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# TEFT: Diffusing technology from research institutes to SMEs

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# TEFT: Diffusing technology from research institutes to SMEs[1]

## Introduction

This paper is produced as a subproject in the overall SMEPOL project. SMEPOL is the acronym of the collaborative activity under EU's TSER program aimed at studying best practice innovation policies vis-a-vis small and medium sized enterprises (SMEs) in Europe. The wider aim of this project is to examine to what extent current policies in selected member states reflect recent lessons from research on policies towards this group, and inform policy makers about ways in which policies and initiatives can be improved.

The consortium conducts the project according to a division of labor implying a number of studies of key policies in each member state. This paper represents one such study, an analysis of the TEFT-program in Norway, a program aiming at stimulating the transfer of technology from R&D institutions to SMEs. It will serve as one of several studies preparing the ground for the national report from the Norwegian scene.

The paper is presented in a draft version to the SMEPOL consortium meeting in Italy in October 1998, and has received valuable comments from collegues in the STEP-group: Arne Isaksen, Bjørn Terje Asheim and Thor Egil Braadland. Of the persons interviewed, Mons Grøvlen, the program manager, has also given valuable comments to the first draft. Any flaws and inconsistencies are, however, attributable only to myself.

[1] The following individuals have been interviewed in the course of producing this study:

Mons Grøvlen, Program manager of TEFT

Ulf Syversen, Research Manager in Østfold Research Foundation

Jan Robert Danielsen, Østfold industrial offensive

Leif Haugen, Østfold Business Consultancy

Per Erik Fossby, Østfold County administration

Alf Holmlie, SENTEK, Eastern Agder

Sigvald Grøsfjeld, TEFT attache for the Agder counties, 1994-1997

Kjell Rangnes, TEFT attache for the Agder counties, 1997-.

# THE THEORETICAL OUTLOOK AND METHODOLOGY

This paper, along with the rest being contributed as national evalution studies in SMEPOL, is conducted according to a set of common guidelines that have been developed in the early stages of the project. The guidelines are formulated so as to ensure a minimum level of comparability between the individual studies, and to ensure a smooth production of the final report through an intermediary phase of national reports. These guidelines reflect the theoretical basis of the SMEPOL project, as this is also covered in working papers (see e.g. Nauwelaars et al 1998, Asheim and Isaksen 1998). Thus, the theoretical basis of this study is available, but for the sake of completeness, and to allow an analytical discussion in this paper, a short overview is given, highlighting the most essential themes and findings relevant for this study. In this review, some themes that are relevant for the analysis of TEFT, but not necessarily explicated in the papers mentioned, are also discussed.

## Innovation theory for policy

Innovation policy finds itself increasingly at the centre of policies for enhancing economic development in general and SMEs in particular. Innovation is seen as the focal policy area in times of major restructuring of the world wide economy, globalisation being the process that gives rise to reexaminations of the appropriateness of various policies and instruments. The globalized economy "leaks", a fact which represents major problems for nation states and traditional macro economic policies. The processes of prioritization and policy formulation need to meet such challenges. Innovation policy has received increased attention since it aims at improving endogenous capabilities while restricting the propensity of leakage so typical of other forms of economic policy (in particular Keynsian ones).

However, innovation it self, or rather how we understand this process, has undergone significant changes during the past 10-15 years, a fact that lies at the heart of the SMEPOL project. This revised understanding gives rise to changing policies, but the understanding, formulated as

various innovation theories, is not uniform, nor does it represent easy transformations to policy.

The new understanding has one key platform, the denial of the linear model as the one and only proper model representing innovation processes in the economy. Rather, innovation should be seen as recursive or circular, linking different activities and resources in complex processes to generate outcomes that are themselves input to further innovation processes. Dosi gives the following definition:

> "In an essential sense, innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups" (Dosi 1988:22).

Dosi underlines two facets of innovation; uncertainty and cumulativeness. The circular or multilink nature of the innovation processes tells us that innovation can hardly be planned, but is victim of unpredictability and multiple causation. Further, innovation takes place within certain modes of asking questions, i.e. of learning, leading to innovation processes being formed into trajectories of cumulating knowledge. Innovation is increasingly seen as a social process, based on interactions between different persons, institutions and firms. Hence, innovation takes place within a systemic mode, even within systems of innovation which are essentially institutional set-ups characterstic for given territories. However, the systemic orientation towards innovation is not per se territorial, as can be derived from one important contribution to the recent understanding of innovation processes, the Maastricht Memorandum, in which the systemic model is summarized as follows (Soete and Arundel 1993):

1. multidirectional links at the the same point in time between the stages of technical changes;

2. cumulative processes over time can lead to lock-in and feed-back effects;
3. technical change is dependent on knowledge and the assimilation of information through learning;
4. the details of the development path and diffusion process for each innovation are unique;
5. technical change is an interdependent and systemic process.

Any territorial implication is not explicit, but may be linked to all the above points via the concept of ”proximity”. A key question in this paper, is therefore whether the systemic or evolutionary approach to innovation implies a proximity variable. Or in other words, whether ”proper” innovation policy towards SMEs needs to rest on some notion of a regional system in which proximity facilitates interaction and learning vital for innovation outcomes. Before returning to this issue, a further examination of the important changes that have taken place during the last couple of decades may cast further light on the issue. Lundvall and Barras refer to these changes in identifying four trends:

a) Acceleration: The rate of technical change has sped up dramatically. Product life cycles are significantly shorter.
b) Interfirm collaboration and industrial networks: Sources of innovation are multiple, making firms more dependant on inputs which they cannot master inhouse.
c) Functional integration and networking inside firms: This refers to a lesser degree of compartmentalization and more intra firm networking within essentially medium sized and larger firms.
d) Collaboration with knowledge production centres: The advancement of science becomes ever more important to the innovation process, implying also an increasing degree of specialization in the knowledge production, and firms will often have to rely on more than one such centre (Lundvall and Barras 1997:24).

Such trends point to the importance of proximity, which has implications for a regional systemic outlook on innovation policy. But on the other hand, globalization points to the need of linking up to the international sources and nodes of knowledge production and learning. In the global village, proximity may be achieved "virtually" through contractual relations between partners in some common system of complementary interests. Even SMEs may need to transcend their regional setting and link up internationally through developing new relations or surfing on old ones.

Even though territorial systems are important, the translation of national systems of innovation into regional ones is not free of problems. This operation implies a strenghtening of geographical proximity not necessesarily inherent in the general evolutionary or systemic approach. The institutional linkages gain another quality, which has been thoroughly discussed by Storper (1992, 1995), with the wider political-economic context as a key variable. Untraded interdependencies have a significant economic value, similar to the idea of contractual relations. Regionally oriented innovation policies need to provide an often unrecognized public good: that of capacities for collective action.

Policies to support SMEs are often implicitly linked to the regional level, suggesting that SME-specific policy is regional policy. This link also exist in the rationale for the SMEPOL project. A key component of regional innovation policies is the support system or better, the infrastructure aimed at providing support and services to the client system. The reference to the regional level is usually done without much qualifying criteria. What is exactly a region in these terms? And how should a region be understood in the contexts of the nation states? It is not clear whether the regional level in this case should be understood as the county level, the meso level in Norway which is administratively and politically organized to produce collective action. And added to this is the question of infrastructure: How

much infrastructure should be available regionally to support capabilities and development, and how much should be restricted to the national level? And if the national level to some extent organizes into a regionalized system, how should this be assessed relative to the notion of a regional infrastructure linked to the regional level of interactions, policy making and interfirm relationships? As we shall show in this paper, these questions are not easy to dissolve. However, we need to keep this link at arms' length, allowing for an understanding of appropriate SME-policy buildt on the evolutionary and systemic approach, but without implying the regional dimension. It is necessary to distinguish between the qualities of single policies or programs and the need to retain a regional dimension in the overall policy framework. But we shall return to these issues towards the end of the paper.

This is, however, also linked to the question of the need to pay sufficient attention to the demand side, in this case the needs and "modus operandi" of the firms themselves. Innovation takes place in the form of continous improvements, but often limited by the weakness to engage in the management of external relations. This weakness leads to a propensity to avoid a functional search behaviour to exploit solutions and ideas outside the firm. Additionally, the lessons of the past, which has demonstrated the need to avoid supply side and technology push programs for this category of firms (see e.g. Remøe 1989), lead to the need for a firm specific stimulation of searching and learning, and raising the technological capacity of the firm.

In sum, appropriate innovation policies based on the lessons available in the 90's, need to reflect the demand side, the processes of searching and learning, and building capacities for technological development and exploitation of external sources of technology and knowledge. An additional dimension is whether the program in question takes into account the building of regional capacities for collective action and infrastructure, or

whether it rests on other initiatives, through coordination or otherwise, to produce the territorial linkages and context in which the SMEs find themselves.[2]

## Methodological issues

The key research questions to be explored in this paper, are common to all the program specific evaluations in the SMEPOL program, and may be summarized as follows:

- To what extent is the program in question externally consistent? Is the program consistent with the key elements of recent innovation theory as described and discussed above, and is the program focussed on interfirm relationships and how is it linked to a totality of programs or policies on a regional level? Is the program regional or is it a desentralised national program?
- To what extent is the program internally consistent? Are the objectives and derived goals and targets consistent? Are the tools and methods in the program consistent with the program objective?
- To what extent is the program efficient? Does the program reach its target groups, and is it efficiently or cost effectively implemented?
- What are the results and impacts of the program? To what extent are the objectives, goals and targets achieved, and what are the direct and indirect effects of the program?

To answer these questions, we have relied mostly on available material. The TEFT program is well documented, both in its description, and through its internal reporting system. TEFT has, as we shall pay more attention to below, an integrated system of monitoring research, through which data are also available. Thus we have used a great variety of writ-

[2] Further implications for policy from theory are discussed in the section on external consistency.

ten material, also on the predecessor of TEFT, the so called DTS-program.

This use of secondary data has been complemented with interviews with key persons involved directly or indirectly in the program. This concerns first of all the program manager, but also selected persons in selected regions (counties) with the specific aim to explore the regional dimension of this program. A complete list of persons interviewed is found in the annex, and the written reports used as the key data source, are all referred to were appropriate. The methodology and data available in addition to the interviews allow us to answer the above questions and to conduct the analysis according to the SMEP OL guidelines and overall research questions.

# THE HISTORY AND RATIONALE OF TEFT

TEFT cannot be assessed without its specific history and context. This is the case both in general terms with the wider policy framework, as well as in its more specific relationship with its predessor, the DTS-programme. This section will therefore first describe the general policy framework at the time of implementing the DTS, and later the TEFT. Then a brief description of DTS will be done, including programme description, results, and the implications and proposals drawn from the evaluation of DTS that later formed the TEFT programme.

## The policy context of the -80's

The sources of policy formulation for industrial and innovation policy are found in the 1970's. As was the case in most, if not all, industrialized countries, the continued growth during the past decades came to a halt in the mid-70's. Although a visible problem was related to the OPEC-induced oil shock, it soon translated into a wider recognition of the need for industrial change. These were not problems of fluctuating business cycles, but represented deeper structural problems (Mjøset 1986). Traditional markets for industrial goods became saturated, and new growth was envisaged in new technologies and advanced services. By the end of the 70's most industrialized countries acknowledged the need to invest more in reseach and development, and a technology based industrial policy combined with deregulation and a more delibated market approach became the widely accepted medicine (Arbo 1993).

Most countries chose their own route in this period, depending on their own economic and political context. The Norwegian approach, based in increasing degrees of freedom from the emerging oil revenues, was to enforce a keynesian demand oriented policy in the period of 1974-78. This had particular inflationary results, and the competitive position of Nor-

way deteriorated. The political turnaround came by the end of the decade, based on the appearantly reduced effectiveness of keynesian policies in small, open economies at that time. A structural policy approach was developed, giving priority to the competitive sectors of the economy, its technological vitalization and increased focus on knowledge based industrial development. By the beginning of the –80's, a new developmental paradigm settled, paving the way for new initiatives in the field of research and technology policy (Arbo 1993:11).

