Part 2
THE REGIONAL INNOVATION SYSTEM IN C. MACEDONIA

This part focuses on the innovation capacity of Central Macedonia, the strengthening of which constitutes the main RTP objective.

It includes the description of:

- *the productive system of Central Macedonia*
- *the application of generic technologies in the region*
- *the regional technology demand*
- *the regional technology supply*
- *the regional technology transfer.*

5. PRODUCTIVE SYSTEM AND COMPETITIVENESS IN CENTRAL MACEDONIA

This chapter focuses on the diagnosis of the basic characteristics of the production system and the competitiviness in the Region of Central Macedonia. Our particular interest lies in identifying the major economic and industrial trends promoting development in this Region. To this end we have proceeded to explore, describe the productive system, and qualify its strengths and weaknesses from the point of view of the production and transfer of technological and organisational innovations.

Central Macedonia in Greece

The 1980s confirmed the crisis in Greek development, as the negative trends that had emerged after 1973 took on a definitive form. Developments were unfavourable in the most basic sectors: GDP, investment of fixed assets, the sectorial structure of industry, employment, productivity, inflation, deficit, and public economy.

- After 1974, the average annual rate of change of the GDP fell steadily (1976-80: 4.2%, 1981-90: 1.6%, 1991-94: 0.9%). At the same time, de-industrialisation altered the respective contributions of the three sectors. In the 1990s, manufacturing contributed less to the GDP than it had in the '70s (17.9% against 19.5%).
- The same decline characterised fixed asset investments. The average annual change between 1981 and 1990 was only 0.1%. The average annual rate of change in investments fell from 9.3% in the '60s to 2.8% in the '70s and 0.1% in the '80s.
- The average annual rate of growth in industrial production fell from 10.1% in 1961-70 to 6.9% in 1971-80 and to 2.2% in 1981-90. In the 1980s Greek industry slipped back into more traditional activities and increased the proportion of traditional consumer sectors (food and drinks, tobacco, textiles, clothing and footwear). The annual rate of change in productivity gradually fell from 1980 onwards, as a consequence of reduced investment in modernisation and the lack of technological renewal.

However, the geography of this crisis was not uniform. In 1981-90 there was a vigorous geographical re-organisation of development, associated with a variable mosaic of development and recession. The quantitative data relating to the changes in the GDP and

employment show Greece to be completely fragmented into dynamic regions in the north, dynamic regions on the Aegean and Ionian islands, and stagnant regions in central and southern Greece.

- In the traditional industrial centre that has developed around the Greater Urban Area of Athens, the prevailing trends are towards decentralisation, induced by the long-standing lack of investment in basic civic infrastructure and diseconomies of scale that have exacerbated the problems of the day-to-day operation of economic activities. Likewise, many regions of central and southern Greece are marked by urgent trends of de-industrialisation. Firms are becoming less competitive, state protectionism has been withdrawn, privileged access to public procurement is being eroded daily, buying out and mergers are bringing segments of the domestic market under the control of large multinationals.

- The Aegean islands, the Ionian islands, and Crete are showing dynamic activity in the primary sector and in tourism and are commercially exploiting the unique comparative advantages offered by the natural environment and an enduring cultural presence.

- In northern Greece, particularly in Central Macedonia, Eastern Macedonia, and Thrace, a dynamic industrial complex has been developed. This new productive complex showed itself to be capable of internationalisation and adaptation long before the official inception of the single European market.

Neo-industrialisation in northern Greece has led to a considerable rise in employment in many prefectures. All the prefectures in Central Macedonia, Eastern Macedonia, and Thrace are showing a significant increase in GDP and industrial employment. Analytical data indicate that these prefectures were already showing signs of vigour in 1969-87, and this increased in the '80s. It is observed a change in the location behaviour of industrial branches, which are moving away from certain areas, particularly around the Capital, and settling in less central areas.

Central Macedonia appear to be one of the most dynamic area of northern Greece's new industrial space. The region is composed of seven prefectures (Chalkidiki, Imathia, Kilkis, Pella, Pieris, Serres, Thessaloniki,) with a total population of 1.710.513. Nonetheless, the rank of the region regarding the level of GDP per head is one of the lowest in Europe, while it occupies a high position among the 13 regions of Greece.

Table 5.1. tabulates recent comparative figures for population, employment and GDP. The Region of Central Macedonia is compared to the whole country, while certain basic figures are also given for the Prefecture of Thessaloniki, the second most important centre in Greece after Attiki. Its importance is due to the fact that it is a transport hub, that most

of the Region's industrial activity is concentrated here, and that its port and airport handle a substantial percentage of the country's imports and exports. The area immediately

Table 5.1. Basic figures for the Region of Central Macedonia

	GREECE	CENTRAL MACEDONIA		PREFECTURE OF THESSALONIKI	
			% in Greece		% in C. .Macedonia
SURFACE					
	13.195.741,3	1.914.616	14,5	368.273,6	19,2
POPULATION					
Total	10.259.900 *100*	1.710.513 *100*	16,7	946.864 *100*	55,4
Active	3.886.157 *37,9*	675.288 *39,5*	17,4	372.652 *39,4*	55,2
EMPLOYMENT					
Total	3.571.957 *100*	623.909 *100*	17,5	344.214 *100*	55,2
Primary sector	668.766 *18,7*	130.670 *20,9*	19,5	22.175 *6,4*	17,0
Secondary sector	852.946 *23,9*	172.333 *27,6*	20,2	109.988 *31,9*	63,8
Tertiary sector	1.843.612 *51,6*	289.869 *46,5*	15,7	190.322 *55,3*	65,7
UNEMPLOYMENT					
Total	314.200	51.376	16,4	28.438	55,4
% of Active	8,1	7,6		7,6	
GDP					
Total	14.422.533 *100*	2.326.649 *100*	16,1	1.362.409 *100*	58,6
Primary sector	1.982.789 *13,7*	393.747 *16,9*	19,9	83.543 *6,1*	21,2
Secondary sector	3.714.774 *25,8*	640.966 *27,5*	17,3	409.269 *30,0*	63,9
Tertiary sector	8.724.970 *60,5*	1.291.936 *55,5*	14,8	869.597 *63,8*	67,3

Source: NSSG, Population Census 1991, National Accounts, current prices, million GRDs 1993

surrounding the city contains most of the Region's manufacturing and processing industry, while banking, commerce and services are concentrated in the city centre.

Production

The Region of Central Macedonia accounts for 19,9% of the country's GNP in the primary sector, 17.3% in the secondary sector and 13.9% in the tertiary sector (1993). The Region accounts for a disproportionately high percentage (greater that is than its share of total GNP, or 16%) of total production in fishing and farming (19.7%), manufacturing/processing (20%), health and education (20.7%) and trade and commerce (17.2%).

In all the prefectures in this Region (with the exception of the Greater Thessaloniki Area) the principal occupation is in agriculture, with a wide variety of crops and fairly healthy prospects for growth. Industry has developed around the urban centres, and is chiefly devoted to the manufacture and processing of agricultural products (foodstuffs), textiles, furniture and non-metallic minerals.

With the exception of the Prefecture of Thessaloniki, the level of services in the Region is fairly low compared to the national average. The same is true of the level of technical and social infrastructures. Tourism is developed only in certain areas (Chalkidiki and Pieria), while the Region as a whole lags behind in the enhancement and exploitation of its natural and cultural wealth and in the development of alternative forms of tourism.

