	•	•	None but under review	•	None but gen prog	None but gen prog	•
4.1	Local govt measures	•	•		•		•	•	•			•		•	•	•		•				•
5.1	Subsidised info services	•	•	•	•		•	o	•	•	•	•		•	o	•	o		•		•	•
5.2	Subsidised advice/counselling	•		•	•		•	o	•	•	•	•		•	o				•		•	•
5.3	Subsidised SME employer trg	•		•	•		•		•	•		•		•	o		o		•		•	•
5.4	Corporation tax		•	•			•			•		o	•						oNone			•
5.5	Business income tax		•	•			•		•	•		o	•	o		•			oNone		•	
5.6	Local tax									•			•			•			oNone			•
5.7	Relief for 3rd party equity		•					•		•		o							oNone		•	•
5.8	Venture capital		•					•				o		None?					oNone			
5.9	Bank guarantees	•	•	•	•		•	•	•	•	•	o		o	•	•		None?		•		•
5.10	Subsidised loans	•	•	•	•		o	o	•	•	•	o			•		•			•	•	•
5.11	Grants	•	•	•	•		o		•	•	•	o			o		o					•
5.12	Public purchases	•						•		•		•										•
5.13	Employer co-ops	•	•	•	•	•	•			•		•		•	o		•	•			•	•?

Table 10. **SME production measures by central government** (cont'd)

		AUT	BEL	CYP	CS	DEN	FIN	FRA	GER	GRC	HUN	ITA	LIC	NLD	NOR	POL	PORT	ESP	SWE	CH	TURK	UK
5.14	R&D technology	•	•		•		•	•	•	•		•		o	•		•				•	•
5.15	Exemption/social rights	•	•		•		•	None?	None?			•		•				•			•	•
5.16	Start-ups	•	•		•		•	•	•	•	•	•		o	•		•	•	•		•	•
5.17	Competition law	•	•							•				•				•				None?
5.18	Other			Exprt prem				Otrg & rect	None?	•								•	Exprt loans			
6.1	Public law chambers	•				?		•	•	•?		•	•	•	•							
6.2	Voluntary chambers		•	•	•	?	•	•		•	•					•					•?	
6.3	Other private bodies	•	•		•	•	•	•	•	•	•	•		•	•	•	•	•			•?	•
6.4	Independent govt agencies		•	•	•	•	•	•	None?	•	•	•		•	•		•		•		•	•
6.5	Govt offices	•	•	•	•	•	o	o	•	•	•	•			•		•				•	•

Explanations: S...small enterprises; M... medium-sized enterprises; *... indicates that this policy instrument is used; o... indicates that this instrument is seen as a very effective one; ?... unclear; E/I/M/X... mean the Ministries for Economics, Industry, Middle Classes and multiple respectively.

Abbreviations of country names:
AUT... Austria, BEL... Belgium, CYP... Cyprus, CS... Czechoslovakia, DEN... Denmark, FIN... Finland, FRA... France, GER... Germany, GRC... Greece, HUN... Hungary, IT... Italy, LIC... Lichtenstein, NLD... Netherlands, NOR... Norway, POL... Poland, PORT... Portugal, ESP... Spain, SWE... Sweden, CH... Switzerland, TURK... Turkey, UK... United Kingdom.

Source: Bannock, G. (1993), "The Promotion of Small and Medium-sized Enterprises in Europe", revised report for the Council of Europe, EM-DE(93)2, 31/32, Strasbourg.

Although SME policies still occupy only a modest position compared to other policy areas, major technology programmes are increasingly designed to meet the specific needs of SMEs more carefully than was the case in the past. Moreover, a programme with a technology focus will not necessarily foster IT diffusion in SMEs. Successful examples of technology diffusion promotion include "soft" instruments, such as the provision of consultancy and business services. In order to attract SMEs, the barriers for entry to these programmes must be kept as low as possible. For example:

-- they should include awareness measures and marketing for the programme itself;

-- bureaucratic barriers must be kept low;

-- programme duration should be sufficiently long to give time to adjust the programme flexibly to unanticipated needs of SMEs;

-- the funding should be raised above the comparatively low levels that have been devoted to SMEs in the past; and

-- programmes should help SMEs to access technical and scientific information; either:

i) *via* the encouragement of co-operation between users and producers of IT to establish stable relations. Networks of this type have been found to be one of the main sources of innovation;[65] or

ii) *via* links to universities, technology transfer institutions or other parts of the technological infrastructure.

As has been argued above, SMEs face many difficulties in implementing IT. Far from being the spearhead of a new "manufacturing paradigm", they show lower levels of diffusion of new technologies and are, as yet, unable to fully utilise their potential.

Government intervention to overcome these problems would seem to be justified if it is well tailored to the needs of SMEs. Although the attention given to SME problems in the course of the introduction of new technologies is a fairly recent phenomenon, there are already some encouraging examples of successful policy approaches.

These examples have revealed some requirements for successful policy approaches, which have been elaborated above. The most important requirements are:

-- the supply of a comprehensive range of policy instruments in order to make sure that the different (and changing) needs of different types of enterprises, technologies, etc. are met; and

-- a shift from "hard" to "soft" diffusion policies,[66] that is, putting less emphasis on the subsidised introduction of hardware, but addressing the internal potential for adoption of the firm itself. A high intensity of investment subsidies might lead to a better age structure of the capital stock and to a higher level of diffusion of IT (in this case CNC machine tools), but not necessarily to a subsequently higher level of labour productivity.[67]

The adoption potential necessary for the efficient utilisation of IT can be fostered best by:

-- the provision of skilled labour and support in retraining the workforce;

-- the opening up of access to external sources of competence, be it consultancy services, databases and information networks, or links to research facilities and universities; and

-- awareness and demonstration programmes showing examples of successful IT implementation.

The provision of these "infrastructural" prerequisites for innovation and diffusion processes in SMEs would help them to fully exploit the potential of IT and considerably raise productivity and competitiveness.

7. Summary -- policy lessons from the country reports

This section attempts to draw conclusions for the design of "good" policies for the diffusion of IT among SMEs. The analysis is based primarily on country reports prepared for the "*Ad hoc* Meeting of Experts on Information Technology Diffusion Policies for Small and Medium-sized Enterprises", held at the OECD on 24-25 June 1993. Valuable additional information was gained from discussions during the meeting as well as from background material provided by the country delegates before and after the meeting. Further findings from recent research on technology policy programmes[68] have been incorporated.

The principal questions tackled in this section are the following:

-- What are the perceived problems and barriers with respect to the diffusion/adoption of IT which underpin different technology programmes? Is there a high degree of conformity (as suggested by some globalisation arguments), or is there more heterogeneity (a presumption suggested by the concept of "national systems of innovation"), emphasising the uniqueness of nations with respect to their modes of production as well as of creation and diffusion of technologies)?

-- What kinds of policies are employed in different countries to overcome these perceived problems? Do they actually overcome the problems, or will some of them remain unsolved or be postponed?

-- Are selective policies: *i)* oriented towards IT; *ii)* targeted on SMEs; and *iii)* focused on diffusion? Or do more generic policies exist, which are less selective in some aspects?

-- To what extent can similarities be observed with respect to the principles of design and how far is it justified (on the basis of the available material) in maintaining trends in development in the policy triangle IT-diffusion-SMEs?

7.1 Government intervention in the process of technology diffusion

Following Arnold and Guy (1992), we distinguish between the following types of failures and deficiencies which justify government intervention in the process of technology diffusion:

-- Infrastructural deficiencies: Well-functioning and reliable infrastructure (both institutional and physical) are prerequisites for economic activity in general and for the rapid adoption of new technologies in particular. A specific role is attributed to telecommunication networks and services and to the level of liberalisation of network usage.

-- Information failure: Inadequate and untimely information about new technological opportunities and threats usually causes sub-optimal allocation of resources, etc.

-- Capability failure: In addition to a lack of funding for innovative activities, several other kinds of capability constraint occur with respect to the adoption of IT, especially in SMEs, namely lack of the technical, organisational and managerial skills necessary to fully exploit the potential of IT.

7.2 Perceived problems and barriers in the diffusion of IT among SMEs -- the policy response

The extent and means of government intervention in the process of technology diffusion are reviewed in Table 11 which shows the problems and barriers to IT diffusion among SMEs as perceived by each country. The most obvious finding is that the range of perceived problems varies greatly in number and type both among countries and within each country.

Table 12 provides information on how far policy actions are carried out in order to meet the perceived problems. As will be argued below, it is impossible to separate problem perception from policy choice and to treat them separately. From this table, detailed insights can be gained as to problem perception, policy-design and policy-making in the field of IT diffusion for SMEs.

-- There appears to be only a small fraction of perceived problems which remain untackled. This should not lead to the conclusion that no further problems and barriers exist. On the contrary, there is some evidence to show that there is a certain co-incidence of problem perception and problem solution by implementing specific policies. Only a small number of countries (Canada, Finland, Hungary, Japan, the Netherlands and Sweden) have carried out a comprehensive analysis of the SME and IT sectors, which may act as a master plan for policy choice. Hence policies are often created and launched according to the specific situations, power and level of experience, former rates of success or failure, etc. of specific institutions and groups. However, this does not suggest arbitrariness with respect to policy choice, leading instead to the conclusion that the emergence of specific policies is attributed to specific institutional and social settings, which can be explained by referring to the national system of innovation.

-- Looking at the perceived problems and barriers of each country, it can be observed that no country is confronted with a single problem. Accordingly, policy measures are typically multiple, leading to the conclusion that the "soundness" of policies plays a crucial role in their success. This makes *ex-ante* as well as *ex-post* evaluations of implementation indispensable. Several countries, among them Austria, Canada, Finland, Germany, Norway, Sweden and the United Kingdom, have undertaken such an evaluation.

Table 11: Perceived problems and barriers in IT diffusion among SMEs

	market failure												
	... in the provision of infrastructure		... in the provision of information				capability failure (regarding financial resources)		capability failures (regarding organisation, human ressources and management)				
Country	insufficient institutional infrastructure for SMEs (national system of innovation)	telecom infra-structure, network-services	lack of awareness for IT use in products	lack of access to information about IT	lack of market information	problems in interaction between SMEs and authorities	lack of in-house financial resources	lack of access to (venture) capital markets	lack of compe-tence in managing advanced manufacturing technologies	lack of qualifications/ human resources (specialists)	organizational problems with IT	rising deve-lopment, implementation and mainten-ance costs	lack in the supply / availability of SME-specific IT-goods
Austria				xx	xx		xx (1)		xx (2)	xx (2)	xx (2)	xx (2)	xx (2)
Canada									xx (3)	xx (3)	xx (3)	xx (4)	
Czech Rep.	xx (5)	xx (6)		xx (7)	xx (8)	xx (6)							
Finland		xx (9)		xx (9)	xx (9)	xx (10)							
Germany							xx (11)		xx (12)	xx (12)			
Hungary	xx (13)	xx (14)		xx	xx	xx		xx					
Japan		xx			xx (15)			xx (15)	xx (15)	xx (15)			
Netherlands			xx (16)	xx				xx		xx (17)	xx	xx	xx
Norway		xx (18)		xx (19)					xx (20)	xx (20)	xx (19)		
Sweden				xx (21)				xx	xx (21)	xx (21)			
Turkey	xx	xx (22)		xx (23)	xx (24)					xx (25)			
UK				xx (26)			xx (27)		xx (28)				

Source: Country reports and various national sources

Notes to Table 11:

(1) ME/IV programme, Flex-CIM programme (1992-95).
(2) Flex-CIM programme (1992-95).
(3) AMTAP (1989).
(4) Perceived as problem after evaluation of the AMTAP (1989-).
(5) Targeted programmes: START, ROZVOJ, AESKULAP, REGENERACE, KONZULT, TRANSFER, PARK.
(6) State Information System (SIS).
(7) National Information Centre (NIS), Regional Counselling and Information Centres (RPICs), Science-technological and Economic Information Centres (VTEI).
(8) National Information Centre (NIS), Regional Counselling and Information Centres (RPICs).
(9) TED, Synergy Exchange Project.
(10) Project for reducing bureaucracy.
(11) Manufacturing Technology I - III (1980-92), programme for "Neue Länder" (former GDR) (1992-95), programme on Quality Control (1992-96) -- not SME-specific.
(12) Growing emphasis in the later stages of the mentioned programmes.
(13) White Paper on Innovation Policy.
(14) Information Infrastucture Development Programme (IIF).
(15) Small Business Corporation (CIC).
(16) MiToe programme (1991-94), Business-oriented Technology Stimulation programme.
(17) MiToe programme (1991-94).
(18) FUNN programme (1988-92).
(19) BUNT programme (1989-92).
(20) BUNT programme (1989-92), deficiencies at the company and consultancy levels.
(21) Technology Cheque programme (1987-92), Technology Consultant programme (1991-).
(22) SMIDO Information Networks.
(23) Technoparks, Information Centres (both organised under SMIDO).
(24) Information Centres (organised under SMIDO).
(25) Training Laboratories (CAD, CAM, etc.), Consultancy Services (organised under SMIDO)
(26) Open Systems in Manufacturing Technology Transfer programme.
(27) Several R&D programmes (SMART, SPUR, LINK).
(28) One-Stop-Shops programme, Managing into the 90s programme, The Consultancy Initiative.

Table 12. **Hands-off measures *versus* hands-on measures in IT diffusion policies for SMEs**

	hands-off measures							hands-on measures						
Country	establishing/ re-organising institutional infrastructure for SMEs	establishing physical infrastructure		establishing knowledge infrastructures				providing/subsidising consulting				providing/ subsidising human resource development	funding	
		databases	telecom-munication networks	links to universities, research institutes etc.	demonstration facilities	technology transfer facilities	information centres/ activities	consultancy for prepratory IT-product innovation	consultancy for prepratory IT-implement ation	consultancy for strategic enterprise development	training of consultants		funding IT-implemen-tation	funding R&D for IT-products
Austria					xx				xx	xx		xx	xx	xx
Canada					xx				xx	xx	xx			
Czech Rep.	xx	xx	xx			xx	xx							xx
Finland	xx	xx	xx											
Germany		xx		xx									xx	xx
Hungary	xx		xx	xx		xx	xx							
Japan		xx	xx		xx		xx			xx				
Netherlands					xx			xx					xx	xx
Norway										xx	xx			
Sweden				xx			xx			xx	xx			
Turkey	xx	xx	xx			xx			xx					
UK					xx		xx			xx				xx

Source: Country reports and various national sources.

-- Concerning different reasons for market failure, some distinctions have to be made with respect to problem perception. While deficiencies in the institutional infrastructure are typically attributed to transitional processes in the former centrally-planned economies (such as the Czech Republic and Hungary), further development of telecommunication infrastructure and services based on infrastructure aimed at supporting SMEs can also be found in other countries (Finland, Japan, Norway and Turkey).

Two kinds of policy choice and design are appropriate for the reconstruction of the institutional infrastructure of the economies in transition (concerning, among other things, SMEs and IT diffusion): on the one hand these countries must take into account their historical national innovation systems, which is to a certain extent unique and hence resistant to the blind adoption of "me-too" policies. On the other hand they should learn from the -- in some cases rich -- experience of other countries and actors. However, adopting a "pick-the-winner" strategy concerning specific policy instruments may still fail. It is instead more appropriate to learn from specific approaches and procedures how to design and implement policy instruments and measures.

In some countries (the Czech Republic, Finland, Hungary, Japan, Norway and Turkey) SME-oriented telecommunication network-based services are planned or in their trial stage of implementation. In all these cases caution is called for in order to meet the real needs of SMEs and to prevent boosting a high level technology-driven telecommunication service for its own sake. It is sometimes observed that network-based information services are not the solution to the problem insofar as they require those skills which are typically lacking in SMEs.

All countries perceive and react to two problems which seem to most characteristically affect SMEs *vis-a-vis* IT adoption:

-- Lack of access to outside sources of knowledge about IT (Austria, the Czech Republic, Finland, Hungary, the Netherlands, Norway, Sweden, Turkey and the United Kingdom).

-- Lack of competence regarding management, organisation and human resources to match general business practices with the requirements of IT (Austria, Canada, Germany, the Netherlands, Norway, Sweden, Turkey and the United Kingdom). It is therefore valuable to look closely at the respective policies, insofar as they vary greatly from country to country.

There is a common element in that almost all countries subsidise the involvement of outside consultants. However, there are some differences. As indicated in the case of Canada's "Advanced Manufacturing Technology Application Program (AMTAP)", the Netherlands' "MiToe" programme, Norway's "BUsiness Development using New Technologies (BUNT)" programme, Sweden's "Technology Cheque" and "Technology Consultant" programmes, and the United Kingdom's "Consultancy Initiatives", government assistance is strongly restricted. In some cases, consultants act not as experts themselves, but merely as guides to expertise. Within this set of policy instruments governments restrict themselves to the role of catalysts and change agents.

At the other end of the spectrum, of which the Austrian "Flexible Computer Integrated Manufacturing (Flex-CIM)" programme is an illustrative example, government subsidises not only the involvement of outside consultants in the pre-preparatory phase, but also the process of IT implementation itself. As several *ex-post* evaluations (of Canada's AMTAP and of the Netherlands' MiToe programme) indicate, the business community would welcome an extension of the assistance provided in the implementation of new products, processes or organisational changes. This recommendation to include

implementation as a matter for governmental subsidised consultancy should be taken into account in future policy design for the very reason that the implementation of IT bears a remarkably high degree of risk and uncertainty.

As a general feature of the lack of access to information about IT and the lack of competence regarding management, organisation and human resources, we can draw the following conclusion. Those countries that put their main emphasis on the "soft" aspects of the process of IT adoption typically look back at specific experiences with both supply-oriented and demand-oriented measures.

-- As mentioned above, the involvement of outside expertise is critical for the adoption of IT in SMEs. One of the main instruments to secure access to outside sources is the provision of technical/business consultants. The role of consultants varies greatly from programme to programme. In the Austrian Flex-CIM programme they are involved from the early (searching and selection procedures, technology analysis, strategy formulation) to the very late phases of IT implementation. In AMTAP (Canada), the MiToe programme (the Netherlands) and the BUNT programme (Norway), on the contrary, their task is confined to the completion of an action plan (product development, IT implementation, re-organisation, etc.). In Sweden's Technology Consultants programme, the consultant acts not as an expert, but rather serves as a guide to expertise.

   The experiences of Canada, Norway and Sweden seem to be noteworthy insofar as they demonstrate the strong necessity for training consultants as a prerequisite for effective assistance. As an example of training for consultants, Norway's BUNT programme is outstanding: a toolbox with over 50 procedures and methods for general strategic analysis as well as for the creation of strategies and plans for technology utilisation was made available to consultants.

-- Coming back to the first question of whether conformity and similarity or heterogeneity prevail among perceived problems and barriers, the answer may be stated as "convergence in heterogeneity".

   With respect to the perceived problems of and barriers to the diffusion of IT among SMEs, heterogeneity rather than similarity between different countries can be observed. This heterogeneity is attributable to the structure and stage of development of the respective national systems of innovation and the specific role of SMEs therein.

   On the other hand, insofar as different countries have a similar perception of problems and barriers, they respond to these problems with sets of policy instruments which are more similar than diverse. Hence we can conclude that countries which exhibit similarity regarding prevailing market failures within their SME community react with similar methods of policy intervention. The most striking feature of policy choice, *i.e.* the shift towards "softer" measures, can be observed in the more advanced national systems of innovation.

-- To summarise we return to the second question of whether the policies employed actually respond to all the perceived problems, and to what extent problems remain unsolved. To answer this question we have to consider that it is the exception rather than the rule for governments to carry out comprehensive *ex-ante* analysis regarding SME and IT policy instruments, not to mention preparing White Papers or some sort of master plan on the respective policy subjects, which are explicitly based on foregoing analysis as well as on

general political strategies. Hence the creation and implementation of policies and the perception of problems are often seen as the two sides of the same coin.

7.3 IT diffusion policy for SMEs -- an embedded policy?

The question here is whether the policies relevant for IT diffusion in SMEs are explicitly directed at this specific subject or whether they tend to be embedded in other, more generic, policy measures.

Examining all programmes and policy measures presented at the EIIT meeting as well as available background material and applying strict criteria, only a few programmes could be found which are explicitly directed towards SMEs, IT and diffusion at the same time. These are the "MiToe" programme of the Netherlands, which is restricted to the use of microelectronics in products, the "Open Systems in Manufacturing Programme" of the United Kingdom, and the "Application of IT in SMEs" project in Finland, which was, however, rather small-scale. All these programmes, which explicitly contain some form of IT, are diffusion-oriented and show a strong focus on SMEs.