The emerging market approach and policies for deregulating economic structures implied that the international conditions for policy development converged: The continued integration and liberalization between states in the global economy led to increased copying or imitation of policies between them. And the liberal economic context gave neo-classical arguments authority in formulating the policies for a more technology based economic development. These are basically elements in a market failure approach to policy:

- Appropriation of investments in knowledge and R&D is difficult due to externalities, and this leads to incentive problems;
- Similarly, failures in the capital markets were seen as crucial, causing even profitable projects to lack funding;
- High transaction costs in diffusing technologies and innovations imply economic losses;
- Other countries are increasingly involved in R&D, and this dictates to some degree the policy agenda for a small, open economy (Streeck 1989, Hervik, Berge and Wicksteed 1992, cited in Arbo 1993).

Policy areas like industrial policy, regional policy and research policy went through significant changes during the –80's. Like what happended in many countries, increasing trends towards globalisation reduced the effectiveness of keynesian policies,

or even policies aimed at selective support for key firms and industries. Industrial restructuring as a new objective was coupled with the perceived need to enhance firms capabilities in ways that did not "leak out". The beginning of the 80's was therefore a period of intense policy planning with several white and green papers produced from the government, and several programmes, a new approach at that time, were initiated, often with a certain experimental bias. The trend in the 80's in Norway can be summarized in the following points:

a) Both the industrial, regional and research policies develop a sharper profile on technology and competence. This goes together with an increasing integration of these and other policy areas. The visible number of political instruments increases. The institutional set-up for regional policies is enhanced. This change towards an endogenously oriented policy, albeit still supply-based, goes together with a process of similar macro-economic policies in Europe and worldwide, giving similar frameworks for firms and governments to develop their strategies.

b) The period of selective support was over, and instruments were developed in a neutral way vis-a-vis the various industrial branches. Small and medium-sized firms were seen as an important target group, since they were perceived as having problems in capturing the knowledge and know-how needed to compete. The support became less rule-based and more based on the assessment of project quality. A strategic approach was developed, and from the mid-80's a set of action plans was the main tool to enhance key technology areas.

c) Towards the end of the 80's, a certain critique of the R&D system became visible, pointing to the main technological research institutes' position in the wider system. These received a great part of the funding for industrial research, while to little drizzled down to the receiving end, the SME's. Evaluations of some of the programmes in the mid-80's also underlined the need to develop in-

strum ents that were based on the real needs and problems of the SME's. Thus, dema nd-led policies were developed, giving resources to the firms and less to the institutes, which implied an increase in the relative power of the "client system" in choosing their partners in the R&D system. This demand- or need-oriented policy approach was further improved during the 90's. It is, however, necessary to state that the change from a supply to a demand orientation that took place around 1990 was a combined effect from evaluations and recruitment of people with an industrial background to the key positions in policy system.

d) The increased use of programmes throughout the 80's implied a proactive as well as an experimental approach. The long tradition of using social sciences in policy formulation and development generated a platform for policy learning that proved useful for the continued development of a demand oriented, and later innovation system oriented, policy framework.

e) The approach to increase the competence and technological capacity was developed at the time when programmes and instruments became more directed towards enhancing an infrastructure suitable for satisfying the firms' needs. Networking became the principal mode already in the late 80's, an approach that was further developed and enhanced in the 90's according to the logic of value chains and cluster structures, rather than programme initiated project groups.

f) The notion of demand orientation and infrastructure also led to increasing coordination between the various policy instruments, the reason being, among others, that the firms themselves needed a clearer framework of policy in which to maneuver.

A point to underline here, is the rather early reorientation of policy. The 80's became the learning ground in the post-keynesian era, and the decade paved the way for a number of initiatives that in their premises, ra-

tionale and orientation were based in an interactive, systems oriented mode already around 1990. This happened before the innovation systems approach became the new landmark for policy, and the redirection took place 3-5 years before most other industrial countries.

## The predessecor: the DTS-programme

A programme for upgrading the technlogical capacity through technology assistance was introduced already in 1986. This initiative was reformulated and reimplemented through DTS in 1989, a programme to last 5 years. DTS is an acronym for "distriktsrettet teknologiassistanse", or regionalized technology assistance.

The basic idea about this programme was the perceived need for firms to enhance their technological capacity. SME's in particular was the target group, since these usually have weak internal resources and a low capability to handle this on their own. The technological modernization of SME's was seen in parallell with the need to direct resources on the supply side towards SME's. The initiative came from the supply side itself. SINTEF, Norway's largest industrial research organisation suggested a programme that could enhance the transfer of technology from itself to SME's. Thus, the initiative has to be seen in the light of SINTEF's strategic behaviour, meeting the criticisms of being too much "big firm" oriented and of little value for SME's. One also has to bear in mind the fact that the system of semi-private R&D institutions in Norway, like SINTEF, receives a relatively low basic funding compared to many other nations, and that this leads to a strategic need to generate revenues also through exploiting available public programs or help developing new ones. Be it as it may, the idea came at the right time, and given the SME approach, the programme was supported by the ministry for local government and labor. This again restricted the programme's outreach to those counties that were eligible for support within the rules of regional policy at the time. The programme covered 10 out of 19 counties. Thus,

DTS became a rural programme more than a regional one. The ministry allocated 75 mill NOK over the 5 year program period.

DTS contained two elements: First of all a system of county based technology attachees was established. These were senior technologists at SINTEF, each responsible for a county. Secondly, a grant for free technology assistance (TA) was offered, with the limit of 20 000,- NOK for each firm. This equaled 4 man-days in each firm. In the second half of the programme this amount was raised to 25 000 NOK, with the intention to provide a man-week's worth of work. The TA was seen as a mechanism both for problem detection and solving as well as a way for the firm to learn to know the research organization itself. Any further demand from the firm, beyond the TA, had to be paid for by its own resources or through other means. By the end of the programme, the attaches had visited 2135 firms and delivered 1011 TA's.

DTS was both an infrastructural program, through which the attaches generated awareness and contact between demand and supply, and a marketing programme for SINTEF. One of the tasks allocated to the attaches was to create links locally and also help coordinate public initiatives vis-a-vis the client system. Thus, DTS, and TEFT even more, was seen as a means to coordinate policies. On the other hand, the strict focus on SINTEF meant that this research organisation gained advantages in the contacts with SME's to the detriment of other infrastructures like technology centres and regional research institutes, and the public budgets of DTS hence had consequences for the competitive structure in the research system, bearing in mind that these institutions can be seen as commercial organisations. The client firms followed the incentives of available funding, giving other research institutions a competitive disadvantage.

The DTS programme was evaluated in 1990 by a consortium of Segal, Quince, Wicksteed ltd, Møreforskning and Sinova (Segal Quince Wicksteed 1990). The following description is based on their evaluation and Arbo's analysis (Arbo 1993).

A database that was constructed, revealed an expected picture, based on the 207 projcets listed so far (up until 1990):

- 72% were in 25% or 35% areas eligible for support in the regional policy;
- 61% employed less than 20 people;
- 62% did not export;
- 65% were owner-managed;
- 38% har no qualified engineer.

The projects (i.e. the TA's) were divided into product development (37%), process improvements (36%) and combinations thereof (13%). 14% of the projects fell outside this classification. The TA had in 30% of the cases led to further innovative activities (which has to measured according to the objective of increasing the firms' capability for technological upgrading). 29% of the firms considered the TA's as successful, while 53% considered them partly successful. 18% failed.

The conclusions drawn in the evaluation were generally positive, suggesting that the role played by the programme was of value to the firms, and that the TA's of the size of 20 000 NOK were appropriate. The evaluation pointed to the need to decrease the share of fully or partly unsuccessful projects. However, the evaluation raised concerns on a number of issues:

a) The attachees's commitment is critical to the success of the programme;

b) The DTS was at that point in time seen as insufficiently integrated with other programmes, leading to a potential for conflicts, in particular with other organisations locally;

c) The commitment of local business communities and steering committees was seen as a matter of concern;

d) The balance between resources committed from the centres and from the local firms should be reconsidered, implying an increased financial participation by the firms themselves;

e) The difficulty in establishing reliable information on economic benefits from small individual DTS projects suggested improved monitoring of inputs and improved measurement of performance in general;

f) Improved organizational learning within SINTEF itself was seen as essential for a wider diffusion of lessons and experience among its staff.

A number a recommendations were made, among them increased emphasis on a pre-project stage, financial involvement from the firm in the TA, improved relations vis-a-vis local partners, development of a reflective monitoring system, and improved marketing of the programme within SINTEF. One important issue taken up in the evaluation concerned the coverage area of the programme. There had been a growing critique of this, suggesting that the programme should expand its coverage beyond the areas eligible for particular support (rural areas). Furthermore, there was a growing belief that "development assistance to the more remote areas will be more effective it it is concentrated on a limited number of "growth points", rather than being available widely i problematic areas.

Thus the evaluation pointed to a number of relevant issues, but skipped a few also. The concentration on SINTEF as the sole source of technology was not questioned. An analysis of factors explaining the results was not

carried out. This meant that any benchmarking of the results vis-a-vis a coherent theory is non-existent.

The programme provided a regionalization in one region of Norway. In the Agder-counties the attache initiated close collaboration with the regional research foundation, covering both collaborative visitations to the firms as well as linking several TA's to this research foundation. This was referred to as the Agder-model, a version of TEFT that became not strictly firm oriented, but also systems oriented.

No summative, independent evaluation was done at the end of the programme, but SINTEF published two main reports, one official summative report in 1994, and one summary of lessons to learn, published in 1993 (Wulff 1994, 1993). Crude statistics herein report that 2135 firms were visited throughout the programme period, of which 47 % became DTS-firms, i.e. completed a TA. 40% of the firms were in manufacturing, 14% in wood products, and 10% in food stuffs.

SINTEF's conclusion was that the programme was highly useful, both for the firms and for SINTEF, and provided a mode of activity more compatible with the new techno-economic paradigm of knowledge-based economies. SINTEF proposed already in 1993 a continuation of the programme in "LAFT", taking into consideration the need for a country-wide programme along the conclusions from the above evaluation. Although a reference group had monitored the programme, the financial source, the ministry for local government and labor, established a programme board in 1993 to discuss and plan a possible continuation. This board, after considering the results of previous evalutions and other sources, agreed upon continuation, however with certain key modifications. Similar to LAFT, the new programme, called TEFT, became nationwide. And more important, it was based in all of the four main technical-industrial research organizations in Norway, thus demonopolizing the role of SINTEF. TEFT

needed to pay attention to the competitive implications of DTS, which had led to some complaints from other key research institutions. This led again to a decision to leave out solutions like the emerging Agder-model.

At this point an interesting aspect needs to be emphasized. Although DTS was heavily concentrated around SINTEF, an alternative model developed. In Agder, the southern-most twin-county, a model developed where the attache initiated tight collaboration with the regional research foundation in Grimstad. The "Agder-model" receives the following attention in the white paper on regional policy (St.meld.nr.33 1992-93:62):

> "Within the DTS-programme an alternative model has been tried, where a regional technology institute – Agder Research Foundation in Grimstad – has served as a local "agent" for technology diffusion in cooperation with the SINTEF's technology attachee.
>
> The lessons from this model are positive. The principle of linking the support to the firms with a *local professional environment of a permanent character* implies several positive effects:
>
> - *Many of the firms' development projects can be solved lo- cally*. In this way it is possible to separate the problems that really belong to SINTEF, from those that do not presuppose a national advanced R&R institute.
> - If national institutions are used in temporary programmes, *the accumulated experience will dissappear from the region* when the programme ends. A local R&D environment will be able to build on the accumulated lessons and established contacts".

For some reason, this was not taken into consideration when planning TEFT. The ministry's conclusion is clearly inconsistent with the lessons presented in the White Paper. This inconsistency remains unexplained.

# OBJECTIVES, ORGANIZATION AND INSTRUMENTS

## Formulating TEFT

TEFT was launched early 1994 after a planning period throughout much of 1993. As described above, the planning included an assessment of DTS, and the program was seen as an important tool to enhance technological capacities in SMEs' in times that called for innovative firms throughout the economy. The following description of the rationale for formulation TEFT is taken from the program memorandum accepted formally in the research council of Norway 15.12.93. (NFR 1993).