The Region accounts for 19.9% of GNP in agricultural production (fishing, farming and forestry), 8.6% in mining, 20% in manufacturing/processing, 17.2% in commerce, 14.9% in construction and 14.5% of housing. The primary sector provides 16.9% of the GNP of the Region, the secondary 27.5% and the tertiary 55,5% (1993).

58,6% of the Region's GNP is produced in the Prefecture of Thessaloniki. This is followed by the Prefectures of Serres, Pella and Imathia with between 8.3% and 8.9% each, and finally Kilkis with 4.1%.

Employment

According to the 1991 census, 16.9% of the country's population live in the Region of Central Macedonia, more than half of which (56%) in the Prefecture of Thessaloniki. The active population of the Region corresponds to 41.3% of its total population. Unemployment is lower than the national average (6.6% and 7.5% respectively in 1990).

Distribution of employment, at 1991, among the three basic economic sectors is as follows: 29.9% in the primary sector, 28% in the secondary sector, and 42.1% in the tertiary sector. If we ignore the Prefecture of Thessaloniki, which accounts for most of the employment in the tertiary sector, we find that two thirds of the active population of this Region are employed in the primary and secondary sectors.

Industry

Central Macedonia accounts for 21.9% of industrial employment in Greece, with 68% of this number being concentrated in the Prefecture of Thessaloniki (Census 1991).

With respect to manufacturing/processing, the bulk of employment in the Region is in the sectors: clothing and footwear (26.3%), foodstuffs (16.3%), furniture (5%) and tobacco (4.5%), all of which are above the national figures (17%, 14%, 4.4% and 1.8% respectively). Production in these sectors is concentrated in small units, especially in the Prefectures of Pella, Imathia, Pieria and Kilkis, where industrial employment in SMEs, as a percentage of the Regional total varies between 60% and 80%. While these sectors are, in most instances, labour intensive, the high rates of investment being effected in them (especially in the food and textile sectors) indicates a trend towards the transformation of these traditional sectors into capital-intensive industries.

The SMEs that dominate the Region's productive system - as indeed of the country as a whole - generally display low levels of organisation and considerable management deficiencies, giving the Region a particularly low average figure for employees per company (6.5 employees per unit), even in comparison with nation-wide figures. Small and medium-sized units account for 98% of all manufacturing companies and absorb 72% of total industrial employment.

Three sectors accounted for 50% of all industrial capital in the Region in 1988: the food industry with 22.5% of industrial capital, textiles with 14% and beverages with 13.9%. These were followed by chemicals and basic metallurgy with around 7% each. The distribution of fixed assets was similar (as a percentage of Regional totals): food (19.2%), textiles (17.8%), beverages (12.3%), basic metallurgy (9.8%) and chemicals (7.8%).

Strengths and weaknesses

Central Macedonia has shown good signs of an above average industrial performance, in terms of GDP, employment growth and exports. However, these figures are rather precarious since the rely on a industrial system based on traditional branches, standardised products and unskilled labour.

In the period 1987-1990, the Region absorbed 17% of annual state expenditure on research, which is an extremely low fraction, especially considering that total state expenditures on research and development accounted for only 1% of total state funding of industry (the EU average was 10%). In this framework, industrial strategies were developed along more traditional solutions, giving emphasis in (1) the restructuring of

production with respect to exceed automation and process machinery, (2) export-oriented product design and specifications, (4) separation of specialised and routine activities through the externalisation of tertiary activities, sub-contracting, and international integration of firms, and (4) labour market flexibility, deskilling and low wages.

The drawbacks to these neo-taylorist options are well known. On the one hand, they introduce a social polarisation that accompanies the strict separation of labour skills and wages. One the other hand, they reproduce the conditions of peripherality owing to the dependence of the local production system on the innovations and technological equipment brought in from the core regions. Sunrise solutions and SMEs alliances are considerably hampered by established skills, business culture, and the traditional aspect of the industrial policy.

6. APPLICATION OF GENERIC TECHNOLOGIES IN THE REGION

The technological and innovative capacity of Central Macedonia may be evaluated by the level of application of generic technologies, which may by used in many sectors and industrial branches. For the Central Macedonia RTP, as generic technologies were considered industrial information technology, automation, energy and clean technologies, quality control and certification technologies.

Our objective here is to describe the degree of implementation of these technologies in the industry of Central Macedonia, to identify requirements and trends for the near future, and to propose priorities for their expanded application throughout the Region.

Industrial information technology

Industrial information technology is a specialised branch of information science dealing with industrial applications. Enterprises are introducing industrial informatics into their modernisation efforts in three main sectors: accounting, production, and information

The accounting sector was the first to apply information services. In the Greek market in particular, accounting applications addressed to industrial companies are well developed and a wide variety of solutions are available, either in the form of standard packages or customised applications designed to provide a more integrated response to the problem of company financial control.

In the production sector, there are certain areas where informatics has penetrated to a considerable extent, creating islands of automation using data systems in the absence of an integrated support system (programming, monitoring and control) of the production process. Exception and more integrated applications are found in the chemicals sector. Starting from the basic level of CADD (Computer Aided Design and Drafting), industry in Central Macedonia can show a considerable number of installed applications, especially in the textile and metal construction sectors, where this basic application is in many instances linked to a CAM (Computer Aided Manufacturing) system.

In the field of production planning, installed systems are limited mainly to medium term Materials Requirement Planning (MRP). There are a very few cases of integrated industrial resources management systems (MRP II), which offer the possibility of global linkage and co-ordination of all an industry's operations (production, marketing, sales, financial administration, etc.).

Table 6.1. Applications of information technologies in the industry of C. Macedonia

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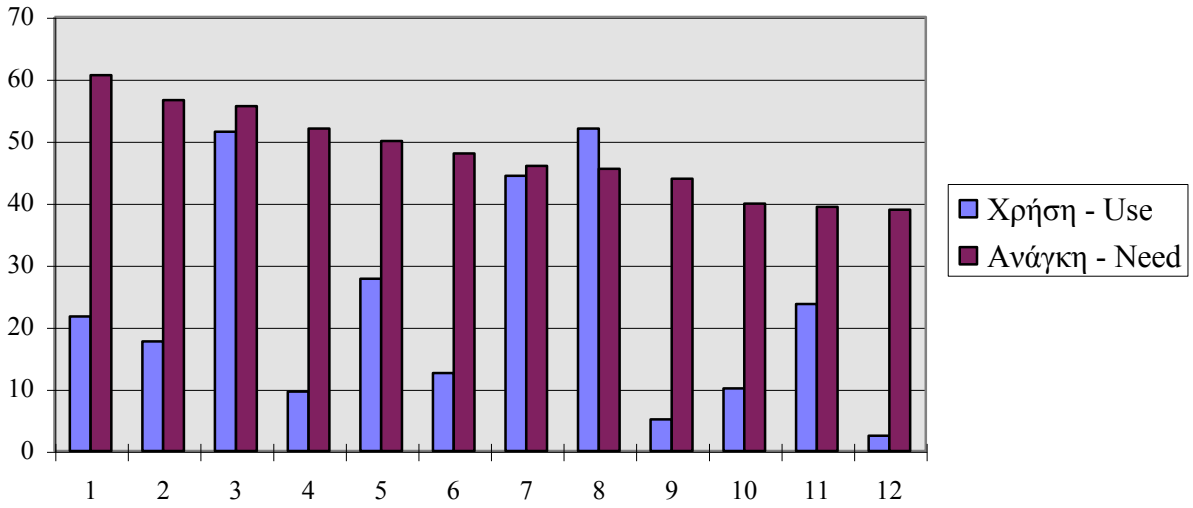


1. Electronic system for economic planning
2. Long-term planning system
3. Stock management system
4. Products promotion on Internet
5. Material requirement planning (MRP)
6. Electronic data exchange
7. Administration information system
8. Unified products codification
9. Multimedia applications for products promotion
10. Intelligent systems applications
11. Electronic commerce
12. Decision support system

In the administrative data systems sector there are a few examples of integrated systems which provide full automation for the collection and processing of information from all the separate operations within the firm.