However, when the strict criteria are loosened, almost every country has several programmes and schemes which can be considered as relevant for IT diffusion among SMEs. Some of these programmes are discussed below:

-- A quite frequent type of embedded policies is the general promotion of either technological advance or, more generally, strengthening the strategic position of SMEs by the utilisation of new technologies in general. This holds especially true for the programmes in Canada (AMTAP), Norway (BUNT) and Sweden (Technology Cheque and Technology Consultant programmes). In these cases there is indeed a strong orientation towards SME and diffusion, but no restriction on specific technologies, such as IT, although IT is by far the most frequently taken up.

   However, there are differences in what is considered as an SME in the individual programmes. To name but a few examples: while the Norwegian BUNT programme was restricted to enterprises with fewer than 250 employees, the Dutch MiToe programme allowed firms with fewer than 500 employees to apply. On the contrary, the Austrian Flex-CIM programme is open to firms of any size, although an entrance barrier exists for firms with more than 500 employees.

   Generally, these cases demonstrate a clear shift in the general orientation of technology policy from technology supply towards technology as a mere instrument to achieve strategic business goals. Hence the "technology fix" seen in other types of technology programmes is avoided.

-- While, in the above countries, the SME condition is very strictly applied and the IT condition at best implicit, there are some countries where the IT condition is strictly applied, while the SME condition is somewhat loose. Austria (Flex-CIM programme) and Germany (the "Manufacturing Technology Programmes I-III") are typical examples of this orientation. However, in the Austrian Flex-CIM programme, large enterprises have to fulfill significantly stricter criteria to obtain subsidies than do SMEs, hence even here the selectivity criteria favour SMEs.

-- A third type of policy mix can be observed where the diffusion aspect is less significant. The case of Finland, where the "TED" and the "Synergy Exchange" programmes are more technology-supply in character and, to some extent, the German programmes (the "Application of Microelectronics", the "Microperipherics Programme" and the "Micro System Programme I"), which are oriented more towards research and development than towards diffusion.

On the question of whether explicit policies for IT diffusion among SMEs are the rule or rather the exception, the following conclusion may be drawn: there is strong evidence to show that explicit programmes for IT diffusion among SMEs exist only in a few countries. The majority of countries have developed programmes and measures which are restricted to some, but not all, of these tasks. Insofar as they are substantially oriented either towards IT, SMEs or diffusion, they may be termed as "embedded policies".

All in all, it may be justified to conclude that most countries have employed some kind of embedded IT diffusion policies for SMEs. The most frequent policies in which the IT diffusion-SME agenda is embedded are general SME policies on the one hand, and those with a general IT focus on the other.

7.4 IT diffusion policies -- is the hands-off/hands-on controversy still valid?

This section deals with the question of whether a more "hands-off" or a more "hands-on" approach to IT diffusion policy for SMEs can be observed, or whether this typology is inadequate in terms of policy design and policy choice.

-- "Hands-off" policies include those measures and activities that are oriented towards creating and maintaining a nurturing environment for SMEs in their attempts to adopt IT and make use of their economic potential.

-- "Hands-on" policies are directly oriented at the individual (small and medium-sized) enterprise and are aimed at enhancing its internal potential to adopt IT and thereby enhance its economic performance.

In order to prove whether a hands-off approach excludes a hands-on approach and *vice versa*, a brief taxonomy based on the policy measures contained in the country reports is given below:

-- "Hands-off" measures:

i) establishing/re-organising the institutional infrastructure of SMEs;

ii) establishing physical infrastructure, in particular telecommunication network services (including the liberalisation of its usage) and databases; and

iii) establishing knowledge infrastructure such as links to universities, research institutes, demonstration facilities, technology transfer facilities, information centres, information activities, etc.

-- "Hands-on" measures:

i) providing/subsidising consultants for preparatory IT product innovation;

ii) providing/subsidising consultants for preparatory IT implementation;

iii) providing/subsidising consultants for strategic enterprise development;

iv) training of consultants;

v) providing/subsidising human resource development;

vi) funding of IT implementation projects; and

vii) funding of R&D for IT projects.

Table 12 provides an overview of different measures contained in the individual programmes of each country. Some findings regarding the hands-on/hands-off agenda are listed below:

-- Except for two cases (providing/subsidising consultants for preparatory IT product innovation in the Netherlands and providing/subsidising human resource development in Austria), each measure is applied in a number of countries.

-- There is a more or less even distribution between hands-off and hands-on measures. This can be interpreted in several ways. It could be maintained that activities in both supplying adequate infrastructures and business environments as well as enhancing firms' internal capabilities are considered necessary for speeding up the diffusion of IT among SMEs.

-- It can be observed that great emphasis is put on databases provided *via* telecommunication networks, mostly aimed at providing SMEs with technical and/or business information (the Czech Republic, Finland, Germany, Hungary, Japan and Turkey).

-- Remarkably, at the same time, a considerable number of countries rely on "social" measures, predominantly in providing and subsidising consultants for strategic enterprise development (Austria, Canada, Japan, Norway, the Netherlands, Norway, Sweden, Turkey and the United Kingdom). Contrasting this pattern with that of genuine technical approaches (such as databases and telecommunication network services), a clear difference is revealed. Almost all countries that employ technical measures (with two exceptions) do not employ social measures and *vice versa*. In this respect countries which proceed more along a hands-off paradigm in SME IT diffusion policy can be distinguished from those which exhibit a more hands-on approach.

-- With regard to funding, which could be expected to be seen as a "fix" for SME problems, different evidence is observed. Some countries fund IT-related R&D and implementation (Austria, the Czech Republic, Germany, the Netherlands and the United Kingdom), while others do not. To explain this difference, two remarks should be made: on the one hand funding IT-related R&D is not typically at the heart of technology diffusion policy, but more of innovation policy and hence of limited relevance for diffusion. However this fact sheds some light on the general relevance of diffusion policy within the spectrum of government

intervention in the development of technology. On the other hand, absence of funding may be attributed in some countries to the high level of funding for general investment.

-- To return to the question of whether a distinction can be made between hands-on, as opposed to hands-off, dominance in individual countries, the following rather unspectacular conclusion may be drawn. No country relies solely on one measure, rather countries tend to set up multiple activities, directed both at supplying adequate infrastructure as well as providing/subsidising direct assistance to individual SMEs in order to overcome technical as well as managerial skill shortages. It can be observed that individual countries have either a stronger orientation towards direct assistance (and towards knowledge assistance rather than financial assistance) or towards providing infrastructural aid (with a double orientation towards more technical/physical infrastructures as well as towards knowledge infrastructure).

7.5 Lessons for the formulation of IT diffusion policies for SMEs

To what extent can similarities between different programmes with respect to the principles of design be observed, and how far is it justified to maintain trends in development in the policy triangle IT-diffusion-SMEs? This section makes an attempt to collect some elements for designing effective government programmes.

-- Avoid a "technology fix". Following this recommendation provides a clear eye for the primary aim of technology adoption, namely its use as a means for enhancing firms' capability.

-- Secure funding, but address also the "soft" aspects of the adoption and implementation process: organisational development, managerial skills, human resource development, access to outside information (on markets and technologies), etc.

-- Use consultants and train them. Consultants can act as experts, as catalysts, as change agents and guides to other experts. In order to fulfill these multiple tasks they must be properly trained. Good advice in this respect is to develop tools for supporting their task.

-- Carry out evaluations. Continuous and *ex-ante* evaluations may be helpful to effectively solve the real problems of the SME community. *Ex-ante* evaluations should be carried out to ensure the efficient performance of programmes and policies.

-- Programme management. Careful programme management is indispensable in order to carry out *ex-ante* evaluation, to implement and market the programme, to monitor the implementation, and to re-direct the programme if necessary.

Notes and references

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Part 2

Country Reports

AUSTRIA

THE FLEX-CIM PROGRAMME: PUBLIC SUPPORT FOR CORPORATE AND ORGANISATIONAL DEVELOPMENT AS A PRE-REQUISITE FOR IT ADOPTION

Table of contents

1. Definition of SMEs

Austria, in accordance with international practice, considers enterprises with less than 500 employees as SMEs. In particular, those with less than 100 employees are characterised as small, while enterprises with a number of employees between 100 and 500 are termed medium-sized.

As Table 1 indicates, almost all companies (97.43 per cent) can be considered as SMEs, covering slightly more than half of all employees (55.95 per cent).

Table 1. **Size distribution of the Austrian economy (industry & crafts)**

Size class	Enterprises (%)	Enterprises (cum.) (%)	Employees (%)	Employees (cum.) (%)
0.4	35.09	35.09	0.58	0.58
5.9	10.38	45.47	1	1.58
10-19	11.8	57.27	2.36	3.94
20-49	17.15	74.42	7.8	11.74
50-99	10.22	84.64	10.3	22.04
100-499	**12.79**	**97.43**	**36.91**	**55.95**
500-999	1.72	99.15	16.49	72.44
> 1 000	0.85	100	24.56	100

Source: ÖSTAT (1991).

Classification tends to discriminate different firm behaviour with respect to firm size. As the following list of size-related problems of Austrian firms show, we are faced with different problems according to different size-classes:

-- With respect to the *adaptability to general economic change*, the dividing line between "small" and "large" runs between smaller and larger than 100, and not, as probably expected, around 500. Furthermore, the distinction between medium-sized (100-500) and "small bigs" (500-1 000) diminishes in favour of a comparatively strong discrimination around 1 000. (BMWA, 1991, p. 35)

-- With respect to the *adoption of new technologies*, we can observe several patterns, which are related to different size classes:

i) Small firms usually adopt new technologies on an *ad hoc* basis while large firms tend to proceed more systematically.

ii) Co-operation with universities and research facilities rarely occurs among firms with less than 200 employees.

iii) Firms with more than 500 employees have a greater awareness of the organisational and managerial implications of technical change.

iv) However, a strong and explicit link between technological innovation and/or adoption and general corporate strategy rarely occurs in firms with less than 1 000 employees.

v) Smaller firms (less than 100 employees) are confronted with specific barriers to access to instruments of public promotion of R&D (at the national level and even more at the level of European programmes such as EUREKA or the Framework Programmes) due to a lower degree of specialisation at both the technical and administrative levels.

2. Perception of SME problems

There is an abundance of empirical investigations regarding the role of SMEs, predominantly with respect to their ability to cope with structural and technological change. The results, however, are rather patchwork and do not represent a consistant theory. As far as technology policy-making in Austria is concerned, a certain degree of common sense concerning the specificities and problems of SMEs can be observed (see Leo, Palme and Volk, 1993; VOI, 1993):

-- notorious lack of equity capital;

-- at the same time lack of debt capital;

-- little strategic orientation in general and with respect to R&D in particular;

-- little specialisation and, compared with large firms, lower expenditures with respect to R&D, except in a small group of small high-tech firms;

-- little willingness to co-operate and/or to merge with other firms (and with universities);

-- problems in the acquisition of external knowledge and skills; and

-- lack of market know-how and access to (export) markets, typically in firms with less than 200 employees.

Policies which address industry in general and SMEs in particular often suffer from size-specific entry barriers, at least in the perception of SMEs:

-- Firms are confronted with administrative and informational barriers with respect to access to R&D assistance and promotion, which holds especially true for international co-operative R&D programmes.

-- There are exceptions: if a firm once finds the way to R&D promotion, it is likely that it will find the way again.

As far as IT and its potential are concerned, there are some underlying assumptions and convictions about the role of IT among the policy-making institutions and actors in Austria:

-- *IT is considered as the principal technology*, since almost half of the funds of the targeted technology programmes during the last eight years (*i.e.* since the existence of this instrument) are devoted to IT: microelectronics and information processing, CAD/CAM, Flex-CIM,

software technology (planned), microsystem technology, (parts of) biomedical technology and space technology.

-- We can observe at least two fundamental shifts of targeted technology programmes by the Innovation and Technology Fund (ITF) during the last eight years. First, a change from a more technology-push oriented promotion to a policy which views technology as an instrument but not as a goal in itself; a policy which takes effect above all in the Flex-CIM and software-technology programme. These two programmes are predominantely directed to genuine economic goals: enhancement of competitive strength by upgrading production organisation; implementing quality control systems (*e.g.* ISO 9000); and establishing business plans as a prerequisite for public support. The second pattern of change is characterised by the inclusion of, and emphasis on, supplementary measures such as awareness activities, training and consultation services.

To summarise, we can state that IT is considered as a strategic agenda within the spectrum of technology policy activities in Austria. The strategic orientation of the respective programmes is strongly directed towards structural adjustment at the level of the Austrian economy and towards the improvement of the competitive strength of the individual firm.

3. General and IT-specific policies favouring SMEs

This section deals with two questions: *i)* whether there are general policies in Austria favouring SMEs; and *ii)* to what extent they are IT-specific.

Due to the division of labour among the principal government bodies in Austria, no coherent set of policies favouring SMEs can be observed. However, there is a certain justifiable rhetoric about SME orientation in technology (diffusion) policy.

In order to prove that this as a pure rhetoric, we have to look at the distribution of the appropriated subsidies from the principal funding bodies, the *Austrian Industrial Research Fund (FFF)* and the *Innovation and Technology Fund (ITF)* according to the size of the receiving firms. While there is limited rhetoric by the FFF with respect to SMEs, we find that 57.4 per cent of the subsidies of the FFF are appropriated by SMEs, although only 20 per cent of intramural industrial R&TD expenditures are borne by SMEs (FFF, 1992). On the other hand, we find a certain rhetoric in favour of SMEs in the ITF: a pattern of subsidy distribution can be observed which does indeed favour SMEs. Almost half of the subsidies of the ITF (45 per cent) -- less than the share of the FFF -- are devoted to SMEs (ITF, 1991).

In conclusion, both the FFF and the ITF have a bias towards SMEs, as measured by the respective multiplication effect. Hence we can conclude that the traditional instruments of innovation and technology policy in Austria implicitly favour SMEs.

To answer the second question (to what extent do specific IT policies exist?) we have to go back to the previous section in which it was argued that almost the half of the funds of the targeted technology programmes during the last eight years (*i.e.* since the existence of this instrument) are devoted to IT. We can clearly state that IT plays a predominant role in the Austrian technology policy system, and, as we shall see in the next section, there is a strong focus: *i)* on SMEs; and *ii)* on diffusion.

4. The Flex-CIM programme

4.1 Background to the programme

Several criteria make the Flex-CIM[1] programme outstanding in the history of technology policy-making in Austria. These characteristics are discussed below as far as the genesis is concerned, and some additional, less spectacular facts have been added:

-- The stimulus for the creation and implementation of the Flex-CIM programme came entirely from government officials: there was almost no articulated need from industry.

-- Prior to implementation, an extensive monitoring exercise was carried out (Hollnsteiner, 1990). This study had as its quintessence: *i)* a strong focus of the intended programme on CIM users; *ii)* an emphasis on organisational, managerial and strategic rather than on technological issues, and *iii)* a specific focus on integration.

-- The programme itself was designed and implementedby a programme committee consisting of government officials from the Federal Ministries of Science and Research, of Public Economy and Transport, of Economic Affairs, and from the Federal Chancellery, representatives both of the Austrian Chamber of Commerce and its Economic Promotion Institute, of the Austrian Chamber of Labour, and finally representatives of the Austrian Trade Union. Several outside consultants were engaged on an *ad hoc* basis. At the deliberation stage, no practitioners from industry took part.

-- A further decision was taken (despite some reservations from outside consultants regarding the difficulties of CIM installations especially for small firms) to focus the Flex-CIM programme explicitly at SMEs and to allow large firms to participate only in the case of outstanding projects.

In summary, the programme's restriction to SMEs, its focus on users and, above all, its strong focus on non-technical issues, deserve special attention insofar as this represented an innovative step, leaving behind traditional programme design philosophy.

4.2 Objectives of the Flex-CIM programme

The declared objective of the programme under discussion is:

"to enhance the competitive strength of firms by employment of flexible computer-integrated methods of production. It is intended to raise significantly the degree of flexibility of the entire firm, to enhance the quality of products and to improve the conditions of work by technological and organisational integration of information and material flows."

This overall objective can be segmented into the following specific goals:

-- strengthening of firms to cope with structural change by supporting training, R&D, and adoption of Flex-CIM technologies;

-- speeding up the adoption of Flex-CIM applications by supporting the development of implementation strategies at firm level; and

-- designing and implementating supplementary activities concerning awareness and infrastructural measures at the national and regional levels.

At the level of programme objectives, it is worthwhile indicating the strict emphasis on the embedding of technical-engineering issues in overall strategic, organisational and social issues and thus a strong concern to avoid technological incrementalism on the one hand and a "technological fix" on the other. Consequently, the objectives of the programme do not establish any qualification to either specific technologies or to any kind of best-practice frontiers.

4.3 Types of services provided by the Flex-CIM programme

Several types of services are provided by the Flex-CIM programme. These can be divided into three types:

Service type 1: Subsidy of costs for the development of:

-- products (hardware, software, periphery, etc.);
-- components and systems (sensors, actors, robots, etc.);
-- production-related services (planning support systems, training systems, etc.);
-- advanced, computer-integrated production processes.

Service type 2: Subsidy of costs for the design of implementation plans regarding:

-- project management;
-- organisational development;
-- systems evaluation and selection;
-- CIM-related modification of existing products;
-- market assessment training;
-- involvement of shop committees and employees respespectively.

Service-type 3: Subsidy of costs for implementation:

-- project management;
-- organisational development;
-- product and process development;
-- hardware, software;
-- prototypes, application tests, trials;
-- training;
-- workplace design.

The overall criterion for granting a subsidy is, of course, the innovative character of the proposed project. Hence the programme does not grant subsidies for the implementation of standard solutions. In contrast, an extra bonus is granted for:

-- inter-firm co-operative R&D;

-- integrative planning directed towards the (step-by-step) implementation of a Flex-CIM solution;

-- development of training facilities within the firm and training of the employees; and

-- involvement of employees during the entire process of design and implementation of the Flex-CIM solution.

The programme covers -- in conjunction with other R&D and investment promotion schemes -- all the steps involved in the project, from R&D to investment in a full-scale Flex-CIM installation.

4.4 Organisational layout

To describe the organisational layout of the Flex-CIM programme, it is necessary to sketch the overall organisation of the Innovation and Technology Fund (ITF), which is in charge of carrying out the programme. As the following chart indicates, the board of trustees of the ITF is chaired by the Federal Chancellor, proving the high strategic relevance of the ITF, which was created in 1988 with the exclusive aim of implementing targeted technology programmes in high-priority areas.

The ITF itself can be considered as a *virtual fund*, insofar as it is administrated both by the well-established *Austrian Industrial Research Fund (FFF)* and the *ERP-Fund*.[2] This allows firms to apply either to the FFF or to the ERP-Fund, where a weekly co-ordination meeting assigns submitted projects either to the FFF (in case of projects with an emphasis on R&D) or to the ERP-Fund (in case of projects which are directed to implementation plans or implementation projects). The staff of the respective bodies then provide the necessary background information to the ITF committee for decision; however, the Federal Ministers have the final vote with respect to the decision about the proposals.

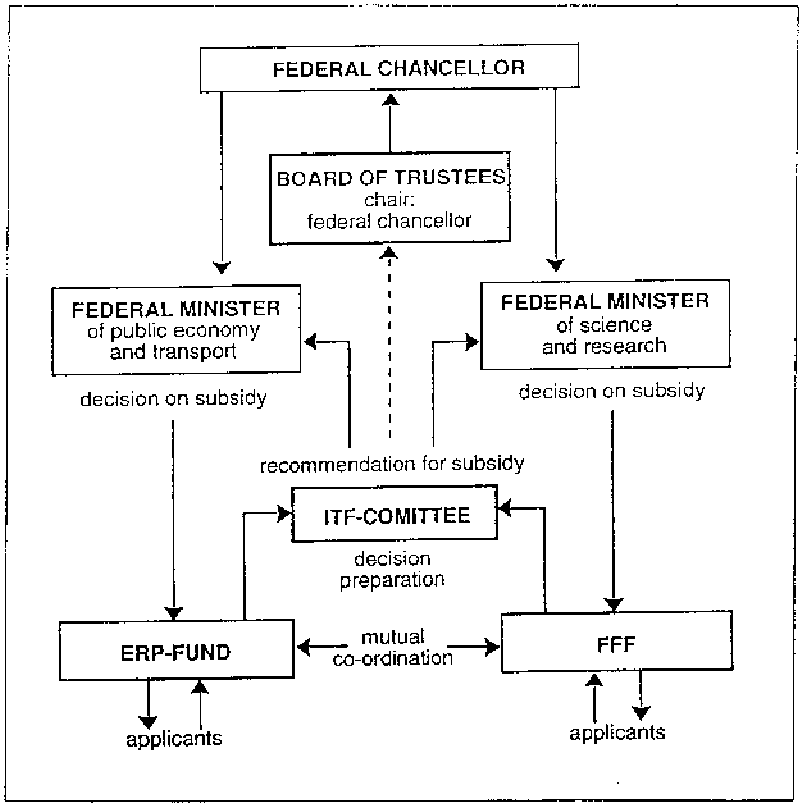
4.5 Duration of the Flex-CIM programme

The programme started in September 1991 with a two-year pilot phase. The primary stage is planned for another three years, making the duration of the programme five years (1991-96).