The main challenges for the Norwegian economy was at that time assessed as increased wealth creation and employment. Wealth creation should take place through product development, increased market shares and higher exports. "In this connection it is important to focus on how the industry could exploit R&D, so that the market and product development is more knowledge intensive" (NFR 1993).

A point of departure was seen in the industrial structure, with very few firms large enough to run their own R&D departments or organize such resources internally. Most of the firms have very weak resources in this respect, and the needs of SMEs (in Norway comprising all firms with less than 100 employees) were seen as increased contact with R&D institutions to enhance their competence and technolocical capacity.

The program memorandum referred explicitly to both national and international lessons in the need for a reorientation of management from daily operations to future oriented activities. Another program called FRAM had been established to help SMEs smaller than 20 employees to develop goals, strategies and plans, in short to enhance their strategic capacity. Associated with this was the challenge of increasing the competitiveness of SMEs through increased technological capacities or R&D activities.

Given their small internal resources, this could only take place through improved relations with technological R&D institutions. However, these relations were filled with barriers, both in terms of competence, and of a social and cultural nature. Geographical distances were also perceived as a barrier.

At this point an additional context should be highlighted: The R&D institutions themselves were typically oriented towards the needs and partnerships of larger firms, often associated with challenging projects with higher merits. Further, the very industrial structure of Norway, with very few medium or large enterprises, and most enterprises in sectors based on value creation from raw materials, could not house a large number of highly educated engineers and research scientists. Thus, R&D resources were typically organized in semi-public R&D institutions. This skewed distribution of R&D personell requires specific policies aiming at an improved cooperation between the institutions and the SMEs in need of R&D competence. To exploit the knowledge buried in the institutions, brokers were needed to link supply with the albeit more or less latent demand. On the other hand, research had increasingly emphasized that smaller firms do not primarily innovate through formalized R&D and use of such institutions, but through exploiting relationships to clients and suppliers (STEP::::::::©.

According to the emerging trend in the end of the 1980s, the system of technical-industrial R&D institutions were reorganized around 1990. This led to two significant changes: Funds were allocated to firms which subsequently had to choose their own connections with the supply, in the Norwegian context termed ”user oriented R&D”. And second, the major institutions were organized into so-called regional R&D corporations, indicating a regionalized, albeit national system of improved specialization in the R&D system. This created a system of five nodes in Norway localized in the major urban areas.

The rationale of TEFT was formulated in the following way:

> "The program shall help SMEs in the manufacturing and industrial services sectors to get in contact with the technological R&D institutions. The key idea is that R&D cooperation with a R&D institution will, over time, improve the firms' capacity to initiate and implement systematic development activities. The firms should develop their ability to become a continous customer of the R&D system. Overcoming barriers vis-a-vis cooperation with institutions will therefore be an objective for the program".

The reference to DTS is clearly made in that TEFT is building upon the lessons from that program. However, TEFT is considerably enhanced to cover technology attachees on full time, more thorough analysis of and in the firms at the outset and before the definition of any project, specified contributions from the firms, strategic anchorage, country wide coverage, participation from 4 research institutions, and monitoring research.

## Objectives

TEFT is directed towards two sets of targets: To initiate behavioural changes in the firms as well as in the R/D institutions. The objective for the program is formulated correspondingly in two main objectives (NFR 1993):

- *Business development*: TEFT shall contribute to enhancing the capability of SMEs both in central and peripheral areas to initiate and carry out R&D projects. They shall thereby contribute to their own and the nation's wealth creation. Thus, the program is an equitable offer to firms in all of the counties (i.e. nation wide programme).
- *Infrastructure development*: TEFT shall help the R&D institutions to reorient themselves increasingly towards activities relevant for SMEs, in such a way that cooperation with smaller firms increases

> and that the knowledge base in these institutions become easier accessible for all SMEs. The program shall hence contribute to a reduction in the barriers which today hinders communication and cooperation between the R&D institutions and smaller firms.

The further decomposition of these objectives is done on two levels: Goals and targets (”delmål” and ”resultatmål”). The idea of this separation is described as on the one hand to give the direction and level for the program, and on the other to represent tools for measurement (evaluation support).

The goals are further broken down in two: They cover key monitoring areas for both the business development and the infrastructure development objectives. Goals are separated in short term operational goals and in longer term impact goals. Some of these goals are operationalized in targets, some of a quantitative and some of a qualitative nature, using several indicators and judgements to reach acceptable measurements.

The goal set for the business development objective was formulated as follows:

> ”TEFT shall contribute to positive economic and employment effects in the firms. This presupposes firstly that it is in a short term possible to measure behavioural changes in the firms as regards *increased R&D intensity.* It should further be possible to state whether this has relevance for product and process development in the firms. Attitudinal studies will be carried out to measure the extent to which changes take place in terms om development capabilities, time and resource allocation etc.”

The following targets were formulated in the memorandum:

- Min 50% of the firms visited yearly are to be localized in peripheral or eligible areas”.

- At least 50% of the firms that have carried out Technology Projects (TP)[3], shall within 2 years of completed TP have visible signs of increased R&D intensity.
- At least 50% of the TPs shall lead to product development with a high degree of novelty for the firms or to more costeffective production processes.
- Firms with completed TP are expected to present an increase in turnover 20% higher than comparable firms during a period of 3 years.
- At least 50% of the firms are expected to give a rating of 4 on a scale of 1 to 5 for the program's contribution to the developments taken place.

Similarly, a system of goals and targets were set for the objective of infrastructure development. The goal was formulated like:

> "The institutions shall through TEFT realize a level of activity corresponding to the budget of the program. The activity shall be implemented in such a way that the planned TPs are carried out. The institutions shall develop their SME orientation by the means of participation of a multiple research scientists, increased managerial attention to SME-related problems, and recurring demand for R&D services in the system as a whole."

Attitudinal studies will be implemented to measure changes with respect to changing attitudes, structural changes in market contracts etc.

Targets were formulated in the following 6 items:

- At least 400 firms are to be visited each year. This also corresponds to 400 pilot projects.
- At least 50% of these visitations shall conclude in a TP (technology project or a contractual relationship with one R&D institution (200 TPs pr year).

[3] See section below on key components.

- At least 25% of the firms that have concluded a TP shall within 2 years contract new services from a research institution.
- The institutions shall develop and implement a SME strategy by the end of 1995.
- In the institutes covered by the programme, 30% of the research staff are expected to participate in at least one TP.
- It is perceived as crucial that research staff participating in the TPs spend as much time as possible working with the firms on their premises. The minimum target is 3-5 days for each TP.

Monitoring research was set up as a continous process of evaluation. This evaluation was expected to cover not only measurable or quantitative elements, but in particular measurement and jugdement of a number of qualitative elements. Although this evaluation necessarily had to derive its deliverables from the system of objectives, goals and targets described above, further development of indicators was left specifically to the program comittee and the evaluators themselves.

## Target groups and selection criteria

The main target group was SMEs in the range of 10-100 employees. The memorandum stated, however, that this limitation was not to be conceived of as inescapable. Exceptions could be made, but the intention was to reach a "normal distribution" of size with the above reference in mind.

Target industrial sectors were identified as the range of Norwegian industry, especially in sectors with low or medium R&D intensity. We note that this deviates from the formulation of the rationale for the program, limiting the sectors to goodsproducing or manufacturing firms and producer oriented services. Hence the target group is somewhat diffuse.

Criteria for selection of firms were, however, not based specifically on sectors, but on assessments of the firms situation. These were of a judgemental nature, covering elements like:

- The general manager's ambitions, motivation, and competence;
- Strategic capabilities;
- Financial situation (here it is added that the firm should possess resources sufficient to embark on relevant activities);
- Willingness to deploy financial resources;
- Ownership matters;
- R&D competence and experience;
- R&D intensity;
- Knowledge level and competence (in the firm);

The memorandum underlines the importance of general manager and his/her personal motivations and comittment. This was seen as a perceived condition for the willingnes to engage in sustained efforts when activities started, and the ability to develop and stick to strategic plans. This point is raised also in connection with strategic development of firms for which another program existed (FRAM), and, as we shall discuss later, the linkage between these and other programs were seen as essential.

The main actors on the supply side were four polytechnical research institutions, distributed in five main regions (north, mid-Norway, west, south-west and east), all except one located in the four major university cities. The primary idea is to link these institutions to the SMEs, or put in different mode, "to search for tasks which could be carried out in this system". It is, however, stated that other research institutions could be selected if their competence is shown to be better or more relevant. The program management has the discretion of choice in this case. Such institutions could be the universities, research colleges, a number a sectorially

oriented research institutes, and other applied research foundations. Other actors, also regionally or county-wide based, were also referred to a partners, specifically if development of strategic capabilities was seen as necessary before any further work could be done.

## Organization and key components

The general organization of the TEFT program can be said to reflect an ordinary chain from sponsors (”owners”) to the operative level. The program’s political ownership is divided between two ministries: Ministry of local government and labor and Ministry of Trade and Industry.

The two ministries fund the program over the period, subject to approval of the state budget on a yearly basis. The funding is channeled to the Research Council of Norway (NFR), division of energy and industry (IE), the one out of six divisions responsible for technological and industrial research and technological transfer. The IE division has organizied its activities in clusters of activities, and TEFT is an integrated and key component of the overall program for technology transfer (PTT). This hierarchy has led TEFT to being called a project within the PTT. (However in this analysis the term program will be used for TEFT as both more proper as well as consistent with the SMEPOL terminology).

The PTT has its own governance system, and the six programs in PTT have all the same general objective: to enhance technology transfer to SMEs and their capabilities, as well as contribute to regional innovation. The overall budget for PTT is 372 MNOK for the period 1996 to 2000, (including the contributions from participating firms) a relatively large resource base. The budget for TEFT for the period 1994 to 1998 (five years) is 125 MNOK, funded as mentioned from the two ministries.

TEFT is governed through a combined mechanism of a board, or program committee, elected by the NFR-IE, and a program manager also chosen

by the latter. As has increasingly been the case in such matters, the program management is outsourced to one of the participating institutions, SINTEF in Trondheim, the same institution which initiated and ran DTS. The program committee is given a relatively high degree of independence from the NFR, and likewise concerning the program manager. The program committee has e.g. the liberty to decide on experimentation on the tools and methods on which the program is based.

This system was changed after two years. Programme for technology transfe (PTT) was established in 1996. The research council signed a contract with a consortium of the four research institutions to run TEFT. This consortium elected a board of directors. TEFT became a programme that was run by the supply side of the transfer system. The funding agencies' role became those of observers, albeit with influence.

The program manager is mainly linked to one of the two key components of the program, the technology attaches (TA). The attachees are based in the four research institutions, at least two in some, but one in Tromsø and Bergen, and are given countywise responsibility vis-a-vis the SMEs, one attache for two counties as the general rule (deviations were made to comply with some regional contexts). Their task is to clarify, through visitations, the technological opportunities in the SMEs that can best be met through R&D activities served through the participating institutions. The initiating process through the attache will lead to technology projects (TP), adapted to the strategic situation of the firm. The attache is not supposed to engage in these projects, but help a best possible selection of one or more research scientists in the institutions (not only their own). The attachees are thus employed by these institutions, but allocated to the program on a contract basis, full time. A crucial responsibility is to assess the firm's situation and help choose the best path for the firm, including chosing other programs or instruments available if that seems more rational for the firm.

The group of attachees is considered an organization in its own right, coordinated by the program manager. The norm for the duration of the attache contract was set to 2-3 years, securing a rotation of people involved and, with a broad participation of research scientists, a best possible penetration of the program in the research institutions. Specific requirements were set for the personal and professional qualifications of the attachees. They were supposed to possess a broad professional and personal background, being able to understand their environment of firms, research scientists, regional problems and challenges, other programs and policies, as well as being capable scientists themselves. The typical age distribution was 45-60. During the course of the programme, the individual capabilities of the attachees became more important than the stipulated period.