The trend in the immediate future is towards new products to cover "deficient" areas in industrial informatics, to link and integrate isolated elements and systems, and through informatics to introduce new technologies into the industrial environment. The principal characteristics of these new information technologies are their significantly reduced

hardware requirements and their proportionately more sophisticated requirements in software and know-how.

Automation

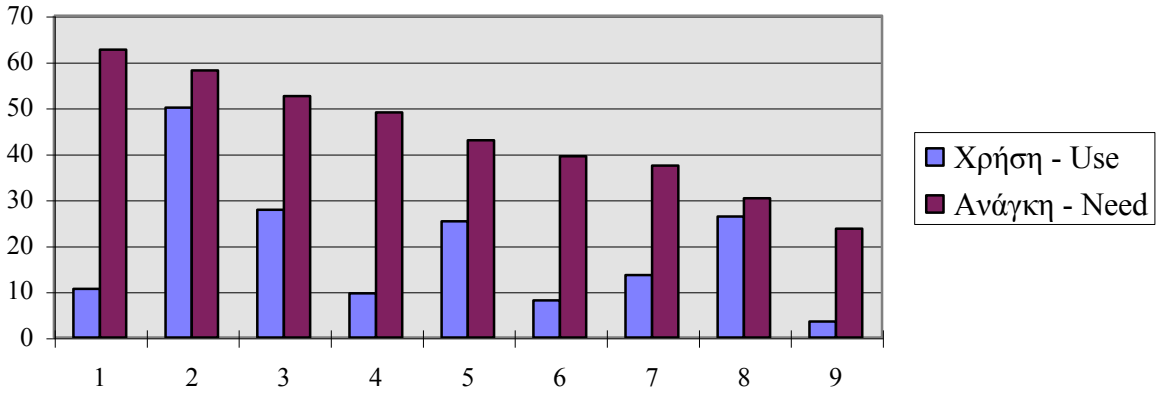
In Central Macedonia, the lowest level of automation (the automation of production machinery) is adequately covered in most industrial sectors. In many companies (especially wood-processing, metals-processing and plastics industries) where the investments were made during the 1970's, production lines are conventionally automated, with the result that breakdowns are frequent and it is impossible to integrate the individual systems into a central control system.

Automation of production lines is adequately covered only in the largest industrial firms, which have invested in integrated production lines: these include textiles, chemicals, steel and foods. Problems frequently encountered in these factories are those of maintenance and adaptation of systems to specific needs (e.g., production of new products). In all other cases, and especially in average-sized companies, the major requirement is the integration of spot systems into a central process control system.

CNC, CAM and flexible automation systems are rarely encountered, except in a few installations in wood-processing plants and in tile-works (paint robots). The main reasons for this are the formidable installation costs and the lack of installation know-how and experience among both industrial engineers and systems suppliers. In the past few years a number of companies fulfilling the appropriate conditions have invested in process visualisation systems (foodstuffs, metal-processing, tile-works).

While very few plants have central production and quality control systems, interest in such systems is nonetheless increasing. On the other hand, industrial weighing and measuring equipment is generally considered inadequate, since in most cases the method used is that of manual adjustment to a reading (animal feeds, foodstuffs).

Table 6.2. Applications of automation in the industry of C. Macedonia



1. Quality control automation
2. Productive equipment automation
3. Facilities and process automation
4. Energy consumption automation
5. Product design automation (CAD-CAM)
6. Computer integrated manufacturing (CIM)
7. Central control automation (SCADA)
8. Weighting and sample measurement automation
9. Robotics applications

The problems which arise and which frequently prevent the application of control systems in industry may be financial, technical or administrative. The technical problems are related to difficulties of measurement, the lack of a model for the system to be controlled and the complexity of the system (large numbers of variables and lack of linearity). Administrative problems have to do with staff training, lack of know-how, problems in access to know-how and limited ability to assess the result of the application of a control system, as well as problems of collaboration, as between industry and the universities. The single principal obstacle to low-level automation (production machinery) is the insufficiency of the equipment, due to age. The fact that production engineers are lacking in know-how tends to make them resistant to new technology automation applications. Where the installation of such systems is decided, it is not on the basis of specifications produced by the firm's own engineers, but in accordance with the suggestions of the supplier, with the result that inevitably deficiencies subsequently appear, especially in the potential for integration. Inadequate back-up for installed systems on the part of foreign suppliers or their representatives in Greece (usually based in Athens) increase investor hesitancy.

Energy and clean technologies

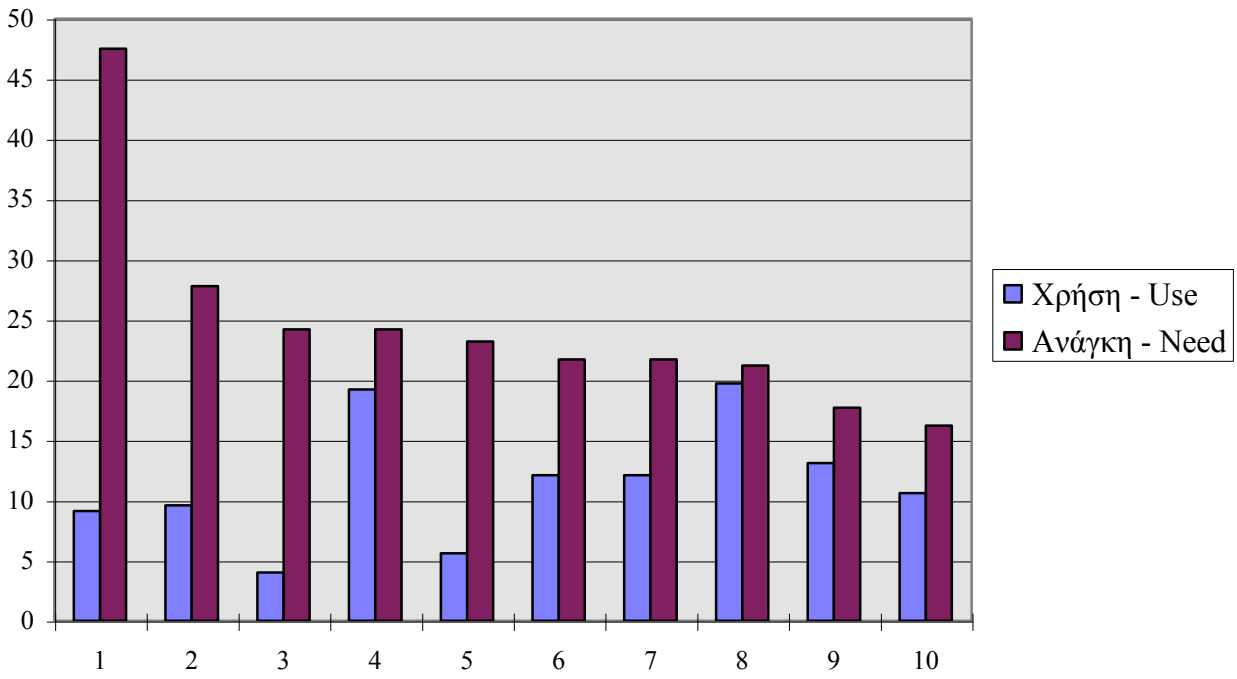
At today's levels of technology Europe has the ability to save considerable amounts of energy in almost all industrial processes. The European Commission lays particular emphasis on horizontal energy technologies, that is, technologies which are not limited to a specific production process but are addressed to various industries, such as:

- Development of energy management system and use of computers in energy management.
- Development of heat recovery systems to capture energy wasted in the form of heat loss from boilers, furnaces, cooling systems, motors, etc.
- Co-production and simultaneous production of electric power and useful thermal energy.
- Use of "high efficiency" furnaces, boilers and motors to reduce both fuel consumption and the production of NOx.
- Use of renewable energy sources which is limited to biomass and the production of biogas.