4.6 Funding level -- target group

Although there is no official declaration of the funding level, internal estimations project Sch 780 million as an overall endowment. This makes the Flex-CIM programme the largest targeted technology programme ever launched in Austria.

Figure 1: **Organisation chart of the Innovation and Technology Fund (ITF)**



With respect to the target group, the Flex-CIM programme is explicitely directed towards SMEs. In particular there are three groups of clients:

-- *SMEs* from the manufacturing sector and related services;

-- *large enterprises* only in the case of outstanding projects (very high degree of innovativeness, inclusion of training, technology transfer and obligation to be used as demonstrator plants);

-- *consortia* of firms, research centers and/or universities with the aim to establish centers for R&D, transfer, training, and demonstration.

The funding level is generally limited to a maximum of 50 per cent of all expenditures. In the case of design of implementation plans, the maximum funding level is Sch 2.5 million. It is worthwhile emphasising that a further restriction of the programme is imposed on manufacturing and related services but that, within these projects, the integration of business issues with technical issues is desired.

5. Experience gained from the pilot stage of the Flex-CIM programme

Programme evaluation is an essential component of advanced policy formulation. This is the case of the Flex-CIM programme, not only in the programme preparation stage but also after its pilot trial. An overview of the most important experiences from the first one and a half years since the implementation of the programme follows.

5.1 Information dissemination

The Flex-CIM programme was widely and intensively promoted. Regional innovation centers and the regional Economic Promotion Institutes of the Austrian Chamber of Commerce operated as platforms for information seminars and performances in each province. In addition, advertisements were placed in newspapers and professional journals.

The two measures had different effects. While the seminars had a strong resonance, especially among participants from industry, the advertisements were less effective and, with regard to the target group, attracted more consultants than industry participants. It is worthwhile noting that a considerable part of the success of the seminars was due to informal contacts between experts from the funds and experts from industry.

5.2 Project evaluation

According to the strategic orientation of the Flex-CIM programme to improvement of the competitive position of the individual firm, extended sets of criteria had to be developed --- except for conventional R&D for specific hardware and software components (see service-type 1 in Section 4.3). For service-types 2 and 3, the following criteria for project evaluation were developed:

Projects for the design of implementation plans (type 2 projects):

- -- quality of the business plan motivating the implementation of Flex-CIM;
- -- prior application of and experience with IT within the company;
- -- intended level of integration within the company;
- -- intended level of flexibility;
- -- intended degree of product improvement;
- -- involvement of employees in the project team;
- -- quality of the planned training.

Implementation projects (type 3 projects)

- -- quality of the business plan which motivates the implementation of Flex-CIM;
- -- novelty and risk of the investment;
- -- intended/expected increase of the technological level of the company;
- -- intended increase of flexibility;
- -- intended degree of product improvement;
- -- intended degree of integration among different areas (at least two components should be integrated, preferably between the business/administrative and technical areas);
- -- economic prospects;
- -- involvement and training of employees.

Prior to the implementation of the Flex-CIM programme, a manual for project evaluation was elaborated (Czerny/Hammer, 1992). However, it was impossible to realise the full potential of the methods suggested in the manual due to their complexity and the data requirements.

5.3 Patterns of participation

Up to May 1993, 120 projects had applied for subsidy. Of these, around 20 per cent are predominantly R&D projects and, as such, covered by the conventional project evaluation scheme of the FFF. Although there was no question of a specific need for subsidising projects proposed by suppliers of CIM-components, the focus of the Flex-CIM programme remained at the user-end. Hence, we will deal in the rest of this paper with the 80 per cent of applied user projects.

In the beginning of the Flex-CIM programme, there was a high degree of uncertainty as to whether service-type 2 ("design of implementation plans") would be adopted by firms. In retrospect, this service was highly successful during the first one and a half years of programme duration. More than 35 per cent of project applications (42 projects) were of service-type 2. The remaining 54 projects (45 per cent) were mainly concerned with Flex-CIM implementations (service-type 3).

The programme started relatively slowly in the first months after its official launch. This slow start was caused by time lags between first contact with the programme and project application. We can observe time lags of several months, decreasing with increasing firm size.

Table 2. **Applications for Flex-CIM subsidies**
Autumn 1991 -- Spring 1993 (est.)

Service type	Projects	Share (%)	Average project volume (million Sch)	Total project volume (millon Sch)	Average study share (%)
Service-type 1 (components)	20	20	n.a.	130	n.a.
Service-type 2 (implementation plans)	42	35	2.5	106	35
Service-type 3 (implementation)	54	45	6.9	372	34
Total	116	100		608	

Source: ERP (1993) and FFF (1993).

The *rejection rate* in the Flex-CIM programme is almost zero. This is not caused by low entry barriers, but by extensive preparatory consultation by ITF staff prior to project application.

It is interesting to examine the *distribution of the projects among different size classes*. As Table 3 reveals, there is a strong peak in the size class (100 - 499) employees. According to the "intensity of subsidy", we observe much stronger activity among firms within the classes (50 - 99) and (100 - 499) employees, compared to smaller firms. However, a caveat has to be made as large enterprises have to overcome specific entry barriers to enter the programme.

Table 3. **Applications for Flex-CIM subsidies (service-types 2 and 3) in different size classes**
Autumn 1991 -- Spring 1993 (est.)

Size class	Projects	Total project volumes (million Sch)	Intensity of subsidy[1]
<19	3	8.42	0.45
20 - 49	5	34.51	0.93
50 - 99	9	82.3	1.67
100 - 499	20	266.65	1.51
500 - 1 000	6	80.51	1.02
> 1 000	1	6.8	0.06

1. Intensity of subsidy in size class i) = (total project volume in size class i) / total project volume) / (employees in size class i) / total employees).

Source: ERP (1993) and OSTAT (1991, p. 10)

Looking at the *project size according to the different size classes*, we observe an increase in the absolute project volumes with firm size, except for large firms.

Table 4. **Average project volume (service-types 2 and 3) in different size-classes**
Autumn 1991 -- Spring 1993 (est.)

Size class	Average project volume (million Sch)
<19	1.73
20 - 49	4.26
50 - 99	5.65
100 - 499	8.23
500 - 999	8.28
> 1 000	4.19

Source: ERP (1993).

Regarding the sources of project costs, Table 5 provides some information for both service-type 2 (design for implementation plans) and service-type 3 (implementation projects) .

Table 5. **Cost distribution in type 2 and type 3 projects**

Cost type	Project type 2: design for implementation plans (%)	Project type 3: implementation (%)
Personal (internal)	55	32
Personal (external)	9	4
Training	7	4
Consulting	18	3
Software	3	17
Hardware	2	36
Others	6	4

Source: ERP (1993).

Finally, Table 6 presents the distribution of the projects according to industrial branch.

Table 6. **Distribution of type 2 and type 3 projects among industrial branches**

Branch	Project volumes (million Sch)	Project volume share (%)
Chemicals	39	10.5
Services	32.7	8.8
Wood processing	22.4	6
Pulp & paper	1	0.3
Leather	2.9	0.8
Food	0	0
Machinery & construction	36.7	9.9
Motor vehicles	55.8	15
Metalworking	62.3	16.7
Electrical & electronic production	41.9	11.3
Printing	2.15	0.6
Textiles	73.3	19.7
Clothing	0	0
Construction	1.8	0.5

Source: ERP (1993).

6. Summary

The Flex-CIM programme is the largest targeted technology programme ever launched in Austria. During its pilot trial it has been adopted by Austrian firms at an unprecedented rate, and it is in a good position to become a well-performing programme in terms of project applications. Two further aspects make it a candidate for a successful programme: first, its orientation towards CIM users; and second, its orientation towards strategic, organisational, and social issues rather than technical issues, which avoids the danger of supporting outstanding technological solutions with minor economic effects.

Notes

1. Flex-CIM = Flexible Computer-Integrated Manufacturing.

2. ERP = European Recovery Programme.

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CANADA

ISTC PROGAMME EVALUATION STUDY:
ADVANCED MANUFACTURING TECHNOLOGY APPLICATION PROGRAM (AMTAP)

Table of contents

1. Introduction

This report presents the results of an evaluation study of the Advanced Manufacturing Technology Application Program (AMTAP), which was carried out by the Corporate Planning and Evaluation Directorate of Industry, Science and Technology Canada (ISTC) at the request of the Departmental Audit and Evaluation Committee. The study was conducted in the period between September 1991 and June 1992, with a view to providing input for a senior management decision on whether or not to renew the programme.

AMTAP was introduced in December 1988 to stimulate the more effective use of advanced manufacturing technology by Canadian industry. The programme's initial grants and contributions budget was established at C$ 8.5 million, to be spent over a period of four fiscal years. An additional C$1 million in operation and maintenance funding was authorised for purposes such as staff training and programme promotion and management.

AMTAP provides financial assistance to help small and medium-sized companies hire outside expertise to investigate the commercial and technical feasibility of upgrading their manufacturing processes through the application of modern technology.

Demand under the programme developed quickly and substantially exceeded original expectations. In response, the Department allowed the pace of implementation to accelerate, with the result that the funds intended to support the programme for four years were essentially exhausted at the end of three. In order to conserve funds, programme management in the 1991-92 fiscal year reduced the rate of financial assistance from the previous 75 per cent to 60 per cent of project costs, and the maximum assistance limit from C$ 25 000 to C$ 15 000 per company.

2. Methodology

Management of the study

A structure of committees was established to oversee the study, guide the evaluators and ensure thoroughness and impartiality. The first of these was a *Steering Committee*, composed of senior managers and subject-matter experts, which provided overall direction to the evaluation team. This committee reviewed and approved the terms of reference for the study, the proposed methodology and the key issues to be addressed. The group also reviewed findings, conclusions and recommendations.

The second group was an *Advisory Committee* made up of technical advisers assembled to guide evaluators in a number of specific areas, including validation of the logic model, techniques to improve the evaluation, and the identification of other similar programs in other jurisdictions. In addition to senior departmental staff from both headquarters and the regions, the technical advisors included a consultant and professor from the Research Centre for Management of Advanced Technology of Wilfrid Laurier University.

In addition to these largely internal groups, an *Expert Panel* composed of specialists in manufacturing was established to review and comment on the findings and conclusions emerging from the study. The panel consisted of five members, all with a background in manufacturing and expertise in the specialty areas of the AMTAP projects. Members included an expert from government, an academic working in the area of manufacturing management and three manufacturing practitioners from the private sector.

Fact-finding methods

Case studies

Case studies of five AMTAP projects were used to support findings of the interview phase of the evaluation. The case studies involved on-site discussions with ISTC AMTAP officers, in-person interviews with company officials and consultants who participated in the programme, and a thorough review of the AMTAP project files.

AMTAP documents/literature/database review

A review of AMTAP project files and information from management systems was carried out, as was a thorough review of relevant literature and statistics (OECD, ISTC, CMA, industry associations). All existing literature on AMTAP -- including promotional material, the Policy and Procedures Manual and the officers' training programme -- was also reviewed.

Survey of AMTAP participants

An on-site survey of 20 firms participating in AMTAP projects was conducted in New Brunswick, Quebec, Ontario and Alberta. This survey was based on a structured random sampling.

Survey of consultants used in AMTAP studies

Consultants who have been through the cycle of qualifying with ISTC to work on AMTAP projects, and who have later done AMTAP consultancy and follow-up activities represent a special reservoir of information. To tap this base, eight interviews were held with individual and corporate consultants. Some of these interviews were conducted on a group basis, with as many as five individual consultants present.

Survey of non-participating companies

The study included on-site interviews with five firms that did not receive AMTAP assistance . This provided the evaluators with additional information on the issue of AMTAP's effectiveness. This is essentially a quasi-experimental design, whereby the evaluator attempts to define a "control group" which is similar in every way to the "programme group", except that the former has not participated in the programme.

Survey of government officials

Personal interviews were conducted with nine officials from ISTC, two from the National Research Council and one from the Atlantic Canada Opportunities Agency. These interviews provided a first-hand assessment of the operational links in programme delivery and the organisational structure of AMTAP.

3. Findings and conclusions

Programme rationale

ISSUE: Do the circumstances that existed at the time AMTAP was created still exist?

Key finding:

AMTAP is supportive of major departmental goals and is addressing real problems faced by small and medium-sized enterprises (SMEs).

AMTAP was created in 1988 as a part of ISTC's comprehensive Industry and Technology Program which had the overall objective, as defined in the 1989-90 Main Estimates, of promoting "international competitiveness and excellence in industry and technology in all parts of Canada". This objective has remained essentially unchanged in the intervening years.

AMTAP was expected to contribute to this goal by supporting diagnostic studies designed to help small and medium-sized manufacturing companies across the country upgrade their operations through the application of improved technology and business practices, thus making participating firms more aware of, and responsive to, the requirements which must be met to achieve international competitiveness.

This role has lost none of its relevance in the period since 1988. In fact, business respondents to the evaluation study suggested that its importance had increased during the difficult economic conditions of the past year or two.

Key finding:

The programme is responding to real needs within the manufacturing community. Respondents identified quality of the finished product as the most important priority being addressed by AMTAP, followed by training, technology awareness and labour productivity.

Despite the recent difficult economic times, the demand for AMTAP has by far exceeded initial management expectations with the result that the initial C$ 8.5 million budget will be spent in three years rather than the planned four. This demand is, in itself, a clear indication of a perceived need for the programme by the private sector.

The evaluation study endeavoured to establish the credibility of the programme relative to private sector expectations. Through a structured questionnaire, interviewees were asked to assign priorities to the different elements identified in the current AMTAP programme design.

The impact of AMTAP is not limited to the technological elements of manufacturing. Recommendations are also made with respect to the adoption of improved management practices and state-of-the-art technologies. In that sense, AMTAP has offered services for which demand is high.

Table 1 below displays the views of private sector respondents on the relative importance to the company of the ten elements below. As will be seen, the major emphasis is placed on product quality.

Table 1. **Respondents' ratings of importance of AMTAP elements (%)**

	Highest priority	Medium-high priority	Medium priority	Medium-low priority	Lowest priority
1. Product quality	75	5	20	--	--
2. Training	40	40	20	--	--
3. Internal communications	--	15	55	15	15
4. Awareness of technology	42	37	16	5	--
5. Company mission	21	16	21	6	26
6. Capital productivity	20	35	40	5	--
7. Labour productivity	20	35	40	5	--
8. Cost controls	25	40	25	--	5
9. Profitability	16	37	31	5	11
10. Marketing/exports	20	30	25	25	--

A number of consultants who have conducted AMTAP studies also agreed that, in its present form, AMTAP is responsive to the needs of SMEs even "beyond what could be expected of a government-run programme". The fact that AMTAP projects are approved, delivered and monitored locally contributes to the positive image of the programme and its acceptance by the target clientele.

Government officials were unanimous in their positive feedback to the question: "Do you think AMTAP is still as relevant as when it was created in 1988?" Answers ranged from an enthusiastic "yes" to "more than ever and growing".

At approximately the same time as the evaluation study, the ISTC Services Working Group had a survey conducted by Young and Wiltshire (Y&W)[1] Management Consultants in which more than 500 clients of seven new ISTC services were approached, including 73 AMTAP clients.

Responses to this review support the findings of the evaluation study on the appropriateness of AMTAP design. Company officials expressed a high degree of satisfaction on several programme design features such as the quality of the consultant, the relevance of the information received and ease of access to the programme.

ISSUE: Should the programme provide funding for the implementation stage?

Key finding:

The business community feels that the programme should be extended to provide assistance in the implementation of study recommendations. Many respondents also commented on the need for AMTAP to offer financial assistance comparable to that available under other programmes.

The AMTAP studies have proven to generate a requirement for additional spending on implementation. A C$ 15 000 front-end investment by the federal government typically results in a requirement for expenditures of C$ 100 000 or more for the implementation of the study recommendations.

The comment most frequently received by the evaluators, therefore, was that AMTAP needs an implementation assistance phase. Participants, consultants and government officials all felt strongly that the absence of such assistance represented a real problem. They could see little point in identifying company solutions for problems unless they are likely to be implemented.

This issue was addressed in the Treasury Board submission for a programme extension and the revised programme will include an implementation as well as a study element.

Experts consulted during the study also suggested that assistance available under the programme must be kept above a minimum threshold (*e.g.* C$ 20 000) if AMTAP is to retain an appropriate "incentive effect".

In an effort to make programme funds extend as far as possible, programme management last year reduced the maximum amounts available to companies from C$ 25 000 to C$ 15 000. Although a number of study respondents criticised this action (on the basis that the lower amount of assistance may be less than the critical mass required for incentive purposes), it enabled the programme to reach a larger number of clients.

Aside from suggestions for enrichment, the private sector respondents saw no particular weaknesses in the programme, an impression supported by the findings of the Young and Wiltshire study of departmental services referenced above. Under this latter study, 40 per cent of the AMTAP clients interviewed could think of no suggestions for programme improvement. Where improvements were suggested, they represented, in effect, backhanded compliments to the programme -- *i.e.* make it available to more companies and increase the level of funding.

ISSUE: Does ISTC have the ability to deliver a service-oriented programme?

Key finding:

While ISTC, on the basis of the AMTAP experience, has proved itself fully capable of delivering a service-oriented programme, the effectiveness of its efforts can vary substantially according to the extent of direct and continuing involvement by departmental officers.

The ISTC experience with AMTAP confirms the department’s capability to deliver a service-oriented programme, provided the resources required to do so are available. There are benefits to be gained from this, not only for the client company, but also for ISTC.

The degree of officer involvement in AMTAP projects varies considerably from office to office and even from project to project within a regional office. Although good project results are possible without the involvement of an ISTC officer, it was recognised that the presence of an ISTC officer at key stages of an AMTAP project can be useful to help ensure a good company-consultant match and that the project meets the needs of the ISTC client. There are cases where greater ISTC officer involvement could have been useful in helping to avoid vague reports, lengthy ones of which only a small portion was useful or recommendations which clearly exceeded the financial capability of the firm.

The following types of officer involvement, either by phone or in person, could contribute to a high quality of client service, a higher probability of project success, an increase in the officer’s level of expertise and greater ISTC credibility:

-- contacting the company before the AMTAP study;
-- advising on the consultant selection process and the project terms of reference;
-- ensuring that the AMTAP work statement meets the company's needs and corresponds to the objectives of the programme;
-- participating in the review of the consultant's report;
-- identifying possible sources of assistance for the company in the AMTAP implementation process;
-- completing the ISTC AMTAP follow-up report.

ISSUE: Are the eligibility criteria for an AMTAP study such that consistency is possible across the country?

Key finding:

The regional offices have some freedom in interpreting the criteria and this has led to minor inconsistencies. Overall, however, the programme is being applied consistently across the country.

In the process of interviewing participants and AMTAP delivery officers, it became apparent that regional offices were interpreting the AMTAP Terms and Conditions somewhat differently. This was particularly true in relation to the term "marketing" which varies from region to region. The potential result of this is that projects which could qualify in one region might not in another. As matters now stand, marketing is not itself an eligible activity, but could be covered under Corporate Strategy, which is eligible. On the whole, however, the study revealed no significant problems with respect to the interpretation of programme criteria.

ISSUE: Should AMTAP concentrate on specific industries?

Key finding:

An increased level of sectoral "targeting" appears necessary if the programme is to maximise its "value for money" results.

In its initial years, AMTAP operated on a first-come, first-served basis since this was deemed to be the most appropriate approach for a new programme involving untested demand.

Since experience has now established that the level of demand exceeds the level of funding available, many of the government officials interviewed during the evaluation argued for more precise targeting of existing resources to key industrial sectors. Seven of nine officials interviewed, however, thought the determination of priority sectors should be done on a regional rather than a national basis in order to take account of differing provincial circumstances.

In some regions, for example, there are relatively few industrial sectors (*e.g.* New Brunswick where fishing and forestry dominate). Staff in three of the regional offices interviewed (Alberta, Manitoba, and New Brunswick) explained that they already apply AMTAP selectively, targeting sectors that are of priority to the province and responding only on a reactive basis in relation to sectors of lower priority.