The other key component was, as mentioned above, the technology projects and associated processes in the firms. The role of the attache is a proactive one, visiting firms on their own initiative. To be able to coordinate this with other activities in the specific regions, a yearly plan for these visitations is established, giving apt opportunities for working in tandem with other initiatives (this will be discussed below). The TP and its associated activities can be described as follows:

The visit to the firm includes an interview. If the attachee concludes that there exists a basis for a TP, a pilot project is done. This is practically the first step in the TP. This is to avoid exessive use of resources: Pilot projects should be avoided where a TP is less likely to be started.

The pilot project takes a maximum of 2 days of work by the attache himself, covered in full by the program. The attache decides this at his own discretion. The objective of the pilot phase is essentially to assess the firms situation, problems and opportunities, scetch those areas were a

R&D project may contribute, assess the economic return and the strategic relevance of this, and consider if other options or programs are more relevant. The pilot project is reported to the firm's general manager, who still makes the final decision on the TP.

In case of a decision favoring a full technology project, this is planned by the attache. Since a key idea with TEFT is to develop learning, or more precisely cooperative relationsships between the firms and the research institutions, a prevailing norm is for the TP to be organized in such a way as to give a maximum range of contacts in both the institution and the firm. The TP may also be organized collectively, covering inter-firm cooperation if that is the proper option. However, this is a loose option, and not reflected deliberately in the rationale, goals or tools of the program. Even so, 40-50 collaborative projects have been initiated with the average of 3 firms in each. Thus, 120-130 of the registered TPs are collaborative projects.

The TP is run by a project manager, and a steering committee may be set up (an option that is seldom used). 75% of the total costs of the TP is funded by TEFT, while the rest is covered by the firm, both in terms of time allocation and cash. The contribution from TEFT is supposed to be used to buy services from the selected institution(s), and the upper limit of TEFT funding is 100 000,- NOK pr project and participating firm, five times the size deemed sufficient in the DTS programme. The average funding is 65 000 NOK, 2,5 times the size in DTS. In given circumstances a second TP may be implemented, however this time with a shared cost solution between the parties (50/50), and decided by the program manager.

Another dimension of TEFT, as described in the memorandum, is the regional anchoring of the activities. The attache is supposed to base his work on the available regional institutional set-up and infrastructure,

and thus develop networks with actors such as the industrial development departements in the county administration, the semi-private county based consulting service, the regional research institutes, colleges, key private consultants, and industrial and labor associations. This regional dimension is, however, not without inconsistencies and problems, a point to be discussed below. Suffice it to say at this point that TEFT's main or "primary" target is the 4 participating research institutions on the supply side, while another norm described in the memorandum is to make maximum use of regionally based competence, particularly since "proximity between the firm and research institute is of great importance".

Attention to monitoring and control was given at the outset, and TEFT was to integrate a system of monitoring research with the program committee as the client. Thus the continous evaluation of the program was supposed to give the program committee full information or feed back on key issues concerning the program, so as to make available adjustments both of the basic rationale and practical course of TEFT. The monitoring research was supposed to be independent, and the contract was given to a regionally based research institute not involved in the program.

Another feature to be mentioned here, is the launching of a "green line", a free of charge telephone/fax connection through which the firms may reach the TEFT program and the research institutions. This green line takes the role as a broker to ease the process of establishing contacts and to guide clients to the most relevant resource base.

# GOAL ANALYSIS: THE EXTERNAL AND INTERNAL PROGRAMME CONSISTENCY

## EXTERNAL CONSISTENCY: IS TEFT A "PROPER" PROGRAM?

In this section the external consistency of TEFT is analyzed. Implicit in the description above, taken mainly from official sources, is the notion that TEFT is not a regional program. A key characteristic in such a case would essentially be a bottom-up approach, with a program design matching the collective or articulated interestest of the social actors involved (Asheim and Isaksen 1998), or designed along specific regional variables, e.g. aiming at enhancing regional production or innovation systems, an approach which implies attention to detecting and developing relations among partners in the regions themselves, and that this "systemorientation" is at the heart of the program. A regional program would need a reference to "collective action" as either an objective or a source. TEFT can be instead seen as a decentralized national program with the target group being individual firms nation wide, categorized as SMEs with certain characteristics.

The general interactive and systemic reasoning behind the analysis, common to all evaluations in SMEPOL, is discussed in the introductory chapter in the paper. The discussion here will be twofold: First a description of norms or guidelines for the new mode of policies, and second a discussion of consistency of TEFT's basic idea and objective given this frame of reference.

### Guidelines for interactive policy design

The most comprehensive analysis of general policy implications from the systemic or interactive model for innovation can be found in the Maastricht Memorandum, a strategic analysis carried out for the European Commission (Soete and Arundel 1993).

This analysis does not pay any specific attention to either the class of SMEs or the regional level, but take the firm level as the frame of reference for the implications from theory.

Table ….. Firm level implications for policy from the interactive model

| **Major characteristics of a systems model of technical change** | **Policy implications at firm level** |
|---|---|
| Multi-directional links at the same point in time | • Support research and education that improve the organization of innovation<br>• Support networking and cooperation among research institutions and firms and the infrastructure of supporting services |
| Cumulative processes over time | • Policies to assist firms in ulearning when needed and to develop new areas of expertise |
| Each innovation is unique | • Preserve a diversity of options by nurturing the technological capacity of firms |
| Dependence on knowledge and assimilation of information | • Provide support for the retraining of staff<br>• Technology transfer and demonstration programs |
| Interdependent system | • Ensure complementarity and coherent policies |

Here attention is given to firms and their knowledge management function. Such knowledge management has both internal and external dimensions, and indirectly it is referred to inter-firm linkages and milieus between firms and the institutional set-up.

When guidelines or implications for policy are designed for SMEs, the problem linked to the regional dimension surfaces. SME's are often associated with some regional attachments, or dependent theoretically on endogenous resources. Thus, the regional dimension is generally implicit in the "good practice", as in the case of Storper and Scott (1995) version of sound policy approaches. These:

- Are context-sensitive, i.e. concerned with the embeddedness of measures in specific contexts and adjusted to the challenges and bottlenecks in different kinds of SMEs, regions and innovation systems;
- Are production-system or innovation system oriented rather than firm oriented;
- Include more than technology support, as innovation processes in SMEs are complex in relation to firm-level resources. This implies that instruments be developed that can respond to the whole range of potential needs, like organization, strategy development, finance, market exploration, training etc);
- Are directed towards the ongoing adjustments capacities and learning ability of regional economies and policy makers, rather than once and for all implementation of "best practices" (cited in Asheim and Isaksen 1998).

The distinction between regional economic development and SME development is not quite clear, as we have noted before, and although we acknowledge the general orientation of these guidelines, they subsume SME as a concept under the concept of regional economies. Since TEFT is essentially a decentralized national program, this mixture does create analytical problems.

However, the value of networks and proximities for SME's competitive development is one cornerstone of the knowledge derived so far. This is also clearly linked to regionally based institutions and other institutional

set-ups in the total web of structures and flows. Interactive learning and endogenous development are seen to be dependent on viable local or regional sources or nodes. This comes through in the following typology of relevant innovation measures for different types of SMEs (again presuming that these are linked, and cannot be assessed without this relational quality) (from Asheim and Isaksen 1998) (see table ...)

Again SMEs are associated with systems or relations, this time however with a specific classification of SMEs according to their position in the system. Thus, as with proper regional policies, programs will have to aim princippally at relations and systems, not at individual firms. As with Storper and Scott above, best practice policy towards SMEs, are not firm based but system based.

Table …. Relevant innovation policy measures for different types of SMEs

| **Types of SMEs** | **Main aim of the innovation policy** | **Example of relevant measures** |
|---|---|---|
| ”End firms” in local production systems | Further develop territorially embedded regional innovation systems | Establish/develop technology centre |
| ”Isolated” end firm outside local production systems | 1) Enhanced embedding of radically innovative SMEs<br>2) Connect less technologically advanced SMEs to competence milieus elsewhere | 1) Increase the significance of the local industrial milieu via more qualified local suppliers and adapted training and education<br>2) Broker institutions |
| Subcontractors for firms outside the region or for large, local firms | 3) Embedding of specialized subcontractors<br>4) Transform capacity subcontractors towards spezialization | 3) Maintain and develop local networks and institutions<br>4) Promote more long term partnership between buyer and subcontractor |
| Small start ups | Connect firms to innovation systems | Support and advice to entrepeneurs. Brokers. |

Another approach is taken in Hassink (1997) and Vickery (1996) (cited in Nauwelaars et al 1998). Based on studies on suppert schemes and agencies targeted at SME’s, the following can be seen as good guidelines for effective or efficient guidelines:

a) Measures should be receiver-oriented and work proactively towards understanding SME’s needs;

b) Advisors should approach SME's personally and in an informal way;
c) They should be staffed with well-qualified and motivated personell, continously trained;
d) They should not limit their service to transfer of technology, but also provide for access to "off-the-shelf" technology and embed technological information within other business information;
e) They should supply and coordinate a wide range of services covering the strategic needs of the small business sector;
f) They should have an emphasis on investment in non-physical assets, on building capabilities and upgrading managerial and technical skills within the firms;
g) They should be subsidized for services targeted at structurally weak SMEs;
h) Funding based on cost sharing will enhance the quality of services delivered;
i) They should support the establishment of networks between SMEs;
j) Their functioning should be evaluated regularly and independently.

These three sources of guidelines for policies towards SMEs reveal a not quite consistent picture. At face value, there is a difference between research coming out of the regional studies tradition, giving great attention to regional properties, and others seeing the SMEs as a class of firms with certain deficiencies and needs as firms. Item i) above is i.e. not consistent with research results pointing to the significance of linking SME's vertically in user-producer relations (see e.g. Lundwall 1992).

However, these approaches do not necessarily exclude one another. Policy implications formulated for the firm level may, or must, be associated with those for the regional or meso level. The main point is that particular instruments must take into account the specific problems and challenges that exist for these firms, as e.g. weak in-house human resources and often excessive production orientation, while the overall policy will

have to deal with the systemic relations in which SMEs find themselves. The key lesson coming out of the interactive and systemic model, is that flows and learning in regional or other milieus are important. Other milieus could encompass national level institutions, and implications of strenghtening firms external management capacity could also comprise sectorial or national innovation systems or their institutions. But given the importance of proximity, enhancing the regional institutional set-up to improve the foundations for regional collective action should be one of the crucial elements in policy design.

**Is TEFT a proper program?**

There are a number of positive elements in the creation of TEFT. The program is clearly designed to avoid a "technology fix" mode of operation, and is targeted at increasing the capacity of individual firms in managing technological development and inducing skills in R&D management. The program's key idea is learning on two levels: It is supposed to induce learning within the firm in identifying and initiating R&D projects, and is in this way also reasonably need-oriented in its focus. It is also supposed to, and this seems to be a major function of the program, to induce learning in terms of using external resources, a rational target since the firms envisaged to participate do not possess internal resources for this kind of work. Learning to use R&D institutions seems a valid objective, which implies in our framework learning to use the national innovation system. On the other hand, this objective, in our view, is nor consistent with the selection of a few dominating R&D institutions, leaving the rest in a less competitive position vis-a-vis the TEFT-institutions. The programme clearly underestimates the importance of personal contacts and networks in this learning process, a fact which will lead to a reproduction of relations with those in the programme.

The informal approach and the foreseen role of the attaches seem consistent with the needs and modus operandi of the firms in question, a focus

also consistent with the use of visitations and pilot projects and attention to the personal motivation and other prerequisites of the manager. TEFT is to work proactively, with little bureaucracy and with experienced attachees. TEFT is oriented to learning, not specific technologies, and the target group is R&D weak SMEs in the manufacturing industry, both rational objectives in our framework.

TEFT is also firmly placed in a complementary position in a bundle of other and similar programs under the umbrella of program for technology transfer (PTT) in the research council. The foreseen relationsship with other programs and initiatives through the mandate of the attachees to guide the firm to these if they seem more relevant, is at the outset clearly a means of coordination, not least with key actors in the local support system.