In Central Macedonia, the main industrial fuel is fuel oil. In 1991, fuel oil accounted for 60% of all industrial energy requirements in the Prefecture of Thessaloniki, as compared to 20% for the European Union. In that same year, Diesel fuel accounted for a mere 5% of power needs, and electricity for 22%. The use of liquid gas has been increasing over the past few years, especially in view of the introduction of natural gas: in 1991 liquid gas supplied about 10% of fuel requirements. Finally, the sole cement industry in the area consumes considerable quantities of coal and coke.

The principal factor hampering efforts to reduce energy consumption and rationalise energy resource management is the large number of relatively small industrial units. The fact that these units are scattered rather than being concentrated in industrial parks or zones, the age of their equipment, their limited capacity, all conduce to relatively heavy energy consumption per ton of production and discourage investment in this sector. Listed below are a number of suggestions for energy use intervention and investment possibilities in three principal industrial sectors.

Table 6.3. Applications of energy and clean technologies in the industry of C. Macedonia



1. Energy saving systems
2. Ecological management systems (EMAS)
3. Renewable energy resources
4. Solid wastes management
5. Ecolabel sign applications
6. Anti-pollution applications for burners and motors
7. Responsible care applications
8. Applications of residue management systems
9. Residue monitoring
10. Biological purification applications

Foodstuffs. In the food industry, which includes numerous separate and distinct branches, the margins for improving energy use are quite considerable. This stems from the fact that in almost all branches energy consumption per ton of production is relatively high. For example, in the Greek dairy industry, consumption of energy is around 1500 MJ per tonne of processed milk, which is 30% higher than the EU average. The principal scope for intervention and investment in the food industry lies in recovering heat for internal use from low temperature liquid effluents, in the use of new types of boilers and improved refrigeration systems, and in the exploitation of renewable sources of energy. In this last instance, possibilities include the production of biogas from organic wastes and the heating or pre-heating of water by solar collector. The co-production of electric and thermal energy, already in application in the sugar industry, may be implemented in numerous large plants, including certain dairies. There is also a margin for co-production in the larger breweries, if better terms for the sale of electricity to the Public Power Corporation can be negotiated, given the intermittent nature of the brewing process.

Chemicals. The chemicals industry, both in the EU and in Greece, has made tremendous progress in energy saving over the past ten years, with results in excess of 35%. Although energy saving is not at the moment the number one priority of the chemical industry (competition from third world countries and environmental issues are currently the principal concerns of the European chemical industry), there are still margins for improved energy effectiveness. Some of the promising fields for energy-related investments in this field include: (1) joint production of steam and common steam grids for small units in the same area, (2) introduction of new technology motors (using approximately 10% less electricity), (3) co-production (already implemented in the Chemical Industries of Northern Greece), (4) use of energy management systems, (5) improved design and operation of heat exchangers and recovery of heat from low temperature liquid effluents, (6) application of "pinch" technology in the analysis and designing of chemical processes.

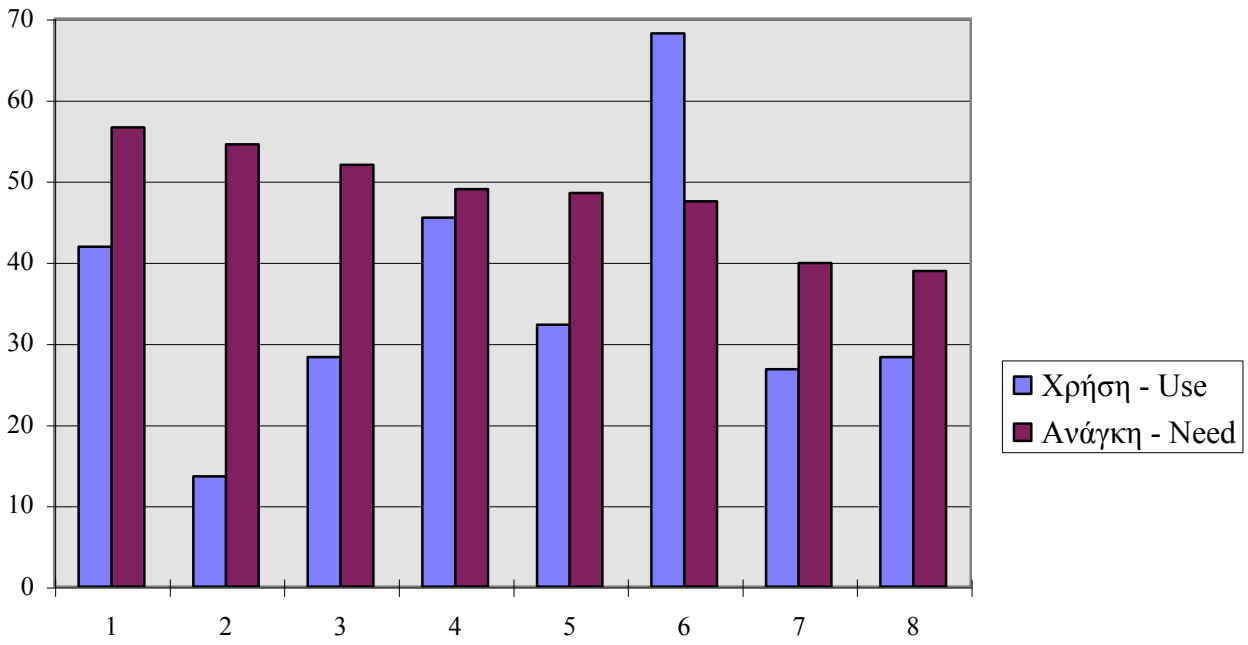
Textiles. Textiles is one of the most important industrial sectors in C. Macedonia, and may be considered a fairly "mature" industry. While energy saving is less of a priority in this sector than is improving product quality, there is scope for improved performance through the use of new technology boilers and motors, the use of heat pumps or the application of direct heating in drying and washing processes, as well as in the introduction of integrated energy management systems.

Quality control and certification

Efforts to improve quality include a series of structural and production processes on three specific levels: (1) quality control, (2) quality certification and the use of quality labels and (3) optimal exploitation of human resources by the application of such systems as quality circles, development of loyalty and recognition of the role of the worker.

Industrial firms in Northern Greece are increasingly aware of emerging requirements relating to quality certification with respect to competitiveness, especially as regards the development of the ISO 9000 quality systems. However, the percentage of companies in Northern Greece which have already been awarded certification (most of which are in Central Macedonia) is still extremely small compared to the country as a whole. On the basis of published figures, by the beginning of 1995 the two major quality certification institutions (BVQI and the Hellenic Standardisation Organisation) had certified 115 companies, of which only 10 (9%) were in Central Macedonia.