In other words, sector officers are, in many cases, already promoting AMTAP to specific target sectors although they are prepared to consider applications from sectors of lower priority if funds are available and applicants meet the eligibility criteria.

The targeting concept was also endorsed by the panel of experts which felt that support should be concentrated on economic segments that are viable and that fit with some sort of "industrial strategy". They suggested a proactive stance in relation to sectors that have been targeted as potential "winners" in the economy.

While the concept of targeting "winning" firms or sectors has considerable appeal, there are obvious difficulties in characterising certain firms as "winners" since this suggests, by implication, that others are "losers". Interviews with AMTAP consultants in the course of the evaluation, however, suggested that a "winner" in the AMTAP context was likely to be:

-- a firm already making a profit, and with a good track record;
-- a firm headed by risk-taking entrepreneurs committed to improving competitiveness;
-- a firm that already has some core of Advanced Manufacturing Technology knowledge and equipment on which to build.

ISSUE: Is there overlap or redundancy with other programmes within ISTC and other government departments?

Key finding:

While there is some potential for overlap with other federal and provincial programmes, analysis indicates that AMTAP is sufficiently different in terms of scope, timing and geographic coverage to minimise the danger of duplication in public spending.

The scope of the present study did not permit the evaluation team to explore this issue at length. There is, however, evidence of some degree of overlapping among programmes, particularly in relation to short-term provincial offensives against economic hardship. Some federal officials suggest this has occurred partly because other levels of government have copied what they regard as an excellent programme.

AMTAP, however, is the only programme to offer a standard of service across all provinces and to have operated consistently over an extended period. It has also proved itself more responsive, with shorter turn-around times, than other comparable assistance programmes. Most other provincial and federal programmes appear, in fact, to be complementary to AMTAP and can be operated in co-operation with it.

ISTC has, within its own programmes, considerable potential for overlap with AMTAP. The Manufacturing Assessment Service, for example, is an AMTAP look-alike designed to help smaller companies, and Sector Campaigns offer the facility to support diagnostic studies of the kind that are at the heart of AMTAP. This approach is already being used in the Automotive Components Initiative (ACI), which is essentially a more generous AMTAP directed to a specific industrial sub-sector. The ISTC Advanced Industrial Materials (AIM) audits focus more narrowly on industrial materials.

This part of the study also identified a specific need for ISTC officers delivering AMTAP to be fully familiar with, and able to identify to, their clients' alternative sources of financial assistance. The representatives of small and medium-sized enterprises (SMEs) remarked repeatedly throughout the study on their difficulty in understanding the many government programmes available.

SUMMARY OF CONSIDERATIONS ON PROGRAMME RATIONALE

The programme is meeting real needs in the manufacturing community and continues to be relevant to the current ISTC objectives and mission statement. Demand has been so strong that the department exhausted the total available budget in three years rather than the four originally planned.

Other points:

-- although there is some potential for overlap with other ISTC programmes, and with similar programmes in other jurisdictions, AMTAP is different enough in scope, timing, and geographic coverage to minimise the risk;

-- a strength of AMTAP is its ability to provide a quick turn-around to applicants;

-- although the programme has been delivered efficiently, its effectiveness could be improved by the increased participation of ISTC officers;

-- there has been some criticism from the private sector respondents of the programme decision to reduce maximum assistance levels; this criticism is based on the perception that the lower assistance levels may be less than the critical mass required to induce company participation in the programme;

-- private sector interviewees suggested that marketing, as an inherent part of the manufacturing process, should be addressed by a separate element of the programme;

-- the nature and limits of AMTAP assistance should be made clear to applicants at their first meeting with ISTC officials;

-- better targeting would maximise AMTAP relevance and the initial "first-come, first-served" approach should be re-examined with that objective in mind.

Programme objectives and impacts

ISSUES: Is there greater awareness of advanced manufacturing technologies?

To what extent has AMTAP contributed to a better understanding of modern management practices?

Has the programme resulted in greater use of advanced manufacturing technology by participating companies?

Key finding:

The means of achieving programme objectives have evolved over time in response to SME needs. The focus of the programme is not solely on the application of advanced technology, as its name might suggest, but also on the implementation of sound modern management practices. The programme has successfully increased awareness of competitiveness issues at the individual firm level.

The AMTAP objective remains to enhance the international competitiveness and growth of manufacturing and secondary processing industries in Canada. Advanced manufacturing technology is a means to this end. AMT can include hardware, software, and techniques, methods or practices which improve the manufacturing process and products; manufacturing management practices such as JIT, SPC, and quality circles, and various automated technologies like CAD, CAM, robotics and CIM. The firms surveyed agreed that AMTAP has contributed, in varying degrees, to a greater awareness of the need for continuous improvement.

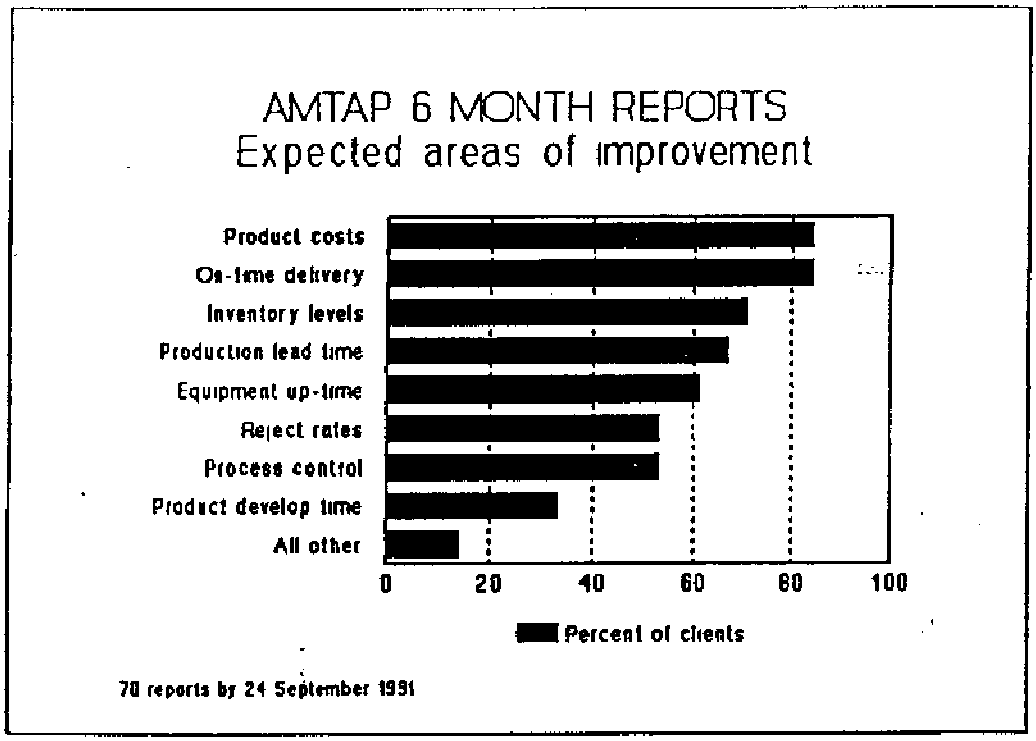
It was generally agreed that completion of the AMTAP diagnostic, even if not followed by actual implementation, served to make the firm's executives aware of the importance of improving competitiveness through better quality of products, improved cost controls (in particular of labour costs through better training packages) and eventually of upgraded technology. The AMTAP results cannot be measured only in terms of the *implementation* of new technology, particularly over the short term.

This is a dilemma of the current nomenclature. The phrase "Advanced Manufacturing Technology" in the title has the effect of placing the emphasis on the means (technology) rather than on the end (competitiveness). In practice, the application of AMT is only one of many options that a company must consider in seeking to improve its competitive performance.

For example, none of the participants interviewed in the study considered the *awareness of technology* to be a major initial area for AMTAP focus. The search for quality was seen to be the most important of the ten programme elements that could be pursued by AMTAP consultants when they go into a firm to carry out a diagnostic. Quality, and the improvement of skilled labour, were the chief concerns, followed by *greater awareness of technology*. These results are highlighted in Table 1.

An internal report titled "Synthesis of AMTAP Six Month Status Reports", released in November 1991 by the national AMTAP co-ordinators, concludes that "an AMTAP project causes many of our clients ... *to think strategically about* their business". Figure 1 below shows product cost reduction and improved delivery times as being the most important of the benefits that clients expected to realise from the programme.

Figure 1. **Areas where participants expect improvements**



The introduction of "advanced" technology was not seen as essential by either by the private companies or public sector officials interviewed. Rather, the term "appropriate" technology was found to be more relevant to the history of AMTAP projects to date. Table 2 below indicates other benefits that clients see themselves obtaining from the programme.

Respondents reported at least three cases where an expenditure of more than C$ 500 000 on equipment and layout changes was directly attributable to the programme. The evaluators were not, however, in a position to ascertain how much "advanced" technology had actually been installed as a direct result of the programme. It was, however, clear that attitudes towards modernisation were modified positively in every case sampled in the study.

Table 2. **Other benefits derived from AMTAP**

	Projects
TANGIBLE BENEFITS	
Additional sales or new markets (11 per cent)	
Company found new markets through AMTAP	2
Probably gained major customers\markets through programme	2
Sales up 40 per cent, customers happier	1
Sales up 15 per cent, unsolicited business arriving	1
Sales increase $ 2 million, further C$ 2-3 million expected	1
Able to support doubled sales (over two years)	1
Efficiency or quality improvements (15 per cent)	
Numerous small improvements adopted right away	3
Reduced RM inventory/plant floor space needs	2
Improved control of processes and/or inventory	2
Reject rate dropped from 30 per cent to under 2 per cent	1
Identified potential savings over C$ 1 million/year	1
We are finding financial (*i.e.* bottom-line) benefits	1
Increased production capacity in same facility	1
INTANGIBLE BENEFITS	
Useful knowledge gained (30 per cent)	
Allowed unbiased/critical look at ourselves	8
Good or very good general business analysis	5
Made us create business plan: rethink strategy	3
Focused attention on need to be competitive	2
Introduction to novel techniques of manufacture	1
Remained competitive and up-to-date	1
Schedule for cost estimating developed	1
Verified many existing practices	1
Morale boost and Other comments (14 per cent)	
Fostered awareness and bolstered staff enthusiasm	3
Confirmed management's view of need for action	2
Reinforced commitment to quality	1
Promotional, company named in several publications	1
Found out how bad skills training is	1
Implementing TQM with consultant help	1
Found out about other government help	1
No comment (31 per cent)	
No other benefits identified	5
No comment	18
TOTAL (possibly more than one per report)	74

ISSUE: How many applicants have implemented recommendations?

Key finding:

All companies surveyed were committed to implementing, within a year, some or all of AMTAP study recommendations, with the actual timetable often subject to the availability of funds. Experts and programme participants suggested that the implementation of more than half the recommendations would be a commendable goal.

The expert panel and major consulting organisations were asked to comment on the question of what implementation rate would be necessary for the programme to be regarded as successful. Their responses were cautious, but the majority suggested that a 51 per cent figure would be reasonable. Although not all participants would have to reach this percentage within one year, overall achievement of this total would provide some assurance that companies are moving in a given direction.

Table 3 presents the findings obtained through review of a limited sample of 22 AMTAP projects for which both six-month and 12-month follow-up reports were available. This sample may not, however, be representative of the programme as a whole since it includes only a limited number of fairly advanced cases which make up only about 5 per cent of the total programme.

Subject to that reservation, there appears to be a clear progression in the implementation of recommendations by the 22 AMTAP companies. If reflected throughout the programme, these results would convey an extremely positive message about client progress in implementing the recommendations contained in the consultants' reports.

The follow-up reports on which this table is based appear to be a very valuable instrument for the assessment of programme impacts and for monitoring the degree to which companies are implementing consultants' recommendations. Although significant progress was made during the evaluation by programme management in obtaining these reports from the field, this is an area that is still in need of improvement.

There are, however, a number of outstanding questions about implementation which were not addressed by the evaluation study. These include:

-- Which recommendations are implemented?
-- Are the most expensive and cash-intensive recommendations set aside?
-- Under those circumstances, what would the level of success be?
-- Should AMTAP be measured only once the firm is recognised as *world class*, and if so by whom?

Table 3. **Extent of implementation**
(November 1991)
Analysis of matching 6- and 12-month status reports

Extent of implementation	6-month reports	12-month reports
Mostly done	4	11
-- All or almost all recommendations implemented		
-- Implemented two of three main recommendations		
-- Equipment purchased, ready to install	(18%)	(50%)
At mid-point	12	9
-- 50 per cent or just over		
-- Implemented one of three main recommendations		
-- Some done, some under way, some not started		
-- Purchased some equipment recommended	(54%)	(41%)
Some or a little done	5	2
-- Changes begun in all areas		
-- Training employees in JIT		
-- Computer program being written		
-- Selected consultant	(23%)	(9%)
Stalled or very cautious	1	0
-- Set up committee to define objective	(5%)	(0%)
Total reports	22	22
	(100%)	(100%)

ISSUE: What sectors and regions received AMTAP assistance?

Key finding:

There is a broad distribution of AMTAP projects in a wide spectrum of industries and in all regions.

The sectoral distribution of AMTAP projects is displayed in Table 4 below. A wide variety of sectors have participated in the programme. This is a result of targeting of specific industrial sectors only at the regional level, and also reflects the first-come, first-served approach which has largely been followed to date.

The regional AMTAP distribution displayed in Table 5 shows that projects have been conducted in every region in a pattern generally reflecting the distribution of manufacturing SMEs across the country. Each ISTC regional office administers AMTAP in a manner seen to best meet regional needs. The numbers of projects are also influenced by such factors as:

-- the needs expressed by the manufacturing community at the local level;

-- the composition of the industrial fabric which regional authorities wished to target; and

-- the dedication of resources to the programme.

Table 4. **Sectors in which AMTAP projects have occurred**

Industry sectors	Projects
Resource industries	5
Food and beverages	24
Plastics and rubber	14
Textiles and textile products	19
Clothing and footwear	40
Wood, lumber and paper industries	43
Furniture and fixtures	49
Metal fabricating industries	52
Machinery industries	30
Transportation equipment industries	18
Electrical and electronics industries	40
Chemical products industries	14
Other manufacturing industries	36
Construction industries	3
Wholesale trade	8
All other industries[1]	8
Total all AMTAP projects	403

1. May include associations/other sponsors of group projects.
Source: PRISM, 22 October 1991.

Table 5. **Summary of AMTAP approvals**
(as of 29 October 1991)

Province	Number of AMTAP approvals					Totals to 22 October 1991	
	Start to Dec. 1989	Jan. 1990 to June 1990	July 1990 to Dec. 90	Jan. 1991 to June 1991	July 1991 to Oct. 1991	Project numbers to date	Authorised assistance (C$)
Alberta	1	10	6	14	3	34	624 407
British Columbia	9	6	12	2	3	32	644 215
Manitoba mini project[1]	0 1	8	3	3	4	19	381 495
New Brunswick, PEI mini project[1]	2 1	7	10	20	2	42	897 191
Newfoundland	0	1	0	1	1	3	45 202
Nova Scotia	2	2	1	3	0	8	148 572
Ontario and HQ OTT mini projects[1]	30 7	30 3	39	51	26	186	4 131 244
Quebec mini projects[1]	10 9	11 11	12	11	8	72	1 138 131
Saskatchewan	2	3	0	2	0	7	158 500
Totals all Canada mini projects[1]	**56 18**	**78 14**	**83**	**107**	**47**	**403**	**8 168 957**

1. Mini projects refer to a series of quality evaluations of a number of manufacturers who supply one major customer (Sears). The projects were all led or sponsored by Sears and involved only C$ 1 200 programme assistance per project. All 32 were carried out early in the programme. Since then similar requests for assistance have been treated as Group Applications, one project per group.-

Source: PRISM; Tony Colven/ITI.

ISSUE: Should management revise its strategy for allocating AMTAP funds?

Key finding:

According to the expert panel and some of the senior officials interviewed, the first-come, first-served approach to disbursing funds will no longer be effective as funds become more scarce. If a greater number of manufacturers are to be reached, there will have to be a balance between "individual" and "group" AMTAPs.

Interviews with ISTC staff in the course of the evaluation elicited a number of suggestions as to how the current AMTAP objectives could be refined to cover projects directed at different groups in different circumstances. The current breakdown into "individual" and "group" AMTAPs does not facilitate the inclusion of the following types of projects and activities:

-- marketing projects;
-- automation studies;
-- supplier development groups (*e.g.* targeting new standards);
-- Total Quality Management projects;
-- implementation activities;
-- Continued Improvement user group seminars (akin to networking).

This constitutes only a partial list of the suggestions gathered in the course of the study. The examples are by no means exhaustive but they do point to a perceived need to review AMTAP objectives and eligibility criteria.

ISSUE: Is the programme having an incremental impact?

Key finding:

Although the evidence is not conclusive, there are strong indications that the programme is having an incremental effect at the company level.

While the sample of 20 cases was too small to permit firm conclusions, data collected on-site and through document reviews revealed evidence of incrementality and this impression was supported by the views of the expert panel.

A number of respondents, for example, stated that they would definitely not have undertaken an AMTAP-type study without the programme. In other cases, AMTAP was credited either with accelerating a project that otherwise would have been undertaken later, or with broadening the scope of the project.

Asked whether they would have gone ahead with the equivalent of an AMTAP study without government assistance, four of 19 private sector respondents said they would have "guessed their way to improvements"; three said the work would not have been done; seven would have proceeded because the study was "inevitable"; three would have delayed and reduced the scope of the study; two didn't know and, finally, one would have "shopped" for financial assistance from other governments.

The Young and Wiltshire study of seven ISTC services generally supports the impression of AMTAP incrementality, although this incrementality appears to be mostly "partial" in that only some aspect of the study was affected, rather than its existence. Only six of 37 respondents indicated that they would

have done nothing if AMTAP had not been available. The other 31 would have carried out some form of study but were influenced by the programme to broaden the scope of the activity (18 of 37 cases), accelerate the pace at which it was carried out (24 of 37 cases), or advance the timing of the undertaking (17 of 37 cases).

ISSUE: What is the overall impact of the programme?

Key finding:

AMTAP is producing immediate benefits at the company level that should eventually create longer-term economic impacts.

Previous sections highlight some results that can be attributed to AMTAP. These are largely attitudinal changes such as a greater awareness of the need for continuous improvement in the firm, better product quality, improved cost controls, and better staff training. The programme has also led to more strategic thinking about business and more positive attitudes towards modernisation.

While such attitudinal changes are necessarily "soft" in nature, they can nevertheless lead over time to more significant, direct economic impacts such as greater investment in management practices and in technologies that will increase competitiveness. The realisation of these longer-term impacts is dependent on a number of factors, including the general economic conditions facing the firm and its capability to introduce change successfully.

The Young and Wiltshire study of seven ISTC services was based on a generic conceptual model which was developed for the project and dealt with "softer" immediate benefits as well as longer-term economic impacts. The findings of this study generally support the conclusions reached by the evaluation. It concluded that AMTAP is successful in generating immediate impacts such as heightened awareness, decision-making by the firm and actual action by companies in the form of projects.

The Y&W report found that *awareness* was increased in high percentages of cases and referred, *inter alia*, to new opportunities, new technology and business practices. It reported that the programme had an influence on the *decisions* of the company in 62 of the 73 cases surveyed. In half the cases, the company had proceeded with a *project*.

Such projects included the development of new *business agreements* such as supplier, production, R&D or marketing partnerships (15 cases); the introduction of new (10 cases) or improved (34 cases) *business practices* relating primarily to production, quality, administration, technology or marketing; and the acquisition of *technology* (30 cases) mainly in the computer and manufacturing fields. The most frequently cited benefits included increased effectiveness of the firm, cost reduction and process improvements.

SUMMARY OF CONSIDERATIONS ON OBJECTIVES AND IMPACTS

The programme is having a positive influence on competitiveness at the level of the firm but it is still too early to look for broad, overall economic returns from the investment of the first C$ 8.5 million. The general evidence gleaned by the evaluation study supports the widely-accepted positive view of AMTAP.

Other points:

-- the current focus of the programme is on the implementation of modern business practices related to the manufacturing process and not just on the application of advanced technologies; the former are recognised as an essential basis for the latter;

-- the programme has been successful in building awareness of competitiveness issues at the company level;

-- AMTAP assistance has been broadly dispersed both sectorally and geographically across the country;

-- at the time of the evaluation, it was estimated that approximately 30 per cent of study recommendations had been implemented, although this assessment was based on limited data and is lower than the estimates of programme management; experts consulted in the study suggested that a realistic target would be 50 per cent over a reasonable timeframe;

-- the extensive evaluation of AMTAP impacts was difficult because progress reports were not available to the evaluators in large numbers;

-- evidence is not conclusive, but there are strong indications that the programme is having an incremental effect at the company level;

-- a concurrent review of new ISTC services to business confirms the findings of the evaluation on the incrementality of AMTAP and on its immediate impacts at the company level.