However, we do have concerns about some of the elements in TEFT. The ideological basis is to some extent supply-oriented, and the heritage from the DTS is still there. TEFT is thus also serving the interests of the participating institutions, and although the mandate is to guide firms to others as well, the positioning of the attaches in the four institutions, including their employment relationship, represents a case of assymetric information to the benefit of these institutions. Although these institutions are conceived as ”regional R&D institutions”, this phrase is linked to an earlier reorganization, releasing them from central ownership and placing them in a system which was called regional research corporations, with one exception located in university cities (see above). Although the majority of R&D for industrial use takes place in this system, it still is withdrawn from the rurally based districts, and may in principal undermine the role of more locally based institutions, or even other sectorially based institutions. While we endorse the improved use of the national system and their increased ability to market their resources vis-a-vis the SMEs, it seems clear that the inconsistency with the regional dimension, clearly

spelled out in the DTS-supported monopolizing of one key R&D institution, is to some extent unresolved.

Here we have to return to the discussion of relating the idea of a region as a basis for collective action to the concept of infrastructure. Although Norway is divided into 19 counties as a meso-level political-administrative system, we assess this not necessarily as regions in the framework of innovation policy. The counties are essentially systems of distribution (of more or less ear-marked state transfers) rather than systems of innovation in a developmental sense. Innovation policy takes hence often the form of decentralized national programs, and the question of "regional infrastructure" (except in physical investments which is abundant) remains largely unresolved in the nexus between R&D and regional policy. TEFT does nor adress this, and defines rather the regional dimension implicitly in terms of the regionalized supply side and to some extent the county-based coordination of public initiatives. Thus, we view the TEFT's regional focus as weak and possibly contradictory, but with a contradiction that lies at the heart of the Norwegian society itself. This is even more so the case as TEFT is not attantive or sensitive to specific contextual situations, e.g. in leaving out the promising Agder-model. Although some activities have taken place that include this regional system better than in other parts of the country, this is more a result of informal adaption than programme design. This is also linked to a low degree of sensitivity to how the firms are positioned (systems based, end firms or isolated firms), although this is also adapted to in the course of the programme implementation.

The capacity building in firms is rather weakly expressed in TEFT's rationale and objectives, although "business development" itself to some extent refers to this. But the associated instruments of competence building, human resource investment and skill development are also weakly formulated, suggesting that the attention to this aspect of the interactive

model is not properly defined. TEFT is more focused on project development than internal competence development, which leads additionally to a lack of focus on resolving lock-ins and creating means of "unlearning" as a key component of knowledge management.

Since TEFT is essentially a decentralized national program aimed at firm level problem solving and learning, the critique presented here is only partially relevant. Networking and learning within and between firms and R&D institutions is firmly placed within the basic assumptions from the interactive, systemic model. The key issue of coherence with existing infrastructure and the ability to build upon and use local resources is an empirical question to which we return later.

## INTERNAL CONSISTENCY: GOVERNANCE, GOAL STRUCTURE AND TOOLS

Questions of internal consistency are not unrelated to those of external consistency. For practical and analytical reasons, however, these will be treated separately. In this section we will discuss issues of internal consistency, mainly those of coherence between goals and means and associated with this, between goal themselves as these are stated in the memorandum. We deem it important to discuss this within a broader framework, and we will pay attention to how the degree of consistency relates to the expectations from the interested parties (e.g. ministries) and how the program is governed (more specifically the use of monitoring research to relate the program's practice to the knowledge needed to govern the program).

### Consistency of expectations

A key question relates to how the objectives and goals of the program reflect the intentions of those who are politically responsible for it. It seems clear that this also relates to whether policymakers designed the premises for the program in the first place. But leaving that aside, the issue here is whether the stated objectives of the program corresponds to the intentions of those who politically initiated the program. This, like other

elements in this section are partly empirical, and the main reference is to a study commissioned by the research council (NFR/IE) on a strategic analysis of the program (Sinova 1997).

TEFT has a relatively complex goalstructure, combining business development and infrastructure development as equally important. Sinova (1997:8) compresses the strategic idea behind TEFT as follows:

i) SMEs need (for them) new technology, new innovations, processes, products and new business ideas to remain competitive in a tougher international competition;
ii) These services are found in R&D institutions;
iii) Neither SMEs nor R&D institutions have resources, capability, time, knowledge (or whatever) to establish contact with the other side to the extent that what they call sweet music is played;
iv) Therefore it is socially beneficial to help create this cooperation through public means.

Implicit in the interactive model is the notion of relationships, that these are the key to development rather than indivudual firms or their factor consumption. Incidentily, this deviates from the distinction between the well protected principle of neutrality of sector in industrial policy and state activism. Neutrality is associated with a notion of the state building frameworks to which firms must adapt (passiv role), rather than engage in selective choices of industries and technologies (active role). The interactive or systemic model of innovation and economic development blurs this distinction, allowing for state activism without selectiveness in developing relations through the mechanism of coordination (Remøe and Braadland 1998).

Although this is not reflected in any articulated rationale of TEFT, the key role given to networks and linkages reflects such a focus. But the two

ministries have different traditions, and while the ministry of trade and industry traditionally focus on enhancing individual firms competitiveness, the other ministry focus on regional issues, structures and development. Sinova states that this also leads to conflicts or disagreements in the TEFT case, albeit with very weak empirical support (Sinova 1997:17). But the tentative disagreement between the two suggests that the objectives of TEFT is not firmly supported by the ministries in tandem. Interviews conducted with representatives from the ministries also shows disagreement with the choice of key success indicators: While the TEFT indicator is the degree to which firms engage in recurring procurement of R&D services, there is considerable disagreement between the ministries on this point. The lack of consistency on the policy level is thus a potential problem. Sinova refers to this as inconsistent demand chains: "Some of the weaknesses in TEFT stem from e.g. inconsistent demand; from the ministry to the research council, from the research council to the consortium (program committee?), from the consortium to the project (program) management and evaluators etc". Further, it is not clear which is the most important objective, business development or infrastructure. The TEFT comittee tried to resolve this in stating that the business development goal was the dominating one, but the way funds are channeled may indicate otherwise.

It would probably be naive to expect that the formulation of objectives and goals to be rational in the classical sense when the political (and often empirical) landscape is more or less inconsistent. Programs, as organizations, typically reflect the institutional environment in which they are embedded, producing formal structures and statements "as myth and ceremony" (Meyer and Rowan 1977), underlining the ceremonial role of these formalizations. So even if inconsistencies at this level is found, it should rather be assessed as a typical environment for such programs, a challenge to be tackled by the meso-level governance structures in the re-

search council and the program committee. Thus, the policy learning capability of these institutions is a crucial issue.

**The goal structure and monitoring research**

The goal structure referred to from the memorandum is that of a hiearchy, aiming at a deductable system from general objectives to (mostly) measurable targets. Sinova's study, based on selected interviews and workshops with key persons within and connected to the program, concludes:

- The goal structure is too complex and difficult to interpret;
- The goal hieararchies are only partly, and in some cases only pretending to be hiearchies;
- The targets are a mix of operational and impact targets.

Thus, the overall goal structure can be seen as a negotiated outcome of processes where different interest groups participate and produce a partly non-consistent governance system. The goal structure is a compromise between the funders or initiators, giving rise to priorities that do not add up. As mentioned before, this does not a priori represent a major problem, since program governance necessarily will have to integrate these inconsistencies into learning processes. Therefore an important function is given a priori to the monitoring research, and the way this activity is fed back to the program. Implicit in this is the question of who or which level should be client for these researchers.

The monitoring research was decided (in the memorandum) to report to the program comittee. Thus, the program comittee was defined as the client, and given the responsibility of this committee to implement the program according to the memorandum. In this way, the formative evaluation process can be conceived of as providing the necessary information for the commmittee to fulfill its task.

The formative evaluation was given the following mandate or role:

> ”The research activity reports to the program manager and the committee 2-3 times a year. These reports shall make it possible to develop processes related to the results and at the same time ease the implementation of necessary adjustments in the program.
>
> The monitoring research can be seen as a continous evaluation. It will consistently measure the program’s temperature. Negative aspects of the dayly operation will be detected. It will at an early stage be possible to assess impact indicators so as to detect unsuccessful concepts and adjust the rationale. The chances to achieve the stated goals will increase.
>
> The monitoring research will serve as an independent quality assurance for the program committee.
>
> Feedback from the research will ease the continous reporting, and make the summative reports easier. The monitoring research will contribute to creating a learning organization”.

The tender documents for the evaluation contract specified three intentions for this activity:

- Assessing the program’s results vis-a-vis the stated goals and targets
- Representing an independent assessment and quality assurance of the dayly operation of the program
- Developing useful knowledge about technology transfer and business development, and through this contribute to a continous learning in the program.

Hence, the formative evaluation was firmly placed in a learning framework, consistent with the overall idea inherent in the systemic models of innovation. The institute finally responsible for the monitoring, gave particular attention to the technology projects (TP), through which it would be possible to assess both firm level impacts as well as long term infrastructural effects (Sinova 1997:14). Sinova argues, however, that there is a tight link between client and the practical execution of the monitoring. The funders (ministries) as well as other national institutions were engaged in giving inputs to the tender process, but the program committee became the formal and real client, taking the final decision on issues concerning choice of research group and the framework in which the monitoring should take place. A certain inconsistency is inherent in this: The research council and the funders (ministries) were highly interested in the monitoring research, the programme management less so. But the latter became the client.

Sinova has some interesting observations on this point. Key priority was given to the needs perceived by the client – the program committee, implying a "controller"- focus on these needs. This implies:

"- a reinforced focus on dayly operations, on discrepencies, and possible actions to prevent discrepencies;
- short and written communication, often standardized, based in the continous data collection;
- that the majority of the tacit insight on behalf of the evaluators is disseminated orally or informally;
- that the learning generated from the monitoring became limited to the core group of persons, the committee, program management and the attachees.

On the other hand, this implies a downgrading of:

- data collection of a social science nature, like time series analysis of the data from the firms to explain successes and failures not immedi- ately visible;
- analyses that could contribute to an assessment of the very model of TEFT, including its relationship to other programs;
- the broader learning process explicit in the tender documents and responded to in the bid from the successful bidder."

In this way, the monitoring excercise became a tool for program management, not for policy level learning. It is an indepenedent controller mechanism. This implies that the reseachers became an integrated component of the program management, that the researchers had influence on the program's priorities, and that they carried out more technical tasks. This is of course legitimate, but we share Sinova's assessment on the skewed nature of the monitoring excercise, diminishing the policy level learning expressed as a key issue itself. The intention in the tender documents about developing knowledge on technology transfer and business development is not existent in the 21 reports that have come out of the monitoring excercise as of today. On the other hand, we may add that Sinova is not very sensitive to their own role, which is supposed to provide the policy-makers in the research council and ministries with a similar "strategic analysis".

### The go-betweens: the TEFT attachees

The TEFT program is essentially a proactive program focused on volume of visitations and TPs. The technology attachees are the key instrument to achieve this, and the very nature of TEFT is linked to the match-making role of the 10 attachees employed in the program. They are all employed by one of the four R&D institutions participating in the program, but are allocated to the program on a contractual basis. Five of them are employed by and located in SINTEF, Trondheim (the institution responsible for carrying out DTS, the forerunner of TEFT), one in SINTEF, Oslo, two are in Rogaland Research, Stavanger, and one each in NORUT, Tromsø, and Chr. Michelsen Research, Bergen, respectively. (In a separate report from the attachees the program management are included in the definition, adding three to the group).

The attache group engaged in self-organized learning processes, meeting several times a year, and producing an experience based report in late 1997. A number of roles (13 in all) were defined in this report (TEFT 1997), suggesting a great variety of activities to be carried out by them. However, the basic roles played by the attachees, are two-fold and and two levels: First, and this is the primary function, the attache is the match-maker between the supply side and the demand side, in this case the R&D institutions and the target firms. This matchmaking is supposed to produce technology projects through visitations and pilot projects in the firms. Thus, the attachee performance is tightly measured according to the program's goal structure related to activity, visitations and technology projects.