Table 6.4. Applications of quality control technologies in the industry of C. Macedonia



1. Recognition of employees role in quality
2. Certification by related institution (i.e. ISO 9000)
3. Quality control statistical methods
4. Standards and specifications (legislative, firm, international)
5. Participation of employees in quality circles
6. Sample control and product testing
7. Calibration of instruments in quality control laboratories
8. Calibration of instruments on the production line

Many companies in this Region, however, are beginning to exploit the financing potential of Community enterprise support programmes to prepare themselves to enter the ISO 9000 quality assurance system. To achieve this, they need support and technical assistance, especially with regard to the organisation of infrastructure and the development of quality assurance systems. They also need monitoring, advice and know-how, possibly via advisory inspection procedures during the course of implementation of the system. Also important is the need for information and advisory services for already certified companies to encourage further quality development.

With regard to product conformity, the requirements with respect to Greek products meeting Community standards are tremendous, especially in relation to the New Approach Directives, by which all products must display both a declaration of conformity and the CE symbol. While lack of information has created considerable confusion among both producers and consumers across the country, the Ministry concerned (Ministry of Industry, Energy and Technology) for its part does not effect sufficient market inspection. Further, with regard to export-oriented products, the need to increase competitiveness on the European level has created the need for the quality of Greek products to meet the standards and specifications required by the destination countries (e.g., ecological textile products). Few companies, however, make use of the possibility of displaying on their products the

Greek quality standards symbol awarded by the Greek Standardisation Organisation to products meeting Greek and European standards.

At the same time, the need to develop product quality and conformity assurance systems creates the need for modern on-line production control equipment and product quality control laboratory equipment. The industries in this Region have, with Community support and through the various Community Development Programmes, begun the process of modernisation in this field.

In the field of quality control and testing, there is a growing trend towards public and private laboratories for testing and measurement, a trend which is also being generally promoted on the regional level by the government development policies in this sector. The principal requirement in this sector is for certified laboratories to cover specific industrial needs relating to conformity with Community standards and the requirements of individual destination countries.

There is also tremendous demand for calibration services, a direct result of the fact that more and more companies are winning ISO 9000 certification, and for specialised measurement and testing services. The great demand for measurement and testing services is dictated by the need to perform specialised tests on products in order to win the CE certification symbol which a product must display before it can circulate freely and without restriction throughout the Single Market.

7. ANALYSIS OF REGIONAL TECHNOLOGY DEMAND

The exploration of technology and innovation demand in C. Macedonia is one of the focal points of the Regional Technology Plan. In contrast to a long-standing tradition of technology planning emphasising the supply side, in the assumption that industry would adapt to improved technology supply, the orientation of this Plan is more conditioned by demand. Technology demand determines the basic orientations of the Central Macedonia RTP and its two fundamental points: the determination of the priorities for action and the fine-tuning of projects within the framework of established priorities.

The examination of regional technology demand has been realised on three levels:
(1) on the level of major industrial firms in the Region, on the basis of technology auditing;
(2) on the level of major industrial branches within the Region, on the basis of meetings with selected companies within each branch;
(3) on the level of local productive systems within the Prefectures of Central Macedonia, on the basis of reports by experts from each Prefecture.

Technology demand by industrial firms

An in-depth survey was carried out by the Thessaloniki Technology Park It included the selection of 60 major companies in C. Macedonia to be studied, contact with the directors of the selected companies to arrange the meetings, visiting the firm and discussion with the appropriate officers, drafting the answers received, and elaboration and presentation of the results. The main conclusions of this survey are:

Technology sources: For the companies which participated in the survey, their main source of technology is by purchase through the purchase of equipment. The development level of internal R&D departments is generally low, and only exists at all in large and well-organised companies. Very few companies have special R&D departments, while in some companies R&D is carried out by either the Production Department or the Quality Control Department.

R&D levels are generally considered inadequate. This is the result of two principal factors: (1) the level of R&D is in many industrial branches fairly low, and (2) information flow and dissemination of research results both from Greece and abroad are insufficient. One of industry's main requirements is access to research results. Another point mentioned by numerous executives was that the research carried out in Greece does not reflect industrial requirements: what is needed is for research institutions to tailor their work more closely to the needs of industry.

Inter-firm technology co-operation: For the most part the idea of collaboration with other companies in the same branch has gained little ground, largely due to lack of interest, suspicion, lack of finance and the absence of a spirit of collaboration within the business world. On the other hand, many companies sub-contract and/or collaborate with producers of complementary products.

*Vocational training***:** In general there is on-going employee training in technical, administrative and financial sectors, either within the firm or outside. Training programmes on general subjects are available in the Region. The need however has appeared for training in specialised technical fields which vary from firm to firm.

*Quality and certification***:** Most companies surveyed lay great weight on producing quality products to meet market demands. Suggested ways of improving quality include automation and certification of production processes. A certain number of companies have already been awarded certification (mainly under ISO 9002), or are in the process of doing so. In fact, certification is one of the major company trends for the future. With respect to product standards and specifications, there are problems for a certain number of sectors with the lack of standards or the failure by competing companies to meet the existing ones, thus creating unfair competition. It is imperative to develop regulations to ensure the wide application of standards. Most companies either already apply or are prepared to apply Total Quality Management procedures, which reflect industry's realisation of the importance of the human factor in the production of quality products.

*Technology objectives and requirements***:** There is little branch variation in technology objectives, which may be summarised as follows:

- product improvement, through the purchase of new equipment, implementation of new technologies, installation of automation systems, better raw materials (new materials or better quality control),
- development of new products via new technologies in accordance with market requirements,
- improved quality control procedures, for most companies practising quality control, by the addition of supplementary equipment and trained personnel
- improved product distribution.

Technology sectors where further support is required : While there are certain differences from one branch to another, the global consensus is that the sectors where progress is required are the following:

- information technology, computer systems, monitoring of stocks, automated control systems
- automation, production control and quality assurance systems, to improve product quality and increase productivity
- certification, which will help in the production of better quality products and consequently in improving competitiveness
- improved quality control processes. Existing problems include inadequate equipment and lack of trained personnel.

Obstacles hindering innovation: A major problem concerns financing: The cost of money for self-financing is very high. The limited national programmes tend to favour "large" enterprises. There is a problem of access to such funding on the part of smaller companies. Mention was made of the limited use made of European programmes, especially by large companies. Small companies rarely participate in such programmes, mainly because of their orientation towards applied research. Our conclusion is that both the technology and the equipment required to improve industrial technology usually exist: what is lacking is the financing for such investments.

A considerable problem is the availability of qualified middle management, especially in the Prefectures other than Thessaloniki: In certain sectors (textiles, non-metallic minerals) there is a tremendous need for middle-level and qualified staff (e.g. foremen, qualified technicians, etc.), who are usually trained on the job rather than in special schools.

A final problem is that of information. The majority of those surveyed reported insufficient information. They need information on such matters as developments in technology, quality, research results, environmental protection, legislation.

Technology needs in principal industrial branches

These needs were identified through meetings with selected firms of C. Macedonia. The purpose was to discuss publicly the technology and innovation needs of companies in Central Macedonia and to relate them to competitiveness, infrastructure, and public technology support policy.