Operations and delivery

I*SSUE: Are the budgetary and personnel resources... sufficient to allow the programme to be properly delivered?*

Key finding:

At the time of the evaluation study, there was a significant level of uncertainty surrounding the programme, particularly with respect to the availability of funding at the individual project level. ISTC officers, consultants and business people were all hesitant about the future of AMTAP.

As shown in Table 5, virtually all of the C$ 8.5 million in available AMTAP funding had been committed by the time the study was conducted in late 1991. Field officers and potential AMTAP clients were consequently in a state of uncertainty about the availability of AMTAP funding for the balance of 1991-92 and 1992-93, until the approval of an addition C$ 15 million over a four-year period in March 1992.

With regard to the availability of human resources, departmental officials in the regions expressed no serious concern, indicating that existing staff appears sufficient for effective delivery, even at the higher funding levels projected for future years. This conclusion does not appear, however, to be entirely consistent with study findings on project follow-up.

ISSUE: Are there more efficient ways of delivering the programme?

Key finding:

There appears to be consensus that the programme is being delivered both efficiently and effectively. Turn-around time, in particular, has proven highly satisfactory to clients in the large majority of the cases examined.

The question of turn-around time was perceived by many respondents as critical to AMTAP's popularity. The speed with which a project proposal can be turned into a reality was identified as a one of the programme's most important features.

Faced with two programmes in the Atlantic Region, for example, at least three respondents indicated that although ACOA could provide greater assistance, particularly in the implementation phase, the AMTAP approach was more appealing and corresponded more to company needs. The great majority of respondents from that region described AMTAP delivery as "exemplary".

Participants emphasised that they appreciated the quick service which they regarded as a key feature of the programme. Although other programmes may be more attractive from a financial perspective, AMTAP has been able to remain relevant through difficult economic times, precisely because of its "quick response" nature.

ISSUE: Are the monitoring activities adequate?

Key finding:

Obtaining follow-up reports within a reasonable timeframe was a problem at the time of this study.

Interviews with headquarters' programme staff, regional AMTAP co-ordinators and sector officers identified problems in the area of project follow-up by ISTC officers.

Of 163 six-month reports due at the end of October 1991, only 69 (42 per cent) had actually been submitted. Similarly, 75 twelve-month reports were due and only 27 (36 per cent) were on file. Most regional offices were weak in this area of follow-up. The follow-up procedures do not involve an excessive amount of paperwork, having been purposely designed to be as simple as possible. The follow-up procedure will be further simplified by a reduction in the number of follow-up reports from two to one.

ISSUE: Do AMTAP officers receive adequate training regarding AMT?

Key finding:
There is a widespread consensus in ISTC that the training and preparation of ISTC officers to deliver AMTAP has ranged from good to excellent. The AMTAP experience in this area may prove useful to other ISTC programmes and services.

Programme staff at headquarters feel the training for AMTAP has been an integral part of the programme's success.

The basic AMTAP training programme consists of:

-- a four-day course (now restructured to three days) which has been given by a consultant on contract to ISTC to approximately 120 sector officers and AMTAP co-ordinators across the country;

-- a one-day workshop offered twice a year to AMTAP co-ordinators on "Activity Update and Training Issues".

In addition, there is a half-day workshop on "Manufacturing Assessment Simplified" which was developed by the Ontario regional office and is also used in connection with another departmental service (the Manufacturing Assessment Service -- MAS). This workshop is offered to any ISTC group that requests it and has been delivered in Ontario, Alberta, and Nova Scotia, with representatives from Newfoundland and New Brunswick present at the latter session.

Much of the specific training regarding advanced manufacturing technologies (AMT) took place during the four-day course, which sought to provide an understanding of the management issues and techniques involved in the introduction of AMT. The course covered the basic concepts of manufacturing and showed officers how to analyse manufacturing problems. Included was an overview of the basic concepts of technologies such as CAD, CIM, Group Technology (GT) and the management philosophies and tools of MRP, JIT and SPC.

Another dimension of training is the appointment of a programme Champion in each region to serve as a resource person for the dissemination of programme knowledge and provide a sustained awareness of how AMTAP can be used in specific instances. Both participants and departmental staff expressed satisfaction with this arrangement which was viewed as another important feature leading to the successful delivery of the programme.

ISSUE: Are current procedures for the selection of AMTAP consultants adequate?

Key finding:

The choice of consultants and their role in the AMTAP process are critical to the programme's success.

The choice of a consultant to carry out the AMTAP study is important not only to the client company but also to ISTC, which wishes to ensure that the company receives the best advice possible. This can be facilitated if the selection process is sound and if the qualifications of the chosen consultant are appropriate.

In many instances, AMTAP studies have been carried out by consultants knowledgeable about AMTAP who identified potential programme clients and "sold" them on the idea of an AMTAP project. In other words, it has been more a consultant-driven than a company-driven initiative.

One tool to assist in the selection of consultants is a directory of 106 consultants, listing their experience with specific systems, technologies and industry sectors. The directory was developed by the programme initially to help programme delivery staff respond to company requests for suggestions regarding the consulting firms best suited to their particular circumstances. As experience with AMTAP projects increased, however, ISTC officers' knowledge of consulting firms grew and the list became less useful. The study found that only the Alberta and New Brunswick offices now use the directory which they have updated with the addition of local firms.

Consultants are often seen as promoters of the programme in that they make the initial approach to companies with the idea of an AMTAP project. This creates some potential for conflict of interest and raises the question of whether the consultant doing the promoting is really the most appropriate for the firm in question. More than half of the programme clients interviewed said that AMTAP was brought to their attention by the consultant who conducted their study.

Selection criteria and the approval process should be refined to determine the best method for selecting consultants and to introduce safeguards to the process. There is some merit to the suggestion that two or three proposals from consultants be required for an AMTAP study, an approach already used in Alberta. Such an approach could improve the likelihood of the firm obtaining the most suitable consultant to carry out the AMTAP diagnostic.

ISSUE: "Individual" or "group" AMTAPs?

Key finding:

The availability of both individual and group AMTAP projects gives the department increased flexibility in its dealings with clients.

The study examined the two types of AMTAP projects in some detail but was unable to establish any clear cut superiority of one over the other. The two serve different purposes and both have definite merits as departmental tools in dealing with clients.

There is a clear division on the question in the ranks of ISTC officers. Some, usually in headquarters, noted that the group approach gives smaller firms opportunities to invest smaller amounts and to benefit from larger studies involving their sector. They saw grouping as a useful way to address and resolve issues common to a number of small businesses (*e.g.* a common containerisation problem faced by a number of small fish-processing plants in the Atlantic provinces).

In the regional offices, on the other hand, individual projects are clearly the preferred option. This is because they involve fast turn-arounds, local approval, a short life span, a quick, non-bureaucratic process, and direct ISTC officer contact with the client company.

Although case studies suggest that group projects can have definite advantages in terms of economies of scale and the encouragement of networking among SMEs, these benefits may be largely offset by more cumbersome administrative requirements.

The group project approval process, for example, is more complex because it involves a larger number of parties and concerns. It can also be slower because of a need for headquarters' approval in cases where companies from more than one province are involved or for Ministerial authorisation when the level of assistance exceeds current delegations (C$ 100 000). In addition, the commitment of individual companies may not be as strong as in individual projects and there are limits on the number of organisations that can effectively co-ordinate a group project.

One particular concern expressed about the group projects was that, although they usually involve some type of company diagnostic, this is often not the kind of comprehensive global study employed in individual cases. Respondents were almost unanimous in declaring that AMTAP should focus on global management studies rather than on specific studies of a company's manufacturing processes.

A global diagnostic study not only examines the company's manufacturing process but looks as well at the areas of management, marketing and finance where companies may also experience problems. A small or medium-sized company may not have the in-house skills or knowledge to identify and tackle these problems.

The expert panel agreed that an overview of a company is the best approach to be taken in pursuit of AMTAP's objective of enhancing the competitiveness of manufacturing companies.

The panel felt that an AMTAP study should include an overall analysis of the company, dealing particularly with the four main elements likely to contribute to a company's success: technology; strategy; management; and marketing.

A number of group projects have been approved which did not appear to include this kind of global diagnostic for each firm, largely because the area of interest to the members to the group was already well-defined. The scope of the project was thus very tightly focused and global diagnostics were not essential.

Although the tendency under AMTAP has been to encourage such broad diagnostics in most cases, there does not appear to be any need to insist on them when they are not required to meet the specific purposes of the project. This does not appear to have been a source of abuse or of problems for the programme.

SUMMARY OF CONSIDERATIONS ON OPERATIONS AND DELIVERY

The findings of this study strongly supported continuation of AMTAP, with an increase in funding levels from the programme's early years and with the addition of a new element designed to provide clients with some assistance in the implementation of diagnostic study recommendations. These requirements have already been addressed by the department, which has obtained Treasury Board approval for an extension of AMTAP and for the introduction of an implementation component.

Other points:

-- the study did not focus on the question of appropriate future funding levels, but the total of C$ 15 million planned for the next four years appears reasonable, assuming annual budgets can be evened out and demand under the new implementation component is not too high;

-- the introduction of the implementation element also seems likely to add to the on-going workload of regional officers and require additional O&M resources;

-- follow-up reports were not being filed by some regions; the study identified a requirement for fewer but more thorough reports and this change has already been implemented by programme management;

-- all ISTC officers delivering the programme have had classroom training and also receive an annual one-day refresher course; this has been a key to enabling maximum delegation to regions in delivery of the programme;

-- case studies show that Group AMTAPs have certain advantages in terms of economies of scale and the networking of SMEs but the high time and financial costs involved may well offset these advantages;

-- programme clients and consultants interviewed thought that ISTC was not making the most of opportunities to promote its services;

-- increased ISTC officer involvement in projects could contribute to obtaining a good company-consultant match for each AMTAP project.

References

1. Young and Wiltshire Management Consultants (1992), *A Study of Selected Services*, submitted to Services to Business Branch, June.

THE NETHERLANDS

IT DIFFUSION POLICY ON MICROELECTRONICS

Table of contents

1. Minimum situation report on SMEs

The EIM report on *IT Diffusion in SMEs* gives an overview of the situation of SMEs in the Netherlands, and a brief background to the application of IT technology by SMEs. It concentrates mainly on the application of IT in processes and, to a lesser degree, in products.

This report contains a description of the Incentive Scheme for the Application of Microelectronics which is geared towards SMEs and aims to promote the initial application of microelectronics in products.

2. Background to the programme

Promoting the application of IT by SMEs has been a major aim of government policy for some years. From around the mid-1980s, various programmes have been launched to promote the application of IT. The basic aim of these programmes was (and is) to strengthen the competitive power of Dutch industry on the (inter)national market.

At the beginning of 1990, the Ministry of Economic Affairs published a four-year "Work Plan on Microelectronics in the Netherlands". The work plan consisted of a series of interrelated activities aimed at removing obstacles in the following areas: transfer of know-how, manufacturers and users, education and training, infrastructure and research. Within this policy, a distinction was made between companies which were leading the field in technological development, *i.e.* innovators, and companies which were "followers" of technology. The activities described above were directed at both groups. The total available budget for the work plan was around Gld 55 million over a four-year period. One of the activities was geared towards stimulating the initial application of microelectronics (ME) in products. The MiToe Scheme was developed on this basis.

The work plan incorporated the results of a study by the CIVI Consultancy entitled *Situation Report on Microelectronics in the Netherlands and Analysis of Problems and Difficulties*. Mainly on the basis of qualitative information, the report concluded that the Netherlands was lagging behind its neighbours in the application of microelectronics in products. This lost ground is explained by the industrial structure of the Netherlands, which involves a great deal of small-scale production.

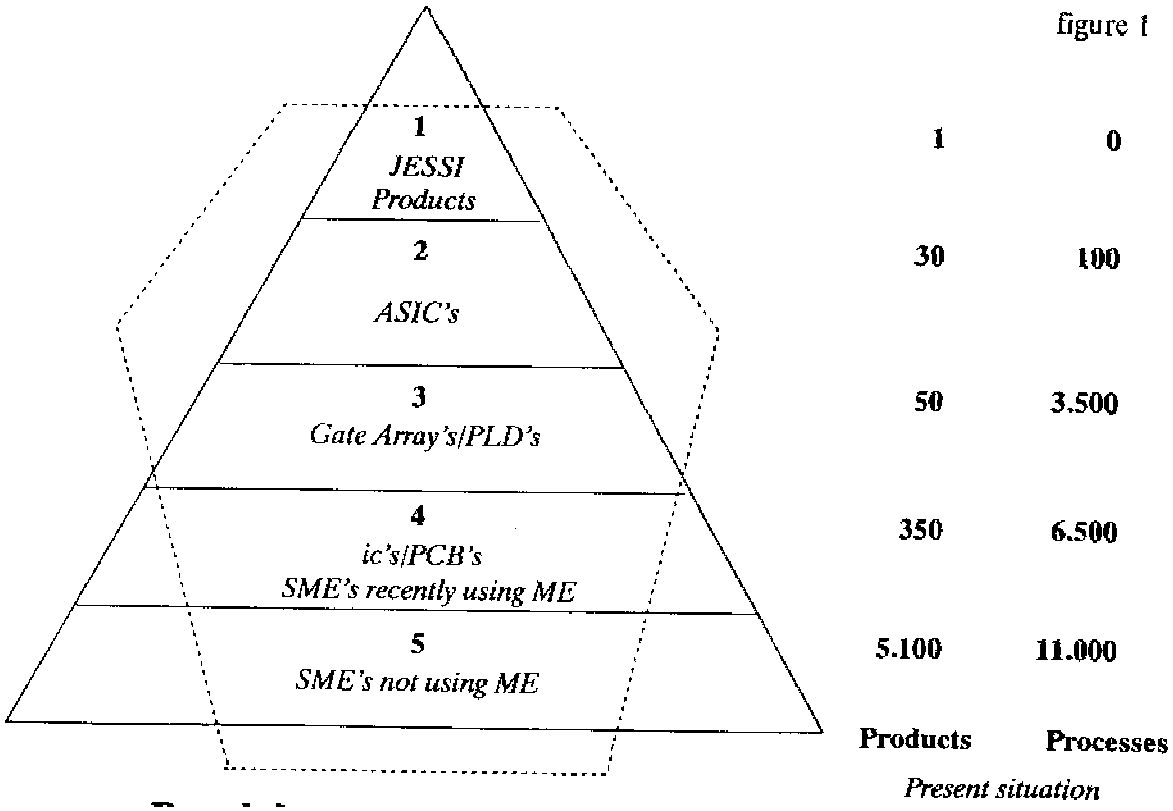
The report concludes that:

-- the potential target group for ME applications in products is around 5 500 companies;
-- the actual degree of penetration of ME in products is estimated at between 8 and 13 per cent, with anticipated peaks achieved in the electronics, instrumentation and machinery branches (15-20 per cent).

The degree of penetration of ME in products for all industrial firms in the United Kingdom, Denmark and Sweden is estimated at 13 per cent. This is significantly higher than the 8-13 per cent cited for the Netherlands.

The work plan contains a pyramid diagram showing a breakdown of the application of ME in products by the 5 500 potential users identified by the CIVI (see Figure 1).

Figure 1. **Breakdown of potention ME users**



Source: CIVI Consultancy.

In Figure 1, the dark line shows the present situation, while the various layers represent the different users. In general, the pyramid is read from bottom to top. Gradually, as more companies begin to apply ME independently and at a more advanced level, the pyramid form will change into a more rhomboid shape. This is indicated by the dotted line. The largest target group consists of initial users integrating ME into applications for sectors other than electro-technology.

The work plan sets out two main aims:

-- to promote the application of ME by Dutch industry. *Target aim*: at least 10 per cent of potential users within the work plan period;

-- to create as broad a basis as possible for the application of the results of research programmes, particularly those carried out in an international context.

Within the work plan, particular emphasis was given to promoting the application of ME in products. Promoting ME in processes was given a lower priority, because the degree of penetration was greater there than for products, and because the stimulation of ME in products has an indirect knock-on effect for processes.

The MiToe Scheme is geared towards the lowest layer of the pyramid. Various other schemes are directed at user groups positioned at higher levels in the pyramid. These schemes include:

i) The PBTS-IT (the Business-Orientated Technology Stimulation) Scheme, with a budget of Gld 17 million a year. Proposals (*i.e.* for demonstration, feasibility and research projects) can be submitted in a number of areas of technology by means of tenders. The areas designated for 1993 are as follows: mecatronics, software engineering, tracing and sequence control and multimedia.

ii) The Demonstration Programme for Innovations in the Netherlands, which is aimed at increasing the knock-on effects of PBTS projects.

iii) The Telematic Guidance Projects, with a budget of Gld 11 million. Projects cover the following areas: multimedia, PDI (Product-Data Interchange) and data security.

3. Programme description

3.1 Name of the scheme

Incentive Scheme for the Application of Microelectronics, known as MiToe (short for microelectronic applications).

3.2 Aim

To promote initial applications of ME in products by Dutch companies.

3.3 Target group

To enable participation by all SMEs established in the Netherlands and wishing to introduce an initial application of ME into their own products. This can include manufacturers, dealers, importers, etc. who develop (or contract out the development of) a product using ME at their own risk and cost.

3.4 Conditions of participation

In order to qualify for inclusion in the scheme, a company must satisfy the following criteria:

-- The company may employ no more than 500 staff. This includes only the number of employees working on the premises concerned, even if the company is part of a larger concern. Company employees outside the Netherlands are also excluded. The company must be an "initial user", *i.e.* it should not already have developed its own products using ME. However, a manufacturer who has already purchased modules containing ME and applied them in his product in the form of a "black box" will still be regarded as an initial user for the purposes of this scheme. A company which has just started trading is by definition an initial user.

-- The product to be developed must be sold by the company at its own risk on the open market (limited series will be permitted). A subsidy will not be granted for products intended for use within the company itself.

-- A subsidy will only be granted for the application of ME in products. No subsidy will be granted for the application of ME in processes. For example, no subsidy will be granted to a bakery wanting to improve its ovens. However a subsidy may be granted to a manufacturer of bakers' ovens.

3.5 Co-ordination of the programme

The scheme is co-ordinated by the TNO Product Centre. TNO is the abbreviation for "'Netherlands Organisation for Applied Scientific Research". The Product Centre carries out contracts on a commercial basis for companies in the area of product development in its widest sense. Its (MiToe) tasks include co-ordination between the various consultants, project management, the conclusion of subsidy agreements with participants, and managing the administration.

3.6 Project phases

MiToe projects are divided into a number of phases. These are as follows:

-- the selection phase;
-- preparatory research;
-- procedural plan;
-- definitive product development.

The basic role of MiToe is to supervise the participants during each of these phases. In other words, they will be monitored in the preparation, definition and implementation of projects designed to develop a new product. The main aim is to ensure a properly structured, phased approach.

Selection phase

During the selection phase, companies are assessed on their basic eligibility to participate in the scheme (less than 500 employees and initial user status) and on whether ME can provide added value for their products.

This phase (the recruitment phase) is almost wholly conducted by consultants from the Centre for Microelectronics (CME), a non-profit organisation which is wholly financed by the Ministry of Economic Affairs. The aim of the CME is to promote the efficient application of electronics by SMEs in their products (not just initial users). The CME encourages the transfer of know-how on a non-profit basis by means of information, advice and project co-ordination and supervision.

Companies are recruited mainly from the following sectors: the electro-technical industry, the instruments and optical industry, the transport industry, the machine industry. These sectors were chosen because they had the greatest potential for the application of ME in products. Obviously, companies from other sectors can also participate.

The MiToe Scheme employs around four full-time consultants who are actively engaged approaching companies. The aim is to approach a minimum of 250 companies each year.

The selection of potential candidates can take place in various different ways:

-- All companies in the Netherlands are registered in a national Companies Register, which also contains details about their products. Registered companies whose products could be given added value by the application of ME are approached.

-- Companies can register for the scheme themselves, since MiToe is widely and intensively publicised, *e.g.* through seminars, direct mailing, stands at exhibitions/fairs and presentations.

-- Companies can be proposed by third parties, *e.g.* design houses.

Most companies, however, are selected on the basis of an active approach.