Second, the attachees are supposed to serve as go-betweens on a program level, thereby contributing to the coordination of TEFT with other policies and programs on a regional level. This activity is specifically geared towards coordination with the regionally based people and institutions working in related areas, thereby contributing to a better harmonization of public initatives vis-a-vis the private sector, as well as with a group of other programs run by the research council or the state's development fund SND. On this level, there are no explicit goals or targets to achieve, the result being that the attachees have not given the priority to it as foreseen in the more general intentions [4]. An exception may be the coordination of TEFT with VARP, a program aimed at R&D in the manufacturing sector, reinforcing the concentration of activities to the traditional goods-producing industry (see next section on results and impacts).

The match-making takes on several roles, described in the report mentioned above, but which are not to be refined here. Suffice it to say that the combination of external roles (like ”technology diffuser”, ”project developer”, ”marketeer of R&D”, ”advisor”, ”mentor” and ”networker”) and internal ones (like ”administrator”, ”supply side networker”, ”researcher” and ”program developer”), makes it a rather demanding role, but where the attachees in the document do not provide a priority to some of these. In practice, the roles of technology diffuser, project developer, and marketeer

[4] Interview with program manager

of R&D rank high. However, the mode of collaboration between them, coordinated by the program management, has been an important device for program learning and development of a common platform for handling a wide range of issues related to SMEs. Thus, one might say that the attachees not only are supposed to be ”learning by doing”, but even more so by ”learning by exchanging”.

The attachees operate by developing yearly visiting plans which makes coordination and communication with regional institutions possible. The plans also contain targets for individual attachees, which are aggregated to achieve the yearly targets for the program as a whole.

### Additional tools in TEFT

In addition to the key tools of technology attachees and technology projects including pilot projects, the TEFT program include some other measures. An *SME-forum* was established early in the program to facilitate improved contacts between the SMEs, the attachees and the researchers. The forum included contact persons in the research institutions on a deartemental level, aiming at a broad range of contact points especially within the research institutions. This measure is thus essentially to support the infrastructual objective through improving contacts and coordination on the supply side. The forum was not very active, and closed down after a short while until it reestablished in 1997 with two meetings.

Specific measures on *information* were organized, in particular through two activities: First, a brochure is distributed to firms, institutions in the wider policy area, researchers in the TEFT program and to the wider research community. Second, and more important, a newsletter was developed and distributed to the same target groups. The newsletter aimed specifically at producing good cases from the program and served in this way to communicate good practice and to enhance the demonstration effect of TEFT. The distribution rate of both the brochure and the newsletter has been 11 000 to 13 000, the newsletter being distributed 3 times a year.

The program memorandum stressed the ease of communication from the client side (SMEs) to the program management. Therefore, a ”green line”, a free of charge tele-

pone service was established. However, the response to this service was low, and it was removed from the program tool box in the second year (1995).

### Assessing consistency

The question of internal consistency relates to the link between the system of objectives, goals and targets, and the tools and activities put in place to achieve these. Bearing in mind that we do not expect any full or complete rationality in this respect, the TEFT program looks on the surface to satisfy major expectations of consistency. The program is essentially a volume-oriented activity program aimed at generating new behaviour through matchmaking and project activities in the firms. It takes up new imperatives like mechanisms for learning, it attends to the need of developing capacities in firms and to the need to place any project firmly in the practical need situation of the firms themselves, essentially through visitations and pilot projects. The program has managed to set up a mode of operation with a low level of bureaucracy, thereby corresponding to the needs of the clients.

There are, however, some considerations. While the system of double objectives, infrastructural and business development respectively, both count, but was in the early stages of monitoring research changed to give priority to business development, TEFT as such, including its tools, is inherently skewed towards the supply side, i.e. the infrastructure, as this is defined in the program. This is often stated, even if accidently, in phrases like ”the prime target for TEFT is the research institutes”, or is shown in the program committee with a majority of representatives coming from the R&D institutions. Although the incentive for the attachees is linked to generating projects of great relevance and importance for the supply side, and although it would be difficult to find neutral positions and still be able to create the sort of communication necessary for TEFT, the program still seems to be unclear at this point. This also relates to the problem of defining ”infrastructure” for SME’s discussed earlier.

Another issues relates to the goal of generating R&D capacity in the firms, essentially through TPs. According to theory, such capacity is essentially linked to learning capacity, e.g. to cumulate as well as dissolve knowledge according to long term needs of the firm. On the other hand, the TPs are relatively short, and according to

the attachees themselves, the initial stages of the TPs take up to much time and leave to little to the problem solving and learning process. Only a minority of the participating firms have gone through a second TP (see next section), and we assess the consistency between the tool of TPs and the goal of developing capacity to be incomplete. This is reinforced with the lack of attention to an educational programme or specific learning component in the attachees' tool box. Even if the TPs themselves perform well (we look into this in the next section), we question this low priority of learning processes within the firms.

A major point is noted concerning the monitoring research. The attention to this, a key issue in modern governance of programs to facilitate program and policy learning, was inherited from the "BUNT"-program which served as the model for monitoring research. Sinova's report is rather critical to the way the TEFT monitoring research was conceived, limiting the research to accountancy, even if it's budget was almost 1,5% of the total TEFT program. The monitoring research made a contribution in the beginning, solving some inconsistencies in the goal structure, but the written reports since then, 21 in all, are simplistic accounting on the key indicators making up the baseline of performance monitoring. We support therefore the critique by Sinova of the monitoring research, which in its conception as well as in its own performance is not consistent with the learning needs of program management nor policy makers. If good and useful evaluation is supposed to produce relevant questions to program responsibles, then this function hardly exists.

# RESULTS AND IMPACTS

In this section we will describe and discuss the results and impacts achieved so far in the program. The data available cover the period of 1994-1997, the remaining year of 1998 obviously not covered. Nevertheless, we view this as sufficient for the present analysis, also because the pattern of results and impacts does not vary that much, and is likely to persist throughout the program period.

The major indicator of impact is the one on recurring procurement, i.e. the degree to which the firms engage in new procurement of R&D services. The major indicator of effectiveness is the share of visitations ending up in a TP, target value set to 50%. Here it is noted that the comittee decided early on that the absolute number of TPs (200 pr year) should be the key target value. Table .... presents all relevant indicators, including the two mentioned.

**Fig.. Key figures on results and impacts**

| **Year** | 1994 | 1995 | 1996 | 1997 | Sum | Target |
|---|---|---|---|---|---|---|
| Visitations | 448 | 424 | 408 | 463 | 1734 | 1600 |
| Pilot projects | 152 | 191 | Na | Na | Na | 800 |
| Initiated TPs (first) | 139 | 185 | 175 | 170 | 669 | 800 |
| Initated second TPs | - | 3 | 16 | 31 | 50 | na |
| Average TEFT contribution* | 66% | 57% | 58% | 55% | 57% | Max. 75% |
| Average firm share** | 34% | 43% | 42% | 45% | 43% | Min. 25% |
| Share visitations in eligible areas | 39% | 53% | 48% | 58% | 49% | Min. 50% |
| Share TPs in eligible areas | 30% | 48% | 44% | 39% | 40% | na |
| Share TPs in core goodsprod. Sectors | 52% | 50% | 54% | 50% | 51% | Aver. Norw. 33% |
| Recurring procurement*** | | | | | 30% | 25% |
| Degree of novelty*** | | | | | 41-50% | 50% |
| Increased R%D intensity*** | | | | | 41% | 50% |
| Firms' assessment of TP contribution*** | | | | | 20% | 50% |

* Only first TP

** Cash and hours

*** Based on monitoring research

The table shows that the target of 1600 visitations have been met by a good margin, but that the number of initated TPs is below expectations, even if allowing for the 50 second time TPs. The pilot projects, the target implicitly stated in the program documentation as similar to visitations, implying that all vititations should end up in a pilot project, has not been met, and is not even measured beyond the initial stage of the program. This suggests an incomplete tool box, as well as an inappropriate monitoring which is not able to detect this, let alone initiate a discussion to allow for necessary changes.

We do not assess this deviation as an indicator of failure in its own right, since there are other positive results achieved. This concerns in particular the average share of firm contribution (cash and hours) to the TPs, which has developed positively throughtout the program giving an average of 43% of total project costs, as compared with the target of 25%. The importance of this result is undercommunicated in the yearly reports from the program management and monitoring research, but indicates clearly that TEFT has achieved a satisfactory degree of effectiveness in implementing TPs, and it indicates as well that there is a lack of consistency between the target of 800 TPs in this period and the available resources in the program. If the participating firms should have contributed with only the target value of 25%, TEFT could not have afforded even the number of TPs that has been implemented. But more importantly, it indicates a willingness on the part of the firms to invest more than expected in the TPs, suggesting a positive attitude to engage in these projects.

The share of visitations in so-called eligible areas, i.e. areas eligible for support under schemes from the Ministry for regional affairs, is an important indicator in the present context. The target has almost been met, with 49% visitations in these areas, compared with 50% target value. This has been achieved persistently throughout the period with the exception of 1994, a year which was compensated for through extra activities in 1997 to achieve a better average. The share of TPs in the same areas is 40%, suggesting a slower response to engaging in R&D in firms in rural areas.

The share of TPs in traditional goodsproducing sectors has not been included in any goal or target statement, but is included here to show a tendency in this as well as other programs. The traditional focus of programs for technology transfer to industry

in general is persistently on metal and equipment producing firms, sectors that account for ca 33% of the Norwegian industry. Yet, the TEFT share is 51%, suggesting a self selection in the relationship between the supply and demand side in the sense that the key competence areas in the R&D institutions tend to be related to these industries. Other sectors, like food processing, wood products etc, are present in the program to a lesser degree, even if they suffer more from lack of R&D capacity. The overall result indicates a certain mismatch between the latent needs on the demand side and the reproducing mechanisms on the supply side.

The key indicator of impact, recurring procurement, has achieved a value of 30%, i.e. 30% of the firms participating in TPs engage in new procurement from their own initiative within a period of 2 years of completion of the TP, against 25% target value. It is difficult to assess the basis on which this value was set, but it was certainly judgemental and not based on lessons from other programs, although the lesson from DTS of 30% of the TA's led to what was referred to as "further innovative activity". Still, the result of 30% is positive, and together with the high rate of firm contribution to the TPs, it suggests impacts on firm behaviour above expectations. We may add here some data on the pattern of procurement, shown i table ….

Table …. Pattern of recurring procurement

| | % | Av. size |
|---|---|---|
| Share of firms with rec. proc. with the same R&D inst | 18% | 643 000NOK |
| Share of firms with rec. proc. with another R&D inst | 17% | 225 000NOK |

Interestingly enough, the firms which enter into continuing relations with the same R&D institutions that conducted the TP, also enter into significantly larger projects. There are no further data on this subject, but one can speculate that sufficient trust has been developed among the TP-partners to give rise to significantly larger follow-up projects (although a great deal of these are not directly follow-ups from the TP itself). It seems, therefore, that successful TPs create the foundations both for further

external participation as well as increased R&D intensity in the firms continuing the old relationsship. Thus, if these are reliable at all, relations are important.

To some extent, this is contradictory to the three indicators on the bottom of the summary table. The degree of novelty for the firms and the share of firms reporting increased R&D intensity (R&D expenses relative to turnover) are both below expectations, although the final year may change this. The more surprising result is that the share of TP firms reporting that the contribution of the TP to the overall strategic development of the firm is 20%, far below the target value of 50%, a result that is deemed very positive by the programme management, and rightly so. This is even more surprising since the monitoring research's measurements of the attitudes in the firms themselves show that 73% of the firms report a good linkage between the TPs and the firms' business plan. This, and other relatively positive assessments on the part of the firms, suggest some serious validity problems in the way these impacts are measured. This inconsistency is not given further attention in the monitoring evaluation, a fact that underlines the weak role played by this research.