The meetings were organised and co-ordinated by the Thessaloniki Technology Park, the Association of Industrialists of Northern Greece, and the Thessaloniki Chamber of Commerce and Industry, with the assistance of the RTP Management Unit. Approximately 100 companies from three broad industrial sectors were invited to attend: (1) foods, beverages and chemicals, (2) clothing and footwear, and (3) manufacturing of machines,

appliances and building materials. About 40 companies took part in these meetings. The discussions focused on:

Identifying technologies considered important for the competitiveness of individual companies and of the Region in general, such as:

- production-related technologies (energy management and saving, application of automation and data systems in the production process, waste management and treatment systems)
- product-related technologies (design and development of new products, quality control, quality automation, certification, quality symbols)
- collaboration and interfirm network-related technologies (networks and telecommunication infrastructures, instant ordering and delivery systems, consumer feedback, institutional mechanisms for industrial collaboration)
- human training and optimising technologies (on-going training schemes, quality circles, linking training and production).

The factors determining the needs in technology and innovation, such as:

- the type of markets within which companies operate, which determines quality requirements and demands
- information on competitors' policies, changes in demand and new technologies.

The ways in which companies currently meet their technology needs:

- whether they purchase technology along with permanent equipment and machines
- whether they collaborate with other companies (competitors, sub-contractors) in order to improve production techniques and develop new products
- how they train their work-force and what methods of worker participation in product improvement they implement
- whether licensing and the payment of royalties are a significant factor in the acquisition of technology.

During the course of these meetings the conclusions and priorities established during the technology audits were confirmed: technology inflow via the purchase of equipment, the leading role played by quality in the establishment of a competitive advantage, the demand for information on new technologies and products, the demand for interfirm collaboration and networking difficulties, the importance of financing in the development of new products and technologies, the difficulties of participating in national and Community research and development programmes, especially for small and medium-sized companies.

Technology needs at prefectural level

In parallel with the technology audits and the meetings with firms, we organised structured discussions on the technology needs of the Prefectural productive systems (Imathia, Kilkis, Pellas, Pierias, Serres, Chalkidiki). This was followed up by the drafting of expert reports codifying local development data and priorities, which identified:

- the most important industrial sectors and fields of economic activity in each prefecture,
- export activity in each prefecture (companies, products, export areas, new market possibilities),
- problems of competition encountered (problems relating to productivity, production costs, product quality, product innovation, infrastructure appropriateness),
- the basic infrastructures existing in the prefecture and susceptible of enhancing competitiveness (industrial zones, innovation centres, development companies, exporters' associations, participation in trade fairs, consultancy companies, institutes),
- infrastructures and actions that could contribute to raising the local productive system's levels of technology and competitiveness.

With the exception of the Prefecture of Thessaloniki, where industry is varied and broadly based, the other local productive systems are dominated by two industries (1) foodstuffs, usually processing of local agricultural products and preparation of animal feeds, meats, tomatoes, sugar, cotton, milk, flours, and (2) textiles and clothing.

Production is characterised by a geographical separation in which production is concentrated in the province and services in the city of Thessaloniki. The lack of executive personnel to organise and manage production tends to reinforce this phenomenon. The minor distances between the other Prefectures and the city of Thessaloniki (around 50 km) permit daily commuting in the framework of a single metropolitan system. This in turn enables to use the city's research and technology potential in order to cover technology needs.

Finally, three main technology and innovation support issues have been identified:

1. The need of access to information on potential markets, new products, financing mechanisms, national and Community research.
2. The need for cross-links with research and technology institutions via local centers for technology services.
3. The need for cross-links between companies and the creation of networks to confront better the competition and the challenges of technological modernisation.

8. ANALYSIS OF REGIONAL TECHNOLOGY SUPPLY

The investigation into technology supply was designed to identify applied research activity in Central Macedonia and the potential for technology applications to companies stemming from non-company research centres.

Companies, especially small and medium-sized ones, are turning more and more to external sources of technology in order to develop their technological capacity, and to this end are making use of a variety of means of access to external technology sources. Technology support from local R&D institutes and universities is playing an ever more important role in applied industrial technology development. Within this context, the investigation of technology supply focused on the regional R&D potential, the technologies which are offered, and the collaboration between research institutes and industrial firms.

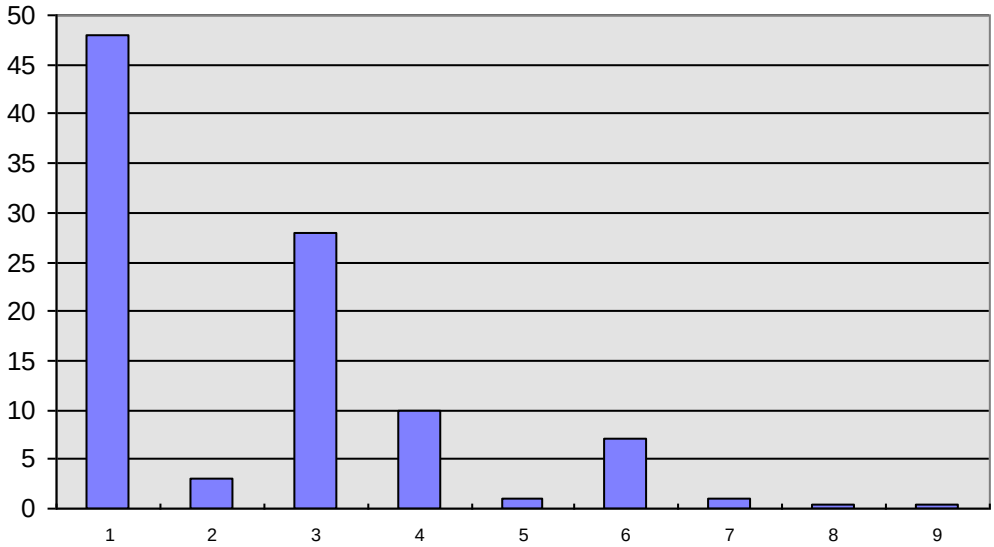
Applied R&D activity in C. Macedonia

Research activity in C. Macedonia is fragmented into a large number of small research units. We identified and listed 277 research units for applied R&D, of which 138 are university laboratories (130 in the Aristotle University of Thessaloniki and 8 in the University of Macedonia), 110 belong to Technical Education Institutes in Thessaloniki and Serres, 5 are associated with the laboratories of the Foundation for Research and Technology (FOURTH), 19 belong to the National Agricultural Research Institute, 2 to the Institute for the Control of Cultivated Plant Species, and one each to the Geology and Mining Research Institute, the National Tobacco Board and the National Cotton Board (see, Table 8.1).

These research units employ on an average over 12 persons per unit. Their scientific specialisation vary with the nature of the unit. 50.3% of those employed are university graduates, 8.9% graduates of Technical Educational Institutes, while 16.3% hold doctoral degrees and 3.1% post-graduate diplomas. A very small fraction is represented by under-graduates and senior students at the Technical Departments. Most of those employed are university graduates, while the percentage represented by those with doctoral degrees or post-graduate diplomas is small.

Building installations are generally considered satisfactory. 18.6% of these units are housed in facilities of under 100 m2, 27.9% have 101-300 m2, 11.6% have 301-500 m2, 18.6% have 501-700 m2, 6.9% have 701-900 m2 and 16.2% over 900 m2. The laboratory equipment available (computers, measurement instruments and other basic apparatus) is also considered satisfactory. 56.8% of the units polled consider that the equipment available to them has certain deficiencies, 34.1% definitely inadequate, and 9.1% adequate.