During the selection phase, a study is carried out, in consultation with the company itself, to explore the possibilities for applying ME in a new product. The application of ME must result in products with a lower price, or else in products with a higher degree of functionality and added value (*i.e.* a product with more functions) for the same or, preferably, a lower price. In other words, the application of ME is not an aim in itself. If opportunities for applying ME are identified, the company is given help in drawing up a preparatory study.

Preparatory study

Following confirmation during the selection phase that the company can see opportunities for developing a product using ME, the next stage is entered. The preparatory study is a feasibility study which puts forward a step-by-step approach to the development of the new product. It should ultimately result in a report containing broad indications as to how ME can be applied in a product, potential obstacles and, if possible, how solutions to these problems can or must be found. Attention should also be given to how to market the final product.

The report produced will form the basis for a decision (by a project team) on how to implement the rest of the project in the form of a procedural plan.

Procedural plan

Following the completion of the preparatory study, the company can enter the next phase: that of the procedural plan. A procedural plan should provide a concrete overview of all the necessary activities, both technical and organisational, which will be required for the design, manufacture and marketing of a product based on ME. This may include developing a test model for more effectively assessing the technical risks.

One of the topics a procedural plan must address is whether the technology chosen is usable (*e.g.* an ASIC or standard components), whether the product can be manufactured within the budget indicated, and whether the desired degree of functionality can be achieved. ME is usually only part of the total problem. In the case of product development, attention must also be paid to materials, design, mechanics, safety, EMC, etc. The procedural plan should cover all these aspects.

Definitive product development

The support for the project provided by MiToe ends with the completion of the procedural plan. The next stage is the actual product development. At this stage, the costs which have yet to be incurred are often many times greater than what has already been spent in the run-up to the project.

The MiToe Scheme is an attractive option for SMEs due to the support it gives to entrepreneurs and its structured approach, which provides a clear insight into the potential risks involved.

3.7 Subsidies

The advice and assistance provided under MiToe is free of charge. During the whole of the run-up to the project, from the first contacts to the completion of the procedural plan, the company is supervised under the scheme. For example, the company is given help in formulating and describing the functional specifications of the new product, in selecting external contractors, and in evaluating tenders of external contractors. MiToe also provides advice to the company during the actual implementation of the project by external contractors. On average, this takes about 10 days.

Preparatory study

Subsidy: 50 per cent of the costs of external contractors, up to a maximum of Gld 10 000.

Procedural plan

Subsidy: 40 per cent of the costs of external contractors, with an additional allowance of 10 per cent. Maximum total of Gld 60 000.

Duration

Total duration of the scheme: four years. MiToe was launched at the beginning of 1991.

Budget

Available budget: Gld 5.5 million for the first two years. Projected allocation of Gld 7 million for the final two years (including co-ordination costs, which will amount to around Gld 500 000 per year).

4. Programme design

The scheme was devised with the help of the OECD publication, *Government Policies and the Diffusion of Microelectronics*. An attempt was made to comply with the report's recommendations that schemes should be simple to implement and transparent, and that SMEs should be assisted in the definition of projects. A study was therefore conducted at the outset of the work plan, and thus also at the outset of the MiToe Scheme. All companies employing more than five staff in the four above-mentioned branches (electro-technical industry, instruments and optical industry, transport industry, machine industry) were

approached. The study examined how many companies applied which ME in products, and to what degree. The questions in the survey were partly based on a list of questions drawn up by the OECD.

The CIVI report indicates a decreasing ability to apply ME in products in these sectors (respectively 90 per cent, 70 per cent, 60 per cent and 40 per cent). The report also points to an actual degree of penetration in products in these four sectors of between 15 and 20 per cent. (For the Netherlands as a whole this figure is between 8 and 13 per cent.)

5. Barriers

The main obstacles in the application of ME in products by SMEs are as follows:

-- SMEs are not used to working on a project-by-project basis;

-- too little attention is given to long(er) term planning. SMEs are often too little aware of future threats and of the importance of product upgrading in general;

-- information about relevant technological developments is generally widely available in the Netherlands but is not always easily accessible for SMEs;

-- the introduction of a new (ME) technology in a company places considerable demands on its personnel, organisation and training.

The active approach to companies by experts from the MiToe Scheme and the involvement of external contractors is designed to make entrepreneurs more aware of the importance of ME and better informed about the technological developments which are relevant to his/her company.

Participants in the MiToe Scheme can also make use of a training subsidy, which is also open to all other entrepreneurs. Attendance on training courses for ME can be subsidised at 50 per cent of the cost of the (external) course, up to a maximum of Gld 15 000 per company. Companies which (intend to) draw up a procedural plan are studied to see whether they can also make use of the training scheme.

6. Evaluation and auditing

The ME work plan has a quantitative aim, namely to push a minimum of 10 per cent of the companies involved into the next "layer" of the pyramid within the programme period. For the MiToe Scheme, this aim is translated into a specific number of projects which must be implemented each year. Targets are formulated each year in terms of numbers: recruitment selections (250), preparatory studies (90) and procedural plans (70). The performance of the MiToe Scheme can be easily measured, since the number of companies approached (recruited) and projects carried out are registered by the programme co-ordinator.

Once the work plan and the MiToe Scheme have been concluded, a new evaluation will be carried out to assess the results.

The MiToe Scheme was reviewed two years after its launch. It was concluded that, following a somewhat slow start, the scheme was now well on target and was expected to meet all its stated objectives over the next two years.

The programme co-ordinator presents a quarterly progress report to the Ministry of Economic Affairs. This report reviews financial expenditure, the number of companies approached and the number of projects (both those being implemented and those still in the pipeline).

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Case study -- MAKOMBI

Makombi MiToe Project

The company

Makombi BV develops and sells premixing and measuring equipment for bakeries. Makombi does not employ a full-time staff, but hires contract workers from an affiliate.

The market

Makombi already markets mechanical premixing and measuring equipment for preparing dough. The water and flour must be added by hand, and the dough temperatures must also be mechanically regulated. The company is now responding to demand for an automated system.

The product

In response to this demand, Makombi has developed a programming unit which can be linked to the premixing and measuring equipment described above, but which can also be used independently of this equipment. It has a calculation unit which can store up to 100 different recipes of any specification. The amounts of flour and water and the dough temperature can be programmed into these recipes. The combination of a calculation unit and the premixing and measuring equipment will make the preparation of dough much easier, as well as ensuring that the end-product is of a guaranteed constant quality.

Product development

The programming unit was developed and produced by Roto Electronics BV in Boxtel. Work began in May 1990 and was completed in December of the same year. Makombi was granted the maximum available MiToe subsidy and also greatly benefited from the advice of the MiToe consultant involved.

The product on the market

The product is doing well on the market; Makombi has already sold and delivered a large number of independent programming units. The sale of the premixing and measuring equipment (in combination with the programming units) has also risen sharply since the introduction of the new system.

Outlook

Together with Roto Electronics -- and with the invaluable assistance of the MiToe Scheme -- Makombi has successfully completed an initial product development. As a result, the company will be able to meet the challenge of any new product developments with greater know-how and confidence.

THE NETHERLANDS

IT DIFFUSION IN THE SMALL AND MEDIUM-SIZED ENTERPRISE SECTOR: QUICK-SCAN INFORMATION TECHNOLOGY DIFFUSION POLICIES FOR SMES

Table of contents

1. Basic information

1.1 Introduction

This section focuses on basic information about the small and medium-sized enterprise sector and discusses the following aspects:

-- definition and characteristics of the SME sector;

-- government programmes aimed at SMEs;

-- the significance of, and developments in, SMEs; and

-- changes in the business environment for SMEs.

1.2 Definition and characteristics of the SME sector

This report will adopt the definition of SMEs used in the Netherlands which defines SMEs as all privately-run companies -- with the exception of those in the agriculture and fisheries sector -- which are run on profit lines and employ less than 100 staff. Companies employing less than 10 workers are defined as small businesses and those employing 10 or more workers are classified as medium-sized enterprises. Private companies employing more than 100 workers are classified as large-scale enterprises.

Despite the heterogenous nature of the sector, SMEs do share a number of common characteristics, such as scale of operations, size of market coverage, a more individual, "hands-on" entrepreneurship, a less complex management structure and direct lines of communication. This is often combined with a low level of specialist knowledge, a traditional style of management and limited financing opportunities.

1.3 Government programmes aimed at SMEs

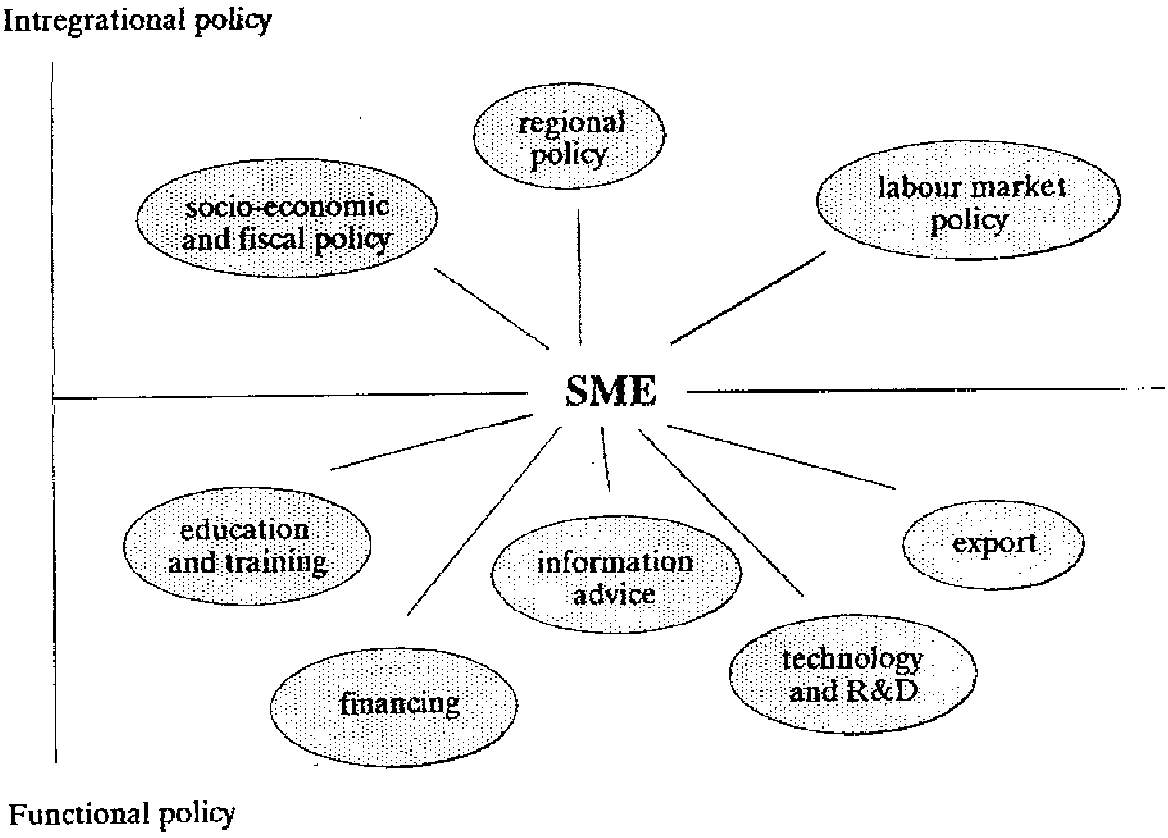
The government does not operate a specific policy targeted at SMEs, but does take account of specific aspects linked to scale in its overall enterprise policy. This policy can be sub-divided into integrational policy and functional policy :

-- integrational policy is aimed at creating a positive enterprise climate;

-- functional policy is designed to offset the specific scale- and business-related weaknesses of enterprises, and to encourage optimum development of their strengths.

Figure 1 indicates which aspects of integrational policy and functional policy are relevant to the SME sector in the context of this study. We shall also be looking at how account is taken of the importance and characteristics of SMEs when dealing with these aspects.

Figure 1. **Aspects of integrational and functional policy relevant to SMEs integrational policy**



Socio-economic and fiscal policy

Although no distinction is made in the government's economic policy between large and small companies, certain exceptions are made in the case of small companies. The major exceptions are as follows:

-- for new start-up companies: extra credit facilities and compensation for start-up losses;

-- for small-scale entrepreneurs: tax breaks for entrepreneurs who have insufficient assets of their own to invest in the business.

Regional policy

Many SMEs are heavily dependent on local and regional demand, while a flourishing SME is also of major importance for regional development. The relationship between an SME and its local and regional

environment is therefore to some extent reciprocal. Regional policy does not involve specific measures for SMEs.

Employment policy

One of the government's main aims is to stimulate employment. SMEs make a major contribution to job creation. Over 50 per cent of total employment in the private sector is accounted for by small and medium-sized enterprises. Measures to stimulate employment (aimed both at large companies and at SMEs) include moderate wage developments and a narrowing of the gap between gross and net salaries.

Education and training

Small companies have more training-related problems than larger companies. They are too small to independently operate a tailored training policy, nor are they able to run their own training facilities. SMEs therefore rely on the external training market and have difficulty in locating and selecting suitable training courses. The government is therefore promoting training opportunities for SMEs in various ways, *e.g.* through subsidies.

Financing

The availability of risk-bearing capital is a major factor in the development of the SME sector. Many SMEs find it either difficult or impossible to borrow money on the capital market. One of the measures in the government's financing policy is therefore to improve access for SMEs to domestic and foreign capital markets. The instruments used for this purpose include the Small and Medium-sized Enterprises Credit Guarantee Scheme (*Borgstellingsregeling MKB*) which enables financial institutions to provide loans to SMEs under state guarantee, and the Private Venture Capital Companies Guarantee Scheme (*Garantieregeling Particuliere Participatiemaatschappijen*), aimed at increasing the flow of risk-bearing capital to SMEs.

Information and advice

Information and advice fulfill a major function in increasing awareness among SMEs of the opportunities provided by IT. A major role is taken by the Innovation Centres, whose task is to increase the diffusion and application of technological know-how by SMEs.

Technology and R&D

The application of new, innovative techniques, the development of knowledge and the transfer and application of know-how are vital for SMEs. The government has therefore created a number of instruments aimed at promoting these developments. The most important of these are as follows:

-- a scheme designed to promote feasibility, research and demonstration projects in the field of IT;

-- a subsidy scheme to encourage branch-orientated IT;

-- stimulation of microelectronics. The Subsidy Scheme for Microelectronic Applications (MiToe) will be discussed in more detail later in this report. The MiToe Scheme is designed to stimulate the initial application of microelectronics in products -- the distribution of knowledge through the aforementioned Innovation Centres and through the Microelectronics Centres. The Microelectronics Centres develop activities aimed at increasing the awareness and application of electronics.

Exports

Exports play a major role in the Dutch economy, which is an open economy with a small domestic market. In general, Dutch SMEs tend not to be internationally-orientated, but nevertheless still account for around one-quarter of Dutch exports. Various broad-based instruments have been developed to promote exports. The most important include the Subsidy Scheme on Export Financing, the Programme for Growth-related Exports and the Programme of Economic Co-operation Projects, aimed at encouraging exports to non-OECD countries.

1.4 Significance of, and developments in, the SME sector

The significance of the SME sector for the Dutch economy can be demonstrated by a number of specific indicators, namely the number of SMEs and their output, employment and sales figures.

Number of companies

On 1 January 1992, there were almost 470 000 privately-run companies in the Netherlands, of which slightly over half were one-man businesses. Almost 40 per cent employed between 1 and 10 workers, while around 8 per cent were medium-sized enterprises. This means that almost 98.5 per cent of all companies in the private sector are SMEs. Table 1 gives an overview of the number of companies in the Netherlands in 1992, divided according to sector and size.

Table 1. *Numbers of private sector companies in the Netherlands*
As of 1 January 1992

Sector	**Small**	**Medium**	**Large**	**Total**
Manufacturing	38 230	9 400	1 530	49 150
Construction	33 590	7 220	420	41 230
Wholesale	59 830	6 750	430	67 010
Retail	85 100	3 380	140	88 620
Hotel and catering	37 600	1 480	70	39 150
Vehicle manufacture and repair	18 900	1 640	100	20 640
Transport	18 820	3 140	420	22 380
Commercial services	78 310	3 920	3 960	86 190
Other services	50 740	1 740	120	52 600
Total	421 120	38 670	7 190	466 980

Source: EIM.

Output

In 1992, the output of SMEs totalled around Gld 150 billion (26 per cent of GNP) and growth in output (*i.e.* the increase in gross value added compared with the cost of production factors) of SMEs was around 1.5 per cent. This growth was smaller than that of the large companies. The sectoral differences were not great, however. The transport sector, the vehicle manufacture and repair sector and the hotel and catering sector underwent the largest growth (between 2.5 per cent and 3 per cent). Manufacturing and the retail trade experienced the smallest growth. A growth in output of 0.75 per cent is expected for SMEs in 1993. This would put SMEs on an equal footing with large enterprises.

Employment

The SME sector accounts for more than half of all employment in the private sector, and has also been responsible for a relatively large proportion (58 per cent) of the growth in employment in recent years. Table 2 shows the distribution of employment among the various sectors in 1991.

Table 2. **Share of employment among companies divided according to sector and size -- 1991**

	Number of staff	SME firms	Large firms	Share in SMEs	Share in large firms
	(in thousands)	%			
Manufacturing	941	41	59	22	34
Construction	347	73	27	15	6
Wholesale	370	73	27	15	6
Retail	453	52	48	13	13
Hotel and catering	127	77	23	6	2
Vehicle manufacture and repair	74	92	8	4	0
Transport	214	62	38	8	5
Commercial services	654	31	69	11	27
Other services	222	51	49	6	7
Private sector	3 042	52	48	100	100
Total for the Netherlands	5 846				

Source: EIM.

Measured in terms of numbers of staff, employment in SMEs grew by a yearly average of 3.6 per cent between 1984 and 1991, compared with 3.1 per cent in the private sector as a whole. In 1992, employment in the SME sector grew by a total of 38 000. SMEs therefore accounted for a major share in the overall increase in employment. In 1993, growth in employment in SMEs is not expected to exceed 19 000.

Sales

The sales of the SME sector account for almost half of the sales of the private sector as a whole. In 1992, the volume of sales among SMEs rose by 1.5 per cent. This was slightly less than that of 1.75 per cent achieved by the large companies. Both among large companies and among SMEs, the growth in sales is expected to slow this year to 0.75 per cent. A slight recovery is expected during 1994, possibly bringing the growth in sales among SMEs to 2 per cent. Table 3 gives a picture of the growth in sales among SMEs in 1992, and of expectations for 1993 and 1994.

Table 3. **Percentage growth in sales among SMEs in 1992 and outlook for 1993 and 1994**

SME sectors	1992	1993[1]	1994[1]
Manufacturing	1	0.75	2. 5
Construction	1.75	-0.25	0.5
Wholesale	1.5	0.5	2.5
Retail	0.5	0.5	0.25
Transport	2.5	1.25	2.75
Other services	2.25	1.25	2
Total SMEs	1.5	0.75	2

1. Forecast.

Source: EIM.

Total sales among SMEs can be divided into the following categories: intermediates, consumer goods and services, capital goods and exports.

Intermediates

These accounted for 40 per cent of sales by SMEs in 1992. The sale of intermediates by SMEs is expected to grow by 0.75 per cent in 1993. Intermediates include raw materials and semi-manufactured goods sold to manufacturing companies, deliveries, sub-contracting and the provision of services to enterprises and government bodies.

Consumer goods and services

In 1992, these accounted for 25 per cent of SME sales. In 1993, sales could rise by 1 per cent. In addition to the growth in private consumption, the competitive strength of SMEs is also vital. SMEs in the trade and services sectors are faced with competition mainly from large-scale companies on the domestic market. For SMEs in the manufacturing industry, most of the competition comes from abroad.

Capital goods

These accounted for almost 19 per cent of SME sales during 1992. In 1993, a fall in sales of 1 per cent is expected. The capital goods market is particularly important for SMEs in the construction

industry, manufacturing industry and the wholesale trade. The development of sales in this area is closely linked to the investment activities of companies and the government, and to developments in the housing construction sector.

Exports

These accounted for 16 per cent of SME sales in 1992. In 1993, a 1.75 per cent growth in exports of goods and services supplied by SMEs is expected. SME exports consist mainly of goods supplied by SMEs in the manufacturing industry and wholesale sector. The sale of services, which accounts for around 10 per cent of SME exports, is mainly supplied by the transport sector and, to a lesser degree, by the commercial services sector and the construction industry.

1.5 Changes in the business environment for SMEs

Changes which occur in the business environment in which SMEs function can affect the position of these companies, *e.g.* changes in labour distribution between large and small companies; increasing demand for just-in-time production and deliveries; increasing costs; internationalisation and increasing demand for vocational qualifications.