### Further firm level impacts

The data available from the monitoring research give some indications of the role played by the TEFT technology projects. The data considered are collected 1-2 years after the completion of the TPs in the respective firms, on average 18 months (Aarvak and Bjørgulfsen 1997). The data shows that 56% of the TPs were single or independent projects with no linkage to other projects or continuation after completion of the TP. 19% were TPs that led to the initiation of a more comprehensive project, while 25% of the TPs were linked to a larger development project already under way. The participation in TEFT had led to the following impacts:

Table ….. Firm level impacts*

| Item | Share |
|---|---|
| Improvements in existent products | 43% |
| New products (new to the firm) | 35% |
| Improved production technology | 40% |

| | |
|---|---|
| Increased turnover | 12% |
| Increased R&D | 41% |
| Increased R&D capability | 59% |

- Based on a survey to 138 firms, response rate 62%

These data indicate that firms seldom achieve economic benefits directly, but that they report significant improvements, and also increased R&D intensity and capability.

Other survey results from the monitoring research are briefly discussed (Aarvak 1998). The attitudes in the firms are relatively positive, especially vis-a-vis the role played by the attachees and their ability to understand the general situation and the technological challenges of the firms. Even 85% of the firms report that they collaborated easily with the researchers engaged in the TPs. 68% of the researchers report that the contact with the respective firms persisted beyond completion of the TP, and 48% reported that this concerned the planning of a new project. In sum, the results indicate that the general model of TEFT, using attachees to initiate TPs in firms as a way to increase R&D and continuing demand for R&D services, works reasonably effectively, producing continued relateions between the two parties.. However, the monitoring research shows that only 50% of the first contacts between TEFT and the firms were initiated by the attachees, while almost 30% established contact through the public support system, other firms or through the information activities of TEFT, again a fact that is deemed positive.

### Impacts on infrastructure

The infrastructural results are worth a closer look. Of the total TPs 68% were conducted by researchers from SINTEF, while 18% were conducted by the three other participating R&D institutions. The rest, 14%, were allocated to 22 other institutions. When average size of the TPs in cash terms are 90 000,- NOK, SINTEF alone has generrated a turnover of ca 48 000 000,- NOK in these four years. Added to this are the recurring procurements, implying that TEFT represents an important market for the R&D institutions, and in particular for SINTEF, the former DTS-node. However,

as these revenues represent only 1% of total turnover, the importance for SINTEF may be more of a political nature than financial.

The relatively high concentration of TPs to SINTEF, northern Europe's largest independent R&D institution, also emphasizes the national character of TEFT, concentrating a great many projects to the key national institution, implying a rather passiv role of the regional institutions and support system. Although the attachees are supposed to generate TPs to the best feasible R&D institution available, TPs are consistently channeled to SINTEF, partly also because 6 out of 10 attachees are employed by SINTEF.

The impact in the infrastructure has been measured by attitudinal responses by the researchers. The researchers are asked on their opinion as to whether their own departments have developed a more positive attitude to SMEs through the lessons from the TPs, in which case ca 82% respond confirmatorily. The response i slightly more positive on their own attitude towards working with SMEs. Seen in isolation, this looks like very satisfactory impacts, all the more so since almost 70% have continued their contact after completion of the TP. But we again question the validity of this indicator, given the rather large market value that TEFT represents for these institutions.

Thus, the infrastructural results are mainly in the four participating institutions, in particular SINTEF, and also between these, while the overall infrastructure on R&D remain relatively untouched. This corresponds also with the chosen indicator, attitudes within the four key institutions, thus avoiding a broader assessment of TEFT's impact on the national/regional infrastructure as such. One has, though, to bear in mind that the very rationale for TEFT has been to strenghten the SMEs technological capacity with the specific supply from the four selected institutions in mind. This narrow definition of infrastructure lends itself to analytical problems, since it does not relate to the basic premises for new innovation policies as referred to in the theoretical introduction. A key question, therefore, is whether TEFT has infrastructural impacts outside the focal R&D institutions and the environment of the firms where they exist and operate, i.e. in the regions or areas where support systems and programs are supposed to be coordinated.

### The coordinating effect of TEFT

While TEFT is explicitly a decentralized national program with few regional dimensions as such, the program is still aiming at linking into the regional system of public support, infrastructure and business development services. The TEFT attachees are supposed to help link TEFT to the other initiatives, and thereby play a coordinating role locally. However, as we have stated earlier, results and impacts are not measured on this, and the monitoring research has not covered this particular activity.

The idea that representatives from one program should be able to initiate an improved coordination on the regional level would imply that this program is given a key role. This is not done formally, so any coordination achieved would be the result of the ”regional willingness” and an emerging tendency to improve the foundations for collective action through cooperation with external people. Hence, we do not expect significant impacts in this respect, in particular because many programs are also decentralized national programs in nature, with the implicit need for coordination on a national level. The discussion in this section are based on the collective report from the group of TEFT attachees (TEFT 1997) and interviews with the coordinating person in the research council of Norway (Program for Technology Transfer) and key persons in two counties, Østfold and Aust-Agder, the latter county is the homebase of Agder Research Foundation which generated a special role in the DTS program.

Coordination with the rest of the public support system would be an immense task for the TEFT attachees. This system is highly complex, both in its structure of diverse programs and initiatives, as well as the interests and premises governing these initiatives. When the attache is supposed to guide the firms to the program relevant for the firm, this presupposes an insight on behalf of the attache and a goal orientation not explicitly compatible with TEFT itself. There is a contradiction between the key role of the four institutions on the supply side, and the objective for the attachees to guide the firms to whatever initiative is the most relevant.

Two modes of coordination can be said to represent realistic options for the attachees, and which have received some attention. The first concerns a vertical coor-

dination between three programs, FRAM (strategic business development, run by SND, the state economic development agency), TEFT, and VARP (a R&D program for the manufacturing sector, run by the research council in parallell with programme for technoology transfer). This mode of coordination suggests a program chain, guiding firms from the strategic development into the technology management aspects of TEFT and thereafter into the traditional, application-oriented mode of VARP for more R&D mature firms. The second concerns the more regional coordination, especially with FRAM since this is essentially locally run, but also with other regionally based initiatives.

The data avaliable on this matter are not sufficient for a thorough and reliable analysis, but the following issues seem relevant. Firms which have little or no experience in R&D activities, do not apply for funding in programs like VARP. The application procedures are too bureaucratic, and the interface with the funding institutions like the research council is not set up to the benefit of the SME. An agreement was therefore made between TEFT and VARP which made the TEFT attachees also representatives for VARP, with the aim of helping the firms set up applications for VARP. This concerns in particular firms that have carried out a TP and need further public support to carry on these activities. The TEFT attache was responsible for the marketing, motivation, councelling and administration of VARP activities, refunded from the VARP program. As this coordination was initiated recently, no reliable results can be reported, but it illustrates that national programs may be better coordinated through overlapping persons involved to reduce ”government failures” of programs and initiatives being to complex to handle for client firms.

The relationship between FRAM and TEFT is variable from county to county, depending on the skills and activities of the attache and of the regional coordinator of FRAM. But the main mechanisms are:

- The attache’s use of the regional coordinator to give input and advice for setting up the yearly visitation plan for the TEFT attache;
- The attache participates in the FRAM work shops to present TEFT to the firms which have completed the strategic development process of FRAM;

- The attache will refer to the FRAM program when the visitation and pilot project show a need to develop strategic capacities before embarking on a TP in TEFT.

Since FRAM only covers firms with less than 20 employees, this relationship has proven useful in reaching the smaller firms with some developmental capacity. And the lessons show clearly that firms recruited to TEFT from FRAM (or the forerunner BUNT) are more capable in engaging in TEFT projects.

The more regional coordination seems more mixed. The relations between the TEFT attachees and the business support system in the county administration are highly variable, often depending on internal matters in the county administrations. This county based support will in some cases contribute with information on specific firms and assistance on developing the yearly market plan for the attache. But in sum, the conclusion on behalf of he attachees is that they do not need to coordinate with this system to achieve their own goals, a fact which together with an increasing regionalization of SND itself into regional offices, leaves the county based support function unclear. As the county administration itself takes on a more general policy role, while leaving operative functions to others, this implies a missing link of policy coordination on the county level

The same goes for the business consultants in the municipalities, of which very few play any significant role in TEFT. In cases where this consultant is proactive vis-a-vis firms in his own domain, a fruitful cooperation has been developed. The TEFT attache needs constructive cooperation with people who have firm knowledge about firms in their area, a fact that should serve as an incentive to develop such relationships systematically and nationwide. This has not happened, leaving TEFT with an unsystematic pattern of local cooperation, including that of the county based business consultancies.

However, there exist interesting patterns of potential coordination. In the Østfold county, the publicly owned business cosuntancy service were highly active in generating contacts and saw themselves, as the institution with specialized insights into the regional firms needs and challenges, as a valuable partner. The Østfold business con-

sultancy participated in nearly all visitations to the firms, generating about 45 TPs. This interest has ceased, as the consultancy does not generate revenues from TEFT, since this funding is allocated to the research institutions. While the system of semi-public consultancies in Norway is increasingly dependent on market based revenues og program funding, this lack of financial incentives to collaborate with the TEFT attachees represents an ”incentive failure”. The failure becomes evident in as much as the business consultancy is involved in other national initiatives like the system og industrial attachees (with international offices to generate technology transfer abroad) and RUSH, an experimental program to stimulate regional colleges’ contact with industry. The potential for a wider regional coordination of this bundle of national level initiatives does not seem to be recognized.

This is even more evident in the case of Østfold industrial offensive, an initiative from the same ministries funding TEFT. The industrial offensive program was initiated to regenerate industrial activities in Østfold, a county with long industrial or manufacturing traditions. There has been mutual information exchange between these two initiatives, but no action has been taken from the ministerial level to coordinate them. The Østfold industrial offensive is run regionally, governed by the firms themselves, and has stimulated a certain regional common attitude or collective sense of ”reindustrialization”. While the two initiatives operate in the ”same market”, they are deliberately kept apart, and while there is no competitive relationship between them, there are examples that TEFT firms move on for support in the industrial offensive later, to some extent creating a program chain since the latter may support projects 8 times the size of TEFT.

In sum, all institutions in Østfold regard TEFT as an additional, and for the firms valuable, program, but which is kept to some extent at arms’ length, since TEFT does not generate any financial benefits for the regional support system, not even in the medium or longer term follow up of the firms’ technological activities. Other programs than TEFT still dominate the regional scene and the firms’ attention.

An interesting development took place in Eastern Agder county. The forerunner of TEFT, the DTS-program, created the so-called Agder model, the only county where DTS gave priority to a decentralized solution, and which resulted in a key role for the

regional Agder Research Foundation. When TEFT started, the specific funding for the this research foundation was removed, a decision taken on a ministerial level, signalling specifically that the four main research institutions in TEFT were the only ones to retain such a role. However, the TEFT attache worked deliberately through the Agder Research Foundation in Eastern Agder, and many visitaions to the firms were done collectively. Agder Research Foundation (recently restructured in a combined set-up with the regional college into SENTEK, currently carries out visitations and pilot projects on behalf of TEFT. As SENTEK is also involved in other decentralized, national programs, a certain level of regional coordination and explicit division of labor is achieved.

Concerning the relationship to the Eastern Agder business counsultancy, this developed more like in Østfold. Inititally this consultancy took part in visitations, and well established personal relations between this and the TEFT attache secured mutual benefits from cooperation. But later this relationship ceased, and it became clear that the lack of generation of revenues in the consultancy resulted in diminishing contacts, except in cases where their own activities vis-a-vis firms implied R&D activities.

The county administration in Eastern Agder engaged in activities of mutual information, and although relations to the TEFT attache were regarded as mutually beneficial, the practical work was in general left to Agder Research Foundation (later SENTEK) and the business consultancy.

The positive situation in Agder should also be viewed in a wider context. Since its start-up in 1984, Agder Research Foundation gave priority to play a key role in the business community, establishing business links in selected sectorial or technological areas. These institutionalized relations have been highly useful in channeling the TEFT activities into the very same network. The research foundation thus managed to create projects in TEFT. On the other hand, the relatively tight relations in Eastern Agder are also challenged by the FINN-program, a sectorially initiative by the Research Council and the National Business Association (NHO), which is using proactive consultants on a sectorial basis. The latent conflicts that are envisaged in this case, underline the importance of active coordination necessary where new proactive

initiatives enter into regions where there is a ”regional basis for collective action” in place.