Table 8.1: Research Units for Applied R&D in C. Macedonia



1. Aristotle University of Thessaloniki
2. University of Macedonia
3. Technological Educational Institute of Thessaloniki
4. Technological Educational Institute of Serres
5. Chemical Process Engineering Research Institute
6. National Institute for Agricultural Research
7. Institute for Geological Research
8. National Tobacco Company
9. National Cotton Company

Research and technology areas

The technology areas which concentrate most of the above units are related to agrotechnologies, biology and biotechnology, and the technologies for materials. Lower is the concentration around automation technologies, energy and communications (see Table 8.2). The technology fields which are covered are:

- *Agrotechnologies and geotechnologies:* agricultural technology, food technology, plant products technology, biotechnology, genetics and amelioration of plants, plant pathology, rural cultivations, rural soil mechanics.

- *Forest technology:* forest genetics, forest products technologies, forest pastures, forest informatics.

- *Biotechnology and biology*: biological production systems, zoology, bio-medicine and health, technologies of animal origin foods, hygiene of animal origin foods, animal nourishment, ecology, fish technology, fisheries, neurobiology, molecular-cellular biotechnology, biochemistry.

- Geology, geophysics: ground and underground analyses, mineralogy, stones technology, seismology, natural resources.

- *Environment technologies*: atmosphere radioactivity, atmosphere pollution, soil pollution, water quality control, water waste elaboration, cleaning units, natural environment, environment quality, atmospheric observations, climatology-meteorology.

- *Energy*: renewable energy resources, energy transformation, optimisation of energy use, mild energy forms, energy saving, energy analysis of processes, construction of energy-saving equipment, atomic power, physics of elementary particles, thermo-illumination control, solid fuel, environmental fuel, synthetic fuel, electric power, quality control, measurements.

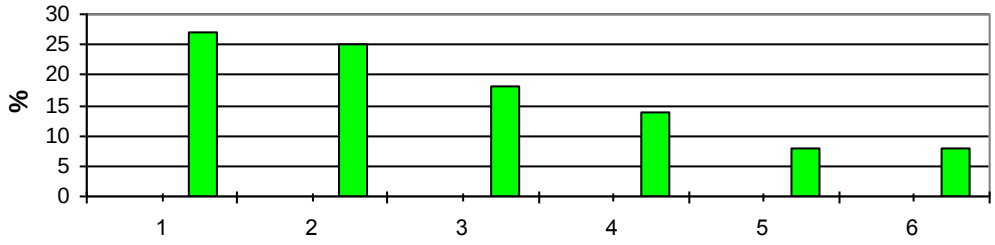
- *Automation technologies, technologies of production processes, constructions and quality control:* propellant technologies (fluid mechanics, aerodynamics), mechanics and design of constructions, equipment, particles, mechanics of micro-systems, automatic production systems, CAD/CAM, mechanical treatment, micro-computers, technologies of testing and control, metrology, weighting and sampling measurement systems.

- *Material technologies:* concrete technologies, inactive materials, organic materials, polymer technology, semi-conductors, super-conductors, optoelectronics, metals, thin membranes, leaf-form materials, catalysts, technologies of cultivation materials.

- *Information and communication technologies*: software, information management, databases, analysis and synthesis of automatic control systems, expert systems, intelligent systems, optical elaboration of information, digital image and sign processing, artificial neuronic networks, data networks, distributed applications, non-linear systems, simulation, optic fibres, multimedia, communication systems-programming.

- *Applied socio-economic research:* business management, business research, financial analysis, urban and regional planning, rural and forest socio-economic research.

Table 8.2: Research units per technology area



1. Bio-Sciences and Technologies
2. Industrial Technologies
3. Environment
4. Information and Communication Technologies
5. Energy
6. Socio- Economic Research

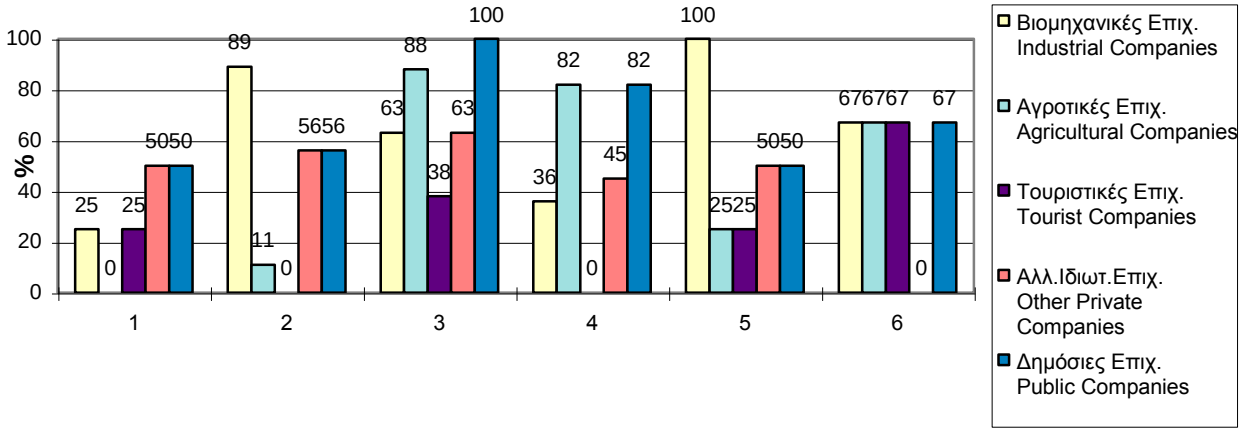
Collaboration with companies

Companies and public organisations generate significant demand for technology. This demand includes services (76.1%), production process development (54.3%) and product development (36.9%). Usually, the capacity of the research units covers more than one of these fields.

77.5% of the research units polled provide technology services and their research activities lead to applications. The recipients of these applications fall into a number of categories: 45.6% of these research units are oriented towards industry and agriculture, 15.2% to tourism, 56.5% to other private companies, 56.5% to public organisations and services, 15.2% to other enterprises. Most of the units (76.7%) have recipients in several categories of enterprises or organisations, large companies, small companies, and public sector organisations.

Despite the significant number of research units providing technology services to companies, the degree of collaboration between research and enterprise does not appear to be very great. Only 30.6% of the units polled feel that they provide substantial support services, replacing company R&D departments with their own R&D services. Further, a similar percentage feels that it makes a significant contribution to technology transfer to industry, while 38.7% feel that their contribution is minor and 30.6% nil.

Table 8.3: Provision of technology per company type and R&D category



1. Information and communication technologies
2. Industrial technologies
3. Environment
4. Bio-Sciences
5. Energy
6. Socio-Economic Research

The problems of cooperation with enterprises are for most of these units multiple. The main source of their inability to develop strong bonds with companies is considered to be the companies themselves. About half the research units attribute this low levels of collaboration to a lack of interest on the part of the companies concerned. A significant number attribute the difficulty of collaborating to the lack of infrastructure, to lack of personnel, equipment and space. Another restrictive factor is the institutional framework within which the public entities function, especially with regard to billing for services rendered.

In any case, the effective co-operation between research and industry demands not only the adjustment of services and products by the research units, but also the development of internal to companies technological capabilities, based on R&D departments or the employed of scientific personnel.

In conclusion, the R&D carried out by research units in Central Macedonia is both substantial and capable of covering numerous fields of application. The basic objective for the immediate future should be: (1) the creation of larger poles of concentration of research activity through networks and joint research units, (2) the expansion of collaboration and networking between enterprises and research institutions, and (3) alteration of the institutional framework governing the public research institutions in order to facilitate the provision of services by these bodies.