Changes in labour distribution between large and small companies

In the industrial sector, SMEs operate mainly as suppliers to large manufacturing enterprises. Large- and small-scale production processes often complement one another, in that large companies concentrate on a series of core activities while contracting out aspects of production to smaller firms. This produces collaborative associations and networks in which the smaller companies must also be able to operate flexibly and at a technologically-advanced level. Two forms of SME co-operation can be identified: vertical co-operation with large companies or large intermediate organisations, and horizontal co-operation with other SMEs.

Just-in-time production and supply

SMEs in the industrial sector are increasingly being forced to deliver high quality, low price products on a just-in-time basis. This places particular demands on the way in which suppliers organise their internal production flow. In the trade and commerce sector, the importance of just-in-time deliveries is also gaining in importance. For example, the stockpiling function of retail outlets is being shifted to higher levels in the distribution chain. These levels are now being required to produce flexible and rapid just-in-time deliveries of ever smaller quantities.

Increasing costs

In 1993, both the sales price and the cost price of goods per unit are expected to rise by 4 per cent. This is expected to affect both the domestic market and the export market. In 1992, the buying in of raw materials and additives was the main factor in the increase of the unit cost price of goods. Moreover, unit labour costs of goods and other operating costs, such as rents, also rose sharply.

Internationalisation

Internationalisation is of limited relevance for Dutch SMEs, most of which concentrate on the domestic market. Around 80 per cent of the goods sold abroad by SMEs are exported to EC member States. Although the export interests of SMEs are still fairly limited in this area, Dutch SMEs nevertheless achieve good results in the EFTA countries and in South-East Asia. This is largely due to the fact that small and medium-sized enterprises are able to operate relatively flexibly and swiftly in response to new opportunities.

Vocational qualifications

The constantly changing nature of markets and the rapid rate at which technological developments succeed one another means that the content of jobs and tasks is also changing increasingly rapidly. Due to the size of the labour market at present, job requirements can be made more demanding, as is already happening in the construction sector.

2. SME-related problems with regard to IT

2.1 Introduction

This section examines:

-- technological innovation in SMEs;

-- the opportunities for applying information technology (IT) to SMEs and SME-related problems;

-- the availability of IT for SMEs;

-- whether IT should be adapted to SMEs, or whether SMEs should be adapted to IT;

-- requirements for the successful application of IT.

2.2 Technological innovation in SMEs

New technologies are being developed increasingly rapidly in a wide variety of areas, while the number of applications and the complexity of these applications is also increasing. The development of new technologies is crossing more and more traditional sectoral and trade barriers, and new areas of knowledge are being created through combinations of two or more fields of technology. Examples of such "hybrid technologies" include mecatronics and telematics.

In terms of innovation processes, a distinction can be made between "inventions" and "innovations". Inventions occur when original research is conducted and new knowledge is generated and applied. In the case of innovations, elements are combined which, in themselves, are not new but which, together, create a new combination of products, markets and existing technology. Within SMEs, technological innovation is usually conducted in the second of these ways. Most inventions occur in large enterprises.

Research and development expenditure as a yardstick for innovation

Spending on research and development (R&D) in the Netherlands has for many years lagged behind that of the leading industrial nations, and has even been decreasing in recent years. Given that as much as half of long-term economic growth is dependent on the application of new technologies, this is a very worrying development. Moreover, the technological basis in the Netherlands is still quite narrow. Around 85 per cent of national industrial R&D at around GLD 6 billion is carried out by around 40 major enterprises, with the SME sector playing only a modest role. In 1989, the share of SMEs in R&D expenditure among Dutch companies was only 2.5 per cent, compared with about 6 per cent in countries such as Germany and France.

Of the SMEs employing between 10 and 100 staff, only 25 per cent conduct R&D activities, as opposed to 70 per cent of larger companies. In the manufacturing industry, these percentages are slightly higher. However, the research activities of SMEs tend to be underestimated. Much R&D in smaller companies is carried out on an informal basis and is not included in official statistics. Twenty-five per cent of the 6 000 or more innovations introduced in the Netherlands in 1989 came from companies employing less than 10 workers, compared with less than 15 per cent from companies employing over 500 workers.

Importance of innovation for SMEs

Most SMEs are followers of technology. The introduction of technological innovations in SMEs -- insofar as there is any -- is generally less structured than in the larger companies. Even so, like other companies, SMEs have a continuous need to innovate. Technological innovation is an increasingly important factor in the competitive struggle. The strength of the SME sector in this respect lies not so much in the research and development of basic technologies, but in less complex innovative applications (such as new combinations of existing techniques/materials or new product-market combinations).

This means that the quality of these businesses and the labour they use must be high. Many SMEs cannot meet these challenges on their own, nor do they have sufficient technological know-how.

2.3 Information technology in the SME sector

Opportunities

A significant proportion of technological innovation takes place in information technology. In both the industrial and the services sector, around one-third of the companies carrying out R&D activities is conducting research and development work in the field of IT. These IT-related R&D activities take place in all sectors of industry, a fact which emphasises the universal nature of information technology. IT applications are used in both products and processes.

Information technology is used in information systems and networks, databases, flexible production automation and logistical systems, etc. Within industry, IT is broadly applied in areas such as process control, numerical control of machinery and CAD/CAM (product design and calculating the materials needed for production). IT applications in products involve the use of microelectronics in consumer electronics, telecommunication equipment and high efficiency boilers, etc.

Information technology offers SMEs a large variety of (new) opportunities to improve their own operational efficiency and (partly as a result of this) to respond efficiently to changes in markets,

distribution channels and production processes. The viability of many companies is highly dependent on an effective application of IT. SMEs use IT mainly in processes and to a lesser degree in products.

Problems

IT applications can aggravate some problems already present within SMEs, such as insufficient capacity (manpower, financial resources), access to information, human resources and insufficient qualifications, organisational problems and access to capital markets. IT applications can also create specific problems for SMEs, such as development and maintenance costs, rapid technological developments and the out-dating of hardware and software.

Access to information

SMEs need to acquire from external sources substantial knowledge and information about IT developments which are relevant to them. The most common sources of information in SMEs are direct business contacts. Fifty per cent of these companies use the services provided by suppliers and buyers. A smaller percentage use the services of accountants, branch organisations and commercial consultancies. A very small number consult computing centres or make use of government information.

Human resources and lack of qualifications

Employees with a relatively low level of training tend to be over-represented in SMEs. There is often resistance to innovation, and the decision about whether to introduce new products or processes is often left to market demand or to expected short-term results. IT applications require a substantial body of know-how on business operations as well as a considerable degree of management skills. A study carried out in 1990 on automation in SMEs revealed that 40 per cent of managers/owners of SMEs thought there was a reasonable enough level of knowledge within the firm to enable automation processes to be carried out efficiently, while as many as 24 per cent believed they had a high level of knowledge. In companies where this was not the case, this was mainly due to (in order of importance): insufficient training; lack of a plan and/or vision with regard to automation; and the fact that external know-how was used.

Organisational problems

Given that many SMEs have insufficient insight into the opportunities provided by IT, some applications which have already been developed remain unused. In implementing IT applications in SMEs, the main difficulties encountered tend to be organisational problems typical to SMEs, such as lack of time and insufficient specialist knowledge. The introduction of new activities such as systems management and other management control tasks requires considerable effort. Hence, for example, in smaller companies automation can lead to a better administration, but there is often insufficient know-how or time available to use new information productively. After all, owners/managers of small companies often carry out a large number of tasks themselves, and therefore have little time to properly address technological innovations.

Access to capital markets

The financing of IT applications is more of a problem for SMEs than for large companies. SMEs have less access to risk-bearing capital and are also sometimes wary about attracting external financing.

Development and maintenance costs

Most SMEs are too small to develop their own IT applications, partly because they lack the necessary know-how, but also because the investments involved are often too high. SMEs are therefore usually dependent on software suppliers.

Rapid technological developments and out-dating of hardware and software

Rapid technological progress creates problems for SMEs. One of these is the increasingly shorter product lifecycles in IT product development, which leads to increasingly short return-on-investment times. With regard to IT applications, many end-users of IT products and services complain that software suppliers tend to concentrate too much on supplying new products. Instead, they say suppliers should devote more attention to solving specific SME-related problems. Moreover, SMEs are faced with the problem of not being able to buy a total package of software from a single software supplier.

2.4 Availability of IT for SMEs

In common with large companies, SMEs are experiencing the technological "push" of new IT applications for processes. However, smaller companies are often prevented from introducing these new applications due to their limited investment capability. SME entrepreneurs also tend to be confronted with a lack of practical application possibilities. For IT suppliers, the SME sector is therefore often not attractive enough. Consequently, when developing new IT applications, suppliers tend to concentrate in the first instance on the more "likely" sectors. These are sectors in which some automation applications have already been introduced; in which operating processes lend themselves to automation; in which sufficient financial resources are available; in which certain standards are already being operated, etc. In branches where there is little or no evidence of any of these, IT is difficult to introduce. Due to their small scale, their non-standard processes, etc., SMEs are usually less attractive to automation suppliers.

2.5 Adapting IT to SMEs or SMEs to IT

Many SMEs do not develop their own IT applications, but buy existing software packages on the open market. IT diffusion in small and medium-sized enterprises therefore takes place through spin-offs from systems developed either by or for the major companies. In other words, systems which have been tried and tested in large companies are also offered to SMEs.

In order to be able to successfully implement such IT applications, the company’s operating processes usually have to be restructured. This requires focusing attention on the relationship between strategy, organisation and personnel on the one hand, and the (technical) possibilities of IT on the other. As a result of the application of IT, business operations become highly formalised and standardised (bureaucratisation). This can lead to a loss of flexibility, which is one of the major strengths of small businesses. For many SMEs, the introduction of IT not only brings about substantial alterations in working

methods, but also means that they must begin to work in line with certain standards. However, the -- by definition -- smaller organisational structure and lower degree of specialisation of the SME makes it better able to rapidly change its organisational structure and division of responsibilities. The degree of flexibility within an SME is linked to aspects such as entrepreneurship, management and organisation.

In practice, there is also evidence of IT adapting to the specific needs of SMEs. An increasing number of IT applications is becoming available for SMEs, in which account is taken of their specific characteristics.

2.6 Requirements for successful application of IT

Many factors are involved in the successful application of information technology in small and medium-sized enterprises. Some of these also apply to larger companies. The most important of these are as follows: the supply of IT; the involvement of SMEs; and financial aspects.

Supply of IT

A greater co-operation between software suppliers, and between suppliers and users can accelerate the development of software for process automation. Many SMEs would benefit from better agreements between suppliers regarding the interchangeability of computer applications. It is also important for SMEs that suppliers are able to supply a total package of products and services.

SME involvement

A good supply of information to SME entrepreneurs and their staff is a major factor in successful IT applications. In addition to creating tangible short-term benefits, this also encourages the involvement of the SME, which will in turn lead to a greater willingness to invest in IT and to change the company's working methods. This involvement can be further increased if SMEs can link up to existing IT applications in an industrial sector or production column.

Financial aspects

Financial or economic developments can impede the introduction of (new) IT applications by SMEs. Moreover, SMEs seem to expect a much shorter return-on-investment period for IT investments in production processes than for IT investments in product applications. In such cases, the advantages of IT and other "push factors" must be very clear indeed if successful automation is to be achieved. A lack of automation know-how can also lead to (overly) high costs and thus exceed the company's financial reach, since a lack of in-house knowledge means that a company is heavily dependent on external know-how, which must of course be paid for.

3. IT applications in SMEs

3.1 Introduction

This section will concentrate on the following:

-- comparing IT diffusion in processes in the various SME sectors;

-- experiences of SMEs in collaborating on IT;

-- the use of information systems based on IT with other companies.

3.2 IT diffusion in SMEs

Although the use of IT in SMEs has for some time lagged behind that in larger companies, there is now a slow but sure increase in IT applications by SMEs. These mainly involve applications in processes. The banking and wholesale sectors have always led the way in IT applications, compared with the slow start in the construction industry, the retail sector and other services sector, notably the hotel and catering industry. Among industrial SMEs, chemical companies and the food and luxury goods industry have tended to lead the field.

Computer ownership

One indicator of the likely success of IT diffusion in SMEs is their degree of computer ownership. Table 4 shows the levels of computer ownership in the various SME sectors in 1992. This includes ownership of PCs, minicomputers, mainframes and process control computers. Fifty-nine per cent of SMEs own one or more computers. Computer ownership is highest in the commercial services sector, where over 80 per cent of SMEs own at least one computer. The hotel and catering industry scores the lowest, with less than one-third of SMEs owning a computer.

IT applications in SME sectors

Table 5 gives an overview of technological innovations in SMEs during 1989 and 1990. The largest number of technological innovations by SMEs took place in the computerisation of administration. Companies also made changes in the area of product development and the automation of their production processes. Around 40 per cent of industrial SMEs and over 10 per cent of construction companies were involved in product development in its broadest sense during 1989 and 1990.

Research carried out on the application of microelectronics in four industrial branches in 1991 indicated that the application of microelectronics in products increases with the size of the firm.

Table 4. **Automation (computer ownership) according to SME sector**
(1992)

	Percentage of companies with one or more computers	Percentage of computer owners with one or more PCs	Percentage of computer owners with other computer(s)[1]
Manufacturing	65	98	14
Construction	53	99	4
Wholesale	71	98	16
Vehicle repair	64	98	12
Retail (food)	35	99	4
Retail (non-food)	45	99	5
Hotel and catering	27	100	2
Transport	52	99	11
Commercial services	81	99	11
Banking and insurance	82	84	27
Total SME sector	59	98	11

1. Minicomputers, mainframes and/or process control computers.

Source: KNOV/NIPO.

Table 5. **Overview of companies which introduced technological innovations in 1989 and 1990, in terms of areas influenced by these innovations**
(in percentages)

	Companies in terms of numbers of employees:						Total
	1	2-4	5-9	10-19	20-49	50-99	
	%						
Computerising administration	30	42	67	75	79	81	47
Product development (updating existing products and/or developing new products)	14	25	22	23	32	52	22
Automation/rationalisation of the production process	9	16	26	31	36	55	18
Electronic banking	8	8	14	27	39	34	12

Source: KNOV.

3.3 Experiences in co-operation on IT

In order to avoid falling behind in IT technology, SMEs can opt for collaboration, in addition to developing or acquiring IT applications on an individual basis. A common form of collaboration is technological co-operation at branch level. Up to and including 1992, SMEs in 125 branches have carried out some 300 branch-related IT projects.

One example of IT co-operation at branch level can be found in the wholesale drinks industry, which covers a large number of smaller companies. The branch organisation has commissioned research to develop a diagnosis instrument which individual companies can use to assess the quality of their own information systems. The model also provides a reference framework for specifying the necessary requirements if the existing system is to be replaced.

3.4 Use of information systems with other companies

In addition to computer applications within a single company, the automation of data exchange between companies and their environment (other companies, government authorities, etc.) also plays a major role. Two different forms of electronic data interchange can be distinguished:

-- the transfer of electronic information between computers (Electronic Data Interchange, EDI);

-- interactive electronic message transfer (videotex).

Although SMEs make relatively little use of EDI applications, there are nevertheless initiatives in which SMEs are involved. One example of an EDI application in the vehicle manufacturing industry is "Odette". This involves electronic communication using international standards, and is aimed at improving efficiency in the logistical production process. A large number of suppliers (including SMEs) both in the Netherlands and abroad communicate electronically with companies such as DAF, NedCar and Scania.

Another example can be found in the trade and commerce sector. Various pharmaceutical wholesalers have developed retail automation systems for chemist shops. Scanning of standardised bar codes at the cash till is part of this system. As a result of this scanning system, chemists can precisely match their stock orders to actual consumer demand. The system also generates automatic EDI stock orders and transmits these to the relevant wholesaler’s computer. Similarly, the computers operated by the wholesalers can in turn send EDI messages to the chemists containing supply and product information and invoices.

4. Summary and main conclusions

This report contains the results of a broad assessment of IT diffusion within the SME sector in the Netherlands. It explores various characteristics of, and developments in, SMEs, SME-related problems with regard to IT, and IT applications in SMEs. The report concentrates on the use of IT in processes.

4.1 Characteristics and developments

The significance of SMEs for the Dutch economy can be indicated by the large number of such companies in the private sector (98.5 per cent of the total) and by the output of the sector as a whole (around Gld 150 billion, or 26 per cent of GNP). SMEs also account for more than 50 per cent of employment in the private sector, and are responsible for almost half of all private sector sales. Although the government does not operate a specific SME policy, it does take account of specific scale-related aspects in its overall policy.

4.2 SME-related problems with regard to IT

IT can involve various problems for SMEs, such as a lack of independence due to insufficient know-how, organisational problems, insufficient financial resources and difficulty in accessing risk-bearing capital, and a lack of suitable applications. On the other hand, there are an increasing number of suitable IT applications available for SMEs. These are used mainly by branches and sectors which lead the field in IT. Some organisational adjustments will be needed if IT applications are to be successfully introduced into SMEs. Other requirements for successful implementation include an adequate supply of IT, sufficient SME involvement and adequate financial capabilities.

4.3 IT applications in SMEs

Almost 60 per cent of SMEs own at least one computer. The services, industrial and wholesale sectors score the highest with regard to computer ownership, and the hotel and catering industry and retail trade score the lowest. IT is used mostly in computerising administration. A large number of companies are also involved in product development and in automating their production processes. Collaboration between SMEs can do a great deal to promote the application of IT in products and processes. SMEs still make relatively little use of electronic data interchange.

NORWAY

BUSINESS DEVELOPMENT WITH NEW TECHNOLOGY (BUNT)

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The Business Development with New Technology (BUNT) programme combines company development with improvement of management (strategic management), networking/regional development, co-operation with research institutions, training and education facilities, and regional development assistance organisations and private consultants.

1. A short description of the SME situation

Using the EC definition of an SME (a maximum of 250 employees), only 170 out of 10 000 Norwegian enterprises do not fall into the category of SMEs.

SMEs can be characterised in the following terms:

-- manufacturing of one product or a limited number of products, combined with some sub-deliveries to other SMEs;

-- low utilisation of CIM technology;

-- strong market demands for flexibility and short lead times, with a large variety of products and processes;

-- purchasing volume too small to benefit from large-volume reductions;

-- few areas where the enterprise can develop and maintain special expertise;

-- SMEs are expected to grow, as demonstrated by fewer job losses in these industries;

-- SMEs lack broad competence and are unaware of the possibilities open to them for future development.

2. Background to the programme

The programme was establised to help SMEs define their technological problems and link those problems to solutions provided by research institutions and universities. It was expected that IT would consitute a significant part of the solutions proposed.

It came as a great surprise to learn that the problems of the SMEs could be solved practically without the involvement of research institutes and universities. Solutions could be provided by suppliers of equipment, technological support centres and consultants. Only in a very few cases (10 per cent) were research institutions involved. This leads to questions as to how the co-operation between SME support infrastructure and R&D institutions should be organised and developed.

When the programme began, it was recognised that SMEs were not in a position to possess the broad competences required for development in the present climate of globalisation. Thus, the BUNT initiative was directed towards ordinary SMEs to help them solve their problems as they saw them.

IT is viewed as a tool and not as an over-riding technology that should be implemented everywhere *per se*. IT should be implemented where required to help achieve the goals and support the strategy requirements of a particular company.

3. Programme description

The BUNT programme addressed all industrial SMEs, larger, and with more than 20 employees. This includes all companies within ISIC Revision 3, except for those companies which are viewed as being non-competitive. Exceptions in Norway would include the food industry and parts of the graphic/printing industry: *de facto* shielded markets. The programme has also tried to support financially-sound companies, *i.e.* those companies that are in the position to do something about their situation themselves once measures have been developed. There is no maximum size of enterprise in the BUNT programme; the average size has been 56 employees, although very few companies have exceeded 150 employees.

The goal of the programme is to increase productivity and profits in SMEs that compete in the international marketplace, and to support learning structures within the company.

The government budget was NKr 80 million (ECU 10 million) over the 1989-92 period.

The programme design was based on the fact that, while enough knowledge exists in IT and other areas to support the development of SMEs, this knowledge is not available to individual SMEs. The structure of the programme focused on strengthening the bond between SMEs and the knowledge base -- the bond being consultants from regional industrial support centres, or private consultants, or consultants from R&D institutions.

The programme design was also based on the hypothesis that this linkage was not functioning because of a lack of competence in the consultant sector. A first approach was to improve the quality of consultancy services by developing and running a development programme for consultants. This was a comprehensive programme, involving a 10-day training course and 20 days of training in companies. Altogether 120 consultants were enrolled in this scheme.