The attachees themselves refer to a number of typical barriers to cooperation, the main ones being different rules of the game for the different people and institutions, and a certain competitive situation between TEFT and many other initiatives. While the latter has been reduced over time, the following points still illustrate real barriers:

- Lack of information and understanding about TEFT among the regional partners (which of course relates to a possible lack of marketing information on the part of TEFT);
- The attachees will need detailed information of programs which they shall promote, a condition which is generally not made;
- As the number of attachees are limited, and their time is subject to priorities, interprogram and regional coordination, a proper attention to these issues is needed on an overall level, adjusting both resources and incentives for the attachees;
- Different cultures and modes of operation exist beween a proactive program like TEFT and the majority of programs being mostly reactive in nature;
- Those programs which intend to exploit the apparatus of TEFT, will need to adapt their procedures and application criteria to those of the proactive mode of TEFT;
- The financial transactions between the programs need to solved at program level, implying that a coherent set of incentives and expectations is diffused throughout all relevant and interdependent programs (based on information in TEFT 1997).

In sum, TEFT represents several intentions, some of which are formally set up in objectives, goals and targets, and for which there exists a system of incentives and procedures. Some have not been translated into such formalized structures, and become victim of the motivations and interests of people involved. It is stated in the program documents that the TEFT attachees are defined as an independent part of the overall support system, but tasks and activities necessary to fulfill these, are not formalized,

and the attachees' goal attainment are measured only to the extent that they achieve the firm level targets. The program and regional coordination is a secondary activity, often a precondition to reach the targeted number of visitiations in their area. We conclude that the intention of program and regional coordination is only partially, and even accidentally achieved, and that the link between national decentralized programs, in this case TEFT, and the regional (or county level) based structures and initiatives suffers from a systemic failure which needs to be alleviated if this coordinating role vis-a-vis the regions shall be exploited to a significant extent.

# TEFT IN CONTEXT: WHAT LESSONS SHOULD BE LEARNED?

An interpretation of the data presented so far in this paper, suggests that TEFT works well measured against its own logic. Although the results and impacts are not satisfactory in all respects, key impacts have been achieved, like recurring procurement. This is even achieved with a higher financial participation on behalf of the firms than was foreseen. The level of activity corresponds in general to the targets, confirming TEFT as an essentially a volume oriented program. The distribution of visitations in eligible vrs non-eligible areas is satisfactory, although the distribution of TPs along the same dimension is skewed towards more centrally located firms.

TEFT does not score as well on degrees of novelty to the firm represented by the TP, the level of increased R&D intensity and the firms' assessment of the TP's contribution to the strategic development of the firms. The key tool of TEFT, the proactive and independent attache, is seen as successful, although also highly dependent on the personal skills and experience of the attache in question. The degree of concentration on the supply side is high, SINTEF being the main benefactor of TEFT funds. TEFT is a national program aimed at generating combined impacts on firm as well as the infrastructual level, and succeeds reasonably well with those firms engaging in TPs, and succeeds also in benefitting the supply side, although behavioural changes in these institutions are still a mark below expectations.

TEFT complies with the general ideas of recent innovation theory in the sense that the program is learning oriented (albeit towards learning by doing in the TPs and to some extent learning by exchanging in the attache group), it is proactive and demand oriented in that it links up to the firms' strategic situation. It is often argued that the TPs are often too small for lasting impacts on the firm level. However, this gives more implications for developing appropriate tools for continous learning at the

firm level, rather than larger bugdets for TPs as is suggested for the next phase of TEFT.

However, we do have some concerns with TEFT's position in the wider landscape of the public support system and the regional dimension in this respect. In the vocabulary of our theoretical baseline as presented eearlier in this paper, this concerns the lack of contextual sensitivity. Since TEFT is a national program aimed essentially on firm level impacts, the regional dimension should not be the key for overall assessment. But TEFT is regionalizing the supply side of the national innovation system, indicating that the wider infrastructural impacts have not been considered to the extent necessary. But in some regions there are preconditions for developing innovation systems, also with the stimulus of TEFT. The emerging Agder model from the forerunner, DTS, was not considered in the programme, an example of the lack of contextual sensitivity. While it is highly legitimate for TEFT to concentrate on firm level impacts, a greater sensitivity to the stimulation of emerging systems on a regional level lower than what is represented by the selected R&D institutions is needed.

This relates clearly to the dilemmas of Norwegian regional policy: Self sufficiency of R&D services in sparsely populated regions with low levels of agglomeration, critical mass and collective capacities cannot be the ideal model. Defining the 5 key urban areas as nexus in the overall innovation system may therefore be necessary. But from the –80's a certain level of investment in regional structures below this five-node system has taken place, and TEFT is not particularly sensitive to this. The challenge is therefore to stimulate firms to use the national system to their own benefit, but to alllow for and even stimulate more regionalized clusters and systems where this seems to have potential.

The regional dimension is also linked to the concept of coordination in the sense that TEFT is one of many initiatives representing the support system for economic development and innovation. In TEFT, this coordination is implicitly left to the informal activities of the attachees, while national coordination is limited to generating interfaces with initiatives like FRAM and VARP.

In analyzing these findings, the concept of coordination needs some clarification. A valuable contribution is found in organization theory. Thompson's (1967) seminal work gives a useful typology for assessing the degree of interdependence, a precondition to assessing coordination needs. Thompson (1967:54-55) identifies three levels of interdependence:

- Pooled interdependence: in which activities are interrelated only in that each one contributes to their overall (common) objective;
- Sequential interdependence: which exists when there is a time dependent relation between the activities;
- Reciprocal interdependence: which is present to the degree that activities relate to each other as both inputs and outputs.

These levels of interdependence are interrelated in the way that reciprocal interdependence exhibits also pooled and sequential interdependece, and activities with sequential interdependence also exhibit pooled interdependence.

TEFTs position vis-a-vis other initiatives is not explicitly articulated in these terms, although a pooled interdependence exist with other initiatives in the research council's program for Technology Transfer. This is also the weakest form of interdependence. The other forms exist to a lesser degree, at least as conceived in the program set up.

Here coordination mechanisms enter the picture. Thompson attaches one key coordination mechanism to each level of interdependence: Pooled in-

terdepe ndence can be ma na ged by sta ndardization, seq uent ial interde-pendence by plans or sched ules, and reciprocal interdepe ndence by mu-tua l adustm ent. It see ms clear that pooled int erdepe ndence should be ha ndled by sta ndardized component s in all programs on th e na tiona l level in PTT. Sequent ial int erdependence is partly mana ged by th e visita-tion plans and by coordina ted effort s to link e.g. FRAM and VARP with TEFT. Reciprocal interdependence is but left to th e atta chees ability to adjust informally on th e regional level.

This suggests on th e one han d that int erdepe ndencies ar e att ended to. But it also ra ises th e fun dam enta l ques tion of degrees. Int erdepe ndence is a char acteristic of systems, but it would be a misun derstan ding to stat e that all component s in a system ar e highly int erdepe ndent. The position and role of TEFT suggest far more tha t it finds itself in a *loosely coupled system* in which th e link s betwee n th e component s ar e part ially un der- or un specified, and where coordina tion mecha nisms are not impera tive. A next ques tion is thu s present ed: To what extent is th e regiona l level (or coun t y) th e app ropriate for coordina ting a bun dle of na tiona l programs (as th is bun dle rep rese nt s to some degree interdepe ncies)? This lends it-self to th e notion of *regional system of innovation*, which in th ese terms ma y be seen as *a regional nexus of nationally and regionally initiated ac-tivities*, where a minimum degree of collective action could increase th e degree of coordinat ion betwee n th e activities. But th is again ra ises an-oth er ques tion: To what extent should th ese activities be tight ly coordi-nat ed, in so far as th ey ma y operat e side by side in a loose system? Should TEF T, or oth er program s, be *available* for th e dema nd side to use, but not more, and thu s red uce th e degree of conflict s often typical for highly interdepe ndent and coordina ted systems?

This relat es to th e wide r ques tion of th e distr ibut ion an d th e int erde-pendence of knowledge an d learn ing capacities in th e innovat ion system:

> "Coordination in the innovation system is crucial. In particular, the policy should develop relevant tools and institutions that will allow an adequate level of coordinated diversity in competences inside firms, research institutions, and financial institutions. The diversity of viable competences should be available to economic agents so as to be activated when needed. This can be expected to increase the diversity of products and processes, and to create new research areas,…." (Cohendet and Llerena 1997).

Cohendet and Llerena argue in their paper that diversity represents positive economic consequences, in line with evolutionary economic theory. Diversity is the basis on which selection mechanisms operate. Likewise, retention mechanisms structure the diversity in conservative ways. Selection and retention are therefore mechanisms that may be supported by public policy to achieve a degree and a form of diversity optimal for the learning and search processes so inherent in knowledge based development.

Another position taken by Cohendet and Llerena is on the issue of local systems of innovation:

> "… what matters in evolutionary theory is the complex interaction between technology and local contexts, which means that a local context is an entity playing a role in the process of creation and diffusion of technologies through specific learning mechanisms that mostly rely on the specific instituional framework of the local entity considered. Therefore, different local contexts due to different institutional frameworks will exhibit qualitatively different processes of innovation" (Cohendet and Llerena 1997).

In this way, the institutional framework is essential, and in the context of TEFT, the concept and objective of infrastructure needs further clarification. Implicit in Cohendet's and Llerena's arguments is the need for institutional or infrastructural diversity to allow for varieties of options, search behaviours and network structures to develop. As TEFT's rationale is clearly linked to a definition of infrastructure that is very

limited and represents a mechanism for retention of four selected R&D institutions, this seems contradictual. Smith (1997) argues that ”infrastructures can involve major network externalities, and they are often the place within a system where scale and scope economies are very significant”.

Smith (ibid) defines infrastructure in the following way:

> ”The economic infrastructure consists of largescale indivisible capital goods producing products or services that enter on a multi-user basis as inputs into most or all economic activities.”

While it is thus possible to think of infrastructures as ”generic, multi-user, indivisible, and enabling”, the knowledge infrastructure gains implicitly, but not necessarily, a role as a public good. And while the TEFT objective to help disseminate resources from the knowledge capital stock in given R&D institutions seems legitimate, there are two other considerations that makes this troublesome. First, the infrastructure in question is not only infrastructure, representing accumulated knowledge investments, but also private actors in the knowledge market place. The infrastructure has self interest. To some extent, TEFT itself represents an additional infrastructure since the capital stock is not freely accessible (due to the infrastructure’s need to sell, and due to market failures that are in themselves the rationale for TEFT). We cannot here conclude normatively in other ways than asking the following question: Does TEFT represent proper policy when the retention is aimed at giving significant advantages to a selected and (semi-) private infrastructure?

Second, TEFT’s very rationale is to link the firms’ learning processes to the four major, national R&D institutions. Positive externalities in the local innovation systems are essentially by-products. Does organized self selection to the benefit of these institutions (or in particular one of them), represent costs to the, albeit often immature, local and regional systems where the firms innovate? And is TEFT reducing the diversity needed to enhance innovation processes thorugh the additional infrastructural support to the established, national system? These are questions we cannot

respond to in this paper, but will represent key dimensions for analysis in the national report, where the various policies and instruments are seen in a wider context. But a tentative conclusion is offered:

TEFT's firm level focus is legitimate, but needs to expand its concept of learning. Learning measured as recurring procurement seems too primitive to guide the programme into its next stage. TEFT should be sensitive to the key role played by the R&D institutions participating in the programme, but give far more attention to more regionalized emerging or existing systems that could even enhance the coordination and respond to the reciprocal interdepency between policies and institutions that often exist at this level. Hence the attachees, the key player in the programme, should be equipped both with competence to stimulate firms' wider learning process as well as with powers to initiate and stimulate regional participation, systems development and collective action that in sum would improve the decentralized coordination necessary in a state driven, centralized nation.

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STEP gruppen

STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.