The programme was marketed by the consultants, by regional governments and by the programme managers. It was hard to sell in the initial phase because the product was unknown, and many SMEs do not realise that they need help.

The programme management was carried out by the National Institute of Technology (TI) under the supervision of the programme manager, a member of the Research Council of Norway. The programme manager had broad experience as an industrial manager of both large and small companies as well as experience as a director of the Research Council.

One incentive to help marketing was a 75 per cent subsidy of consultancy costs. There were no other subsidies, which means that the company had to take care of all its own expenses in running the programme and also the investments that followed. The final company spending was four times that of government spending, in addition to an average investment of NKr 2 million.

Another part of the programme was directed at creating networks and alliances. Special emphasis was placed on vertical customer-supplier chains and especially those where technology would be beneficial. In these chains IT proved to be a very important factor in monitoring the company's internal operations and those of the whole value chain, including suppliers and wholesale retail entities. In these programmes a 50/50 split of total costs was agreed. It should be mentioned that the consultants invested close to ECU 10 000 of own funds in their training; the incentive being, of course, the possibility of participating in a larger activity later on.

The programme design was based on the programme manager's industrial experience, and experience from programmes carried out in the Netherlands, Denmark and Germany, in addition to evaluation reports from earlier Norwegian programmes. It was also decided to have action research or continuous evalution of the programme in order to be able to adjust its course, carry out experiments and gain the maximum learning effect from the programme.

Seven doctorates have been undertaken on the BUNT programme; these are related to different aspects of company development and technology transfer.

As mentioned above, the programme was not designed to focus specifically on IT, which should be viewed as a tool to be used to meet the goals and strategies of the individual company.

The main barrier observed in the programme has been the lack of strategic understanding, motivation and orientation in the companies. This barrier is particularly related to a lack of understanding on the part of the board and the general manager of the company, and experiments directed at improving the strategic understanding of managers have been undertaken with great success. All company development should be carried out as part of an overall company plan for achieving the company's goals. It should be understood that the BUNT programme takes an integral approach to enterprise, and the action plans resulting from this approach could be:

-- organisational;
-- quality related;
-- control related;
-- purchasing- or market-oriented;
-- product development-oriented.

All these actions plans can and do include information technology. The barriers to the approach have been overcome by intensive marketing strategies, promoting early companies as examples.

Evaluation and auditing have been carried out continuously by action researchers. The programme has been adjusted as results and experience have given reasons for changes and new experiments. The action research/continuous evaluation was carried out by a human resource research group at the Norwegian Institute of Technology (NTH) at the University of Trondheim. The evaluation yields both quantitative and qualitative results. As quantitative results often take time, the final programme evaluation contains only financial results from the earliest companies entering the programme. The quantitative results are measured in: increase in sales/turnover; increase in the number of employees; and increase in productivity per employee. The results are extremely interesting and positive. The qualititative results are related to knowledge of process consultancy and selection criteria for consultants and the design of the training programme.

The BUNT toolbox has been used as an entrance ticket into the European SPRINT programme, and a special project -- EUROBUNT -- has as its aim to assess and evaluate the BUNT toolbox for use within five European countries: Ireland, the United Kingdom, Denmark, Germany and Spain. The results are very encouraging.

The BUNT methodology has also formed the basis for the design of the SPRINT "MINT" project (Managing Integration of New Technology).

Table 1. **Small and medium-sized companies in Norway**
1991, manufacturing sector, Standard Industrial Classification

Classification		SME establishments (% of total)	Persons engaged in SMEs (% of total)	SME share of gross value of production (%)
3.	Manufacturing	95	50	46
3.1.	Food, beverages and tobacco	95	63	60
3.2.	Textiles, apparel and leather products	97	81	80
3.3.	Wood products (inc. furniture)	98	80	79
3.4.	Paper and paper products: printing and publishing	95	42	40
3.5.	Chemicals and chemical petroleum, coal, rubber and plastic products	93	42	27
3.6.	Mineral products	97	65	68
3.7.	Basic metals	57	10	8
3.8.	Fabricated metal products, machinery and equipment	94	46	49
3.9.	Other manufacturing industries	98	69	64

1. In service-oriented sectors such as SIC 6: wholesale and retail trade; SIC 7: transport and communication; and SIC 8: finance, insurance and business services, the SME share of total establishments is over 95 per cent.

Source: Norwegian Ministry of Industry and Energy, Research and Technology Department.

SWEDEN

A REPORT ON PROGRAMMES FOR IT DIFFUSION TO SMEs

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1. Background

SMEs are given high priority in commercial and industrial policy, and are expected to represent new industrial growth. Large companies are important but they cannot be expected to increase production and employment to a sufficient extent. During the 1980s, employment in SMEs increased by 20 per cent, decreasing by more or less the same percentage in large companies. SMEs support growth and prosperity by:

-- creating new products and services;
-- stimulating entrepreneurship;
-- contributing to the modernisation and restructuring of existing industry;
-- creating new jobs;
-- supporting regional development.

During the last few years, many political decisions of a general nature have been taken to create good prerequisites for SMEs. These decisions concern, for example, taxes, deregulation, competition policy, venture capital, etc. In addition to these kinds of framework measures, special steps are needed to reduce or eliminate more or less permanent handicaps. Such disadvantages can be structured into three main groups: lack of competence; lack of information; and lack of venture capital.

Lack of competence

The continuous development of competence is a prerequisite for the renewal of commercial and industrial life. Surveys show that a connection exists between increased productivity and investment in competence.

A common observation is that SMEs have difficulties in defining their need for change. These difficulties mostly concern enterprise. Government should therefore contribute by initiating future-oriented thinking as a basis for SME renewal.

Lack of information

Changed prerequisites and a constantly changing environment demand rapid and correct information. SMEs naturally have difficulties in keeping up with the flow of information. Often information must be supplemented and adjusted for SMEs before it can be disseminated. It is in the public interest that SMEs are well-informed.

Lack of venture capital

Surveys have always placed venture capital at the top of the list of SME problems.

2. Programme for technology diffusion

General framework

Two programmes for technology diffusion are presented in this paper. The first is the "Technology Cheque", carried out during the period 1987-92. The other is the "Technology Consultants" programme, started in 1991 and which is still in progress.

These two programmes have a broad approach to technology and do not specifically focus on IT or any other technology. However, as will be seen, IT is important independent of the approach taken. Today, IT is a general technology with applications covering the entire enterprise area.

In Sweden there is no programme for technology diffusion linked to a special technology or an industrial sector at national level. At the regional level, however, there are programmes that focus on special areas of technology. During the so-called "technology-centre" movement of the 1980s, IT was given high priority, and was often the basic motivation for investing in technology centres.

During the last few years, the aim has been to place more emphasis on technology pull than on technology push. As will be seen, both the programmes described here are technology pull-oriented.

The government has recently presented a bill concerning its R&D policy for the coming three years. In that bill, IT has been given higher priority than before in terms of economic resources. Furthermore, resources will be devoted to technology transfer to SMEs. This holds for all technology, but it is reasonable to assume that IT will have a central place in the programmes arising from the bill.

The Technology Cheque programme

This programme was carried out during 1987-92. It was a national programme implemented through the Regional Development Funds. The model for it was the British programme, Manufacturing Advisory System (MAS).

SMEs formed the target group. The idea of the cheque was to launch processes in SMEs which would represent a real technology improvement and not just a normal step in upgrading existing competence. The Regional Development Funds offered SMEs a cheque up to a maximum of 50 per cent (but not exceeding SKr 25 000) of the costs of undertaking a technology analysis which would form the basis for an action plan. It was then up to the company to decide what experts they engaged for the analysis and the programme.

In 1991 an evaluation was made based on approximately 350 companies. First, some facts about the SMEs participating in this programme:

- -- average number of employees in the companies was 42.7. Half of the companies had fewer than 23 employees;
- -- average turnover was SKr 32.2 million. Half of the companies had turnovers of less than SKr 15 million;
- -- 50 per cent of the companies had been active for 20 years or less;

-- two-thirds of the companies were to some extent dependent on sub-contracts, and about 20 per cent functioned only as sub-contractors;

-- about 42 per cent of the companies had a turnover of 90 per cent or more derived from their own products.

Some results of the evaluation:

-- The perspectives of the companies were the starting point for the analyses. In some 70 per cent of the analysis, the basic idea was to take advantage of the possibilities offered, and not for problem-solving;

-- In some 50 per cent of the companies, the cheque was used for clearly-defined projects. The average total cost for this kind of project was around SKr 600 000;

-- In some 30 per cent of the cases, the cheque was applied to a chain of projects. The average cost of this kind of project was about SKr 2 million. For about 50 per cent of the companies working with so-called chain projects, the total cost was SKr 500 000 or less;

-- When the evaluation was made, approximately 6 per cent of the companies had implemented the programme resulting from the analysis. One-third of them had together increased revenues of SKr 130 million, and approximately one-third had lowered costs by an average of approximately SKr 457 000.

The areas on which the companies focused were: production planning, 50 per cent; product development, 25 per cent; marketing, 12 per cent; and production administration, 8 per cent. The following structure shows the character of the projects:

Purpose	Share in %
Production planning/control	**55.0**
Introduction /development	9.7
CAD/ CAM/ development of MPS	7.6
Automation	9.7
Quality improvement	25.6
Product development	**25.0**
Modifying existing products	12.4
Development of new products	8.8
New materials	2.2
Marketing	12.0
Development of routines for offer and calculation	3.1
Tools for marketing	3.1
Administration	**8.0**
Introduction / development of Computer-systems	2.7
Changes in organisations	4.4
Remaining	10.6
Total	100.0

The table shows that most companies need IT.

Programme for Technology Consultants

In 1991 the government commissioned the Swedish National Board for Industrial and Technical Development (NUTEK) to carry out a general programme for technology diffusion targeted at SMEs. The programme consists of three activities:

-- training and education of technology consultants through the Regional Development Funds;

-- creating better co-operation between publicly-financed actors working in the field of technology diffusion;

-- stimulating Swedish participation in international programmes for technology diffusion, with emphasis on the EC.

Training and education are the key elements in the programme. Sweden is divided into 24 counties, each with a Regional Development Fund whose main purpose is to implement government SME policy. In addition to the Funds, there are other actors working with technology diffusion at regional and local level.

The objectives of the technology consultants are:

-- to stimulate SME demand for new technology and to increase the ability of the companies to absorb new technology;

-- to make public-financed R&D more accessible to SMEs;

-- to promote better co-ordination between public actors working with technology diffusion.

To enable the consultants to play all these roles, the training programme consists of the following three main parts:

-- exchange of experience, and monitoring and development of tools for technical analysis, etc. (about 25 per cent of the programme);

-- building networks with different actors (research institutes, universities, technology centres, industries, etc.) working with R&D and technology diffusion. Through these networks a consultant will be better able to guide a company to the right source of competence (about 25 per cent of the programme);

-- education in project management, new technologies, licences, patents and standardisation (about 50 per cent of the programme).

Twenty-two of the 24 Regional Development Funds participate in the programme. Each fund has chosen one consultant to take part in the training. Some conditions were set for participation in the programme, *e.g.* consultants should have at the least a degree in engineering and ten years' professional experience in either product development, production technology, material or production control. They should also have the experience and ability to be a stimulating factor in their work with SMEs.

The role of the technology consultant is that of a "house doctor" in technology, and not of a specialist in certain technologies. The idea is that, after a first diagnosis in the form of a technological

analysis performed together with the company, a programme for the company should be worked out. The role of the consultant is to be not only a discussion-partner for the company, but to guide it to relevant competence or to a relevant ongoing programme. The building of networks should be seen as an operating tool in the daily life of a consultant.

As mentioned earlier, one element in the training has been to revise existing methods for technology analysis. These revised methods for analysis are now being tested. The analysis consists of two days' work and is free of charge for the company. The goal for 1992 was to initiate some 400 analyses, but so far only 100 analyses have been completed. One reason for this low percentage is that the consultants are not completely satisfied with the structure of the analyses. In practice, they were considered too schematic to create a constructive dialogue between the company and the consultant. This has now been rectified, but a lot of time was lost. In any case, the main reason for the low outcome compared to the goal is that the objective was too optimistic in the light of general economic developments. Future evaluation will give a more relevant picture.

The work programmes developed in the framework of the analyses have the following profile:

Purpose	Share in %
New production technology	**34.5**
New production methods	8.8
New production equipment	5.9
Automation	1.1
CAD/CAM	8.8
Working environment	6.5
MPS, MAS	3.5
New production administrative solutions	**26.5**
Total resource utilisation	2.4
Quality improvement	14.1
Organisational development	7.1
Wage systems	1.1
Computer support	1.8
Product development	25.0
New product	10.0
Development of existing products	10.0
New materials	4.7
Marketing, etc.	14.1
Total	100.0

As can be seen from the table, the activities cover a broad range, from production technology through administrative solutions to product development and marketing. Another observation is that IT is linked to most activities (at least 40 per cent of the activities are IT-orientated). IT does not require special attention since it is a broad technology and is integrated in almost all technologies.

The budget for the technology consultants is SKr 4.5 million, of which SKr 3.5 million is devoted to technology analysis. Each analysis costs SKr 8 000.

3. Development of technology diffusion policy

The question of how technology diffusion policy will develop in the future is not easy to answer. Based on the present framework and the experiences of Sweden and other countries, certain main directions which will characterise future diffusion policy are discernible:

-- SMEs will be given ever more attention in industrial policy-making;

-- the demands of SMEs (technology pull) will be the starting-point in drawing up policy. So far, too much emphasis has been placed on the supply side;

-- the shift towards demand means that technology diffusion will be built on a more explicit SME perspective. This will also lead to a more realistic relationship between SMEs and R&D. New links and new ways to co-operate will emerge;

-- infrastructure in the form of universities, technology institutes, technology centres, etc. will have to become more customer-orientated, with the effect that SMEs will have more influence on future R&D;

-- the development of networks will increase co-operation between the actors in technology diffusion. Networks using professionals from different areas for different programmes are an unused resource. Working through networks means that in certain projects a professional may be at the centre of activity, whereas in others he or she might have a more periferal position;

-- programmes for technology diffusion will be based more on flexibility and diversity.

4. Barriers to technology diffusion

Investing in new technologies is always risky. The general rule is that the closer the new technology to existing competence in a company, the more investment insecurity is reduced. Independent of the risk factor, an ever-present barrier is lack of access to venture capital.

Another common barrier is lack of technical competence in SMEs to understand, accept and implement the technology. Most qualified engineers are employed in the bigger companies and inciting them to work in SMEs will take time. Some small universities have small-scale experiments where newly-qualified engineers have the opportunity to work for 6-12 months in an SME. In many cases they are then taken on by the company, fulfilling the main purpose. This activity has so far been successful and is one of many ways to build up the capacity of SMEs to absorb new technology.

A third general problem is that information about new technologies is often described and presented in a form that suits big companies. SMEs will usually have to wait until the information is presented in terms they can understand. Very little resources are set aside to speed up this kind of transfer.

A fourth barrier is the targeting of SMEs for technology diffusion. In Sweden one of the targets of the recent bill on R&D is to develop methods designed to build bridges between SMEs and R&D. So far, only a few SMEs have experienced contacts and co-operation with R&D resources. The guidelines mean that methods must be developed so that SMEs with no experience of R&D can take part in technology diffusion in a broader sense. As more SMEs are targeted, new barriers will arise. This is a logical effect that will influence policy development for SMEs.

UNITED KINGDOM

OPEN SYSTEMS IN MANUFACTURING

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1. Rationale for Department of Trade and Industry assistance for small and medium-sized firms

The UK Department of Trade and Industry is responsible within the UK Government for policy towards small firms. This responsibility was taken over from the Department of Employment after the 1992 General Election.

The UK Government is determined to create an environment in which small businesses can flourish by making it as easy as possible to set up in business. There has been substantial growth in the number of businesses in the United Kingdom over the last decade, and the Government continues to seek new ways to encourage new small firms to grow.

The rise of new high-technology firms from small beginnings adds an extra element of rivalry and flexibility to the market's response to technology opportunities. The Government encourages the growth of new-technology-based small firms as a way of encouraging and increasing innovation throughout the economy.

2. DTI support programunes for SMEs

This paper describes in detail the DTI's "Open Systems in Manufacturing" programme, which is aimed specifically at small and medium-sized enterprises (SMEs). This programme has been associated with DTI's "Open Systems Technology Transfer" programme (OSTT). Also mentioned briefly are other DTI support programmes for SMEs which include an IT element.

The Department runs several programmes which are intended to help firms understand and exploit modern technology and its management. This information is often less easily available to small and medium-sized firms, so DTI makes a particular effort to involve such firms as participants in its programmes.

All these programmes fall under the Department's "Enterprise Initiative" which aims to enhance the competitiveness of established firms, particularly in manufacturing, by promoting best management practice and by providing practical help and guidance in several areas such as strategic management advice; exports; and regional development.

3. One-Stop-Shops

In late 1992, the DTI announced a competition to stimulate the development of up to 15 pilot "One-Stop-Shops" based on about 15 English towns and cities. The aim of the One-Stop-Shops is to enable business people to access the full range of existing business support services through a single local point. The shops will be run by local partnerships, with initial DTI financial support. If the pilots are successful, it is planned to establish a national network. The One-Stop-Shops are expected to be of particular assistance to small firms.

4. Open Systems in Manufacturing programme: programme description

The aim of the "Open Systems in Manufacturing" programme is to make manufacturing companies more aware of the benefits of integrated manufacturing using standards-based information systems. It is

aimed predominantly at small and medium-sized enterprises, particularly those with 50-500 employees. Total DTI funding is £2-4 million over three years.

Mechanisms include:

i) live events such as conferences;
ii) workshops in different regions of the United Kingdom;
iii) demonstrator projects, where companies have the opportunity to see existing systems in action;
iv) case studies;
v) publications on technical topics;
vi) market assessment studies;
vii) the establishment of the "Open Systems in Manufacturing Interest Group", which currently has over 1 000 members.

5. Programme design

Before the programme started, market assessment studies were carried out which considered industry's attitude to Open Systems, and examined the need for a DTI programme. A large number of SMEs were interviewed during the course of this study.

Audience response to the programme continues to be important in planning future activities within the programme.

6. Barriers to IT diffusion

We have found that many SMEs do not have the information necessary to take best advantage of the benefits of Open Systems. The programme has aimed to provide that information in an easily-accessible format and to persuade SMEs that the use of Open Systems is as much a management issue as a technological issue.

7. Evaluation and monitoring

The programme is being continually monitored and lessons learned are applied during the course of the programme. Delegates attending events are asked for their comments on the particular event and the programme in general.

Quantitative results are obtained from the number of companies receiving material, attending events, etc. The membership of the Interest Group is also a useful indicator.

Companies who have received information under the programme are also asked what follow-up action towards the implementation of Open Systems they have taken as a result of the programme. This is a useful indicator of the qualitative success of the programme.

All DTI support programmes receive an evaluation, and the evaluation process is monitored by a DTI Committee (EPIC). Evaluations are sometimes carried out by external contractors and sometimes by DTI's own Assessment Unit.

8. Other relevant programmes

Managing into the 90s

This programme focuses on a number of key areas of management where many businesses can expect to face the problems and opportunities for change in the 1990s. These include:

-- marketing;
-- design and new product development;
-- purchasing and supply;
-- production;
-- quality.

The programmee also focuses on the need to innovate and to manage the resulting need for change.

The programme particularly focuses on the needs of small and medium-sized firms, in all sectors. The total budget is around £9 million over three years.

The Consultancy Initiative

DTI provides financial support for consultancy projects in order to encourage the use of outside expertise as a regular part of management strategy. Consultancy help is available to most independent firms or groups with fewer than 500 employees. The projects cover the six key management areas of quality; design; marketing; manufacturing and service systems; financial and management information systems; and business planning.

Research and development programmes

SMART (Small Firms Merit Award for Research and Technology) is an annual competition for individuals or businesses with fewer than 50 employees. It offers phased financial support towards the development of new technology projects with a good prospect of commercial success.

SPUR (Support for Products Under Research) provides help to smaller independent companies of up to 500 employees for the development of new products or processes which can demonstrate a significant technological advance.

Small firms are also actively encouraged to take part in collaborative research and development projects funded under the two support mechanisms (LINK and Advanced Technology Programmes).

Technical Action Line

This helpline is designed to help small firms solve immediate problems concerned with the application and use of technology. It will enable them to have easy access to experienced "trouble-shooters", who will provide a quick problem-solving service at a subsidised cost.