9. ANALYSIS OF REGIONAL TECHNOLOGY TRANSFER

A third important field for the innovation system in Central Macedonia, after the analysis of technology demand and supply in the Region, concerns technology transfer mechanisms. Technology transfer was analysed from the point of view of the related public support, the university-industry co-operation, and the inter-firm technology co-operation in Central Macedonia. In Table 9.1, are codified some major forms of these practices and relations.

Table 9.1: Technology transfer routes

COLLABORATION BETWEEN UNIVERSITY AND INDUSTRY
Forms : Science and technology parks, innovation centres, technology institutes, brokerage bureaux

Institutions and practices :
- Access (for companies) to research infrastructure and technology information
- Networks, consortia, and agreements between companies, universities and research centres
- Provision of technology services (control, evaluation, measurement, training)
- Financial support for spin offs from the academic sphere.

INTERFIRM TECHNOLOGY COLLABORATION
Forms : Sub-contracting, co-production, joint R&D programmes, sale and purchase of technology

Institutions and practices :
- Horizontal and vertical networks of collaborating companies
- Technology licensing
- Financial support for spin offs

ATTRACTION OF TECHNOLOGY-INTENSIVE ACTIVITIES
Forms : Relocation of research institutes, attraction of affiliated companies, new installation of technology institutes

Institutions and practices :
- Creation of acceptance zones
- Attraction incentives
- Attraction marketing
- State R&D policy

Public support for technology transfer

In Greece, the main orientations of technology transfer policy for the period 1994-1999 originate in the Community Support Framework and are described in the Operational Research and Technology Programme. This Programme has a total budget of 580 million ECU, 27% of which is expected to come from the private sector, while the rest will be covered by Community Funds and national contributions. It consists of five sub-programmes, each of which comprises a particular number of actions and policy measures.

- The first sub-programme, which accounts for 26% of the budget, supports programmes submitted by consortia of research companies and institutions in five socio-economic domains: environmental protection, life sciences (agricultural and medical applications), information technology, new materials, and socio-political development.
- The second sub-programme, with 46% of the budget, is oriented towards industrial research, innovation, technology transfer, technology of culture, electronic networks and development of data bases, as well as international collaboration in Science and Technology. The large single chunk of the budget will go to direct encouragement for innovation and technology transfer, supporting demonstration programmes, technology brokering, technology audits and technological assessment. It also promotes the development of science parks, research and technology institutions, technical museums, contact points with university and public sector research centres, and industrial design institutions.
- The third sub-programme (18% of the budget) supports the development of new or existing R&D laboratories and institutes. A specialised programme will study how effective public sector R&D units are providing services to industry. Marine research is expected to receive substantial support, while plans are going forward for the foundation of new institutes in the fields of information technology, industrial automation, health, transportation and cultural technologies.
- The fourth sub-programme focuses on financing university research and is intended to increase the numbers of those actively employed in research in this country. This programme favours post-doctoral research, and thus supplements the activity of the State Scholarship Foundation. One of its proposals is for the establishment of a research and training centre in the field of science and technology policy.
- Finally, the fifth sub-programme is devoted to studies on Science and Technology policy, and the evaluation, dissemination and management of the programme as a whole.

Technology transfer policy received a significant boost from the European Commission's Fourth R&D Framework Programme, which defined the priorities relating to levels of technology development and the dissemination of innovation. The Programme was sub-divided into four activities, dealing with: special R&D programmes, international collaboration, dissemination of R&D results, and training and mobility of researchers. The principal objectives of the programme are: (1) promoting broad application technologies to

as many productive activities as possible, and (2) promoting the dissemination and spread of the results of R&D activities.

The first activity, which covers 83% of its budget, is based on the development of generic technologies. The main applications include information and communications technologies (28.2% of the activity's budget), energy technologies (18.5%), industrial technologies (16%), biomedicine and biotechnologies (13.1%), and environmental protection technologies (9%). The Programme includes also three activities focusing on R&D transfer and dissemination.

- The second activity concerns international collaboration, and absorbs 4% of the Programme's budget.
- The third is rooted in the experience of the Value and Sprint Programmes, and focuses on the dissemination and exploitation of research results, absorbing 2.5% of the budget.
- The fourth and final activity, which focuses on the researchers themselves and accounts for 6.2% of the budget, is designed to support and promote training and mobility.

One of the critical features of the national research system is the limited participation of the business sector in the financing and practical application of R&D. In this sense, most recent policies focus on technology transfer, helping companies and the public to become aware of the importance of research and technology, and to awaken their interest.

Collaboration between research and industry in C. Macedonia

Despite the large number of research centres able to offer both technology and services to the industrial sector, collaboration between universities and companies is extremely limited. This is the unavoidable conclusion of the survey conducted in research units and enterprises throughout Central Macedonia. Only 5-10% of the region's companies collaborate with its post-secondary institutions on questions of product development, production processes, consultancy services, etc. (see Table 9.2). The overwhelming majority of Central Macedonia's businesses do not consult the universities and research institutes for help in resolving the problems they encounter. And this is a serious loss to the regional system of technology support and innovation.

Such collaboration as does exist between industry and the universities bears on the following sectors :

- provision of services (67% of cases)
- product development (39% of cases)
- development of production processes (45% of cases)
- product development and production processes (22 % of cases).

Table 9.2.
Collaboration between universities and industry in Central Macedonia (%)

Area of collaboration	Yes	No	N/A

For the development of new products and production processes	10.1	80.3	9.6
For the training of personnel	4.5	85.9	9.6
As consultants	2.5	86.4	11.1
As a source of staff	5.1	84.8	10.1
For information on questions of innovation and development	3.0	86.4	10.6
For research and technology development	13.6	73.7	12.6

The financing of such collaboration comes chiefly from public revenues. The national public sector was the principal source of funds for programmes aimed first of all at public corporations and secondly at agro-businesses; it also played a substantial role in funding programmes targeting the industrial sector. Programmes aimed at industrial and other private companies were basically funded by the EU, which also provided substantial funding for programmes aimed at public corporations.

Over the past five years a number of new institutions active in the technology transfer sector have appeared: these include the Thessaloniki Technology Park, the Centre for Business Innovation in Serres, and the Industrial Liaison and Placement Offices at the Aristotle University of Thessaloniki. Their activity, however, is still too limited to have had any effect on the university/industry collaboration index.

Inter-company collaboration and technology transfer

Apart from collaboration between research and industry and state support for technology transfer, a significant share of technology transfer is accounted for by collaboration between companies.

This section focuses on the transfer of technology that is effected in the area of business activity by means of collaboration between companies. It is based on published figures for Central Macedonia and for the country as a whole, as well as on survey conducted for the purposes of this study. The sectors studied were: sub-contracting, business collaboration, licensing, and direct foreign investment, as vehicles for technology transfer.

Sub-contracting and technology transfer

The term sub-contracting describes a situation where one company invites another to undertake, on its behalf and according to specifications or designs supplied, the production or the processing of a material or component or the completion of a certain phase of production. Sub-contracting differs from the simple purchase of materials and components from a supplier in that between the two companies concerned there is an on-going contractual relationship defining the specifications of the order. When the sub-contractor does not use his own materials but receives them from the principal, the commission is described as piece-work.

Sub-contracting arose out of the breaking-up of production processes and the re-assignment of certain units to geographical areas or companies offering comparative production and cost advantages. During the 1980s, the crisis in the system of mass

production led to an explosion of sub-contracting, since this system offered flexibility of production volume and capability of rapid adaptation to demand changes.

Although the relationship between principal and sub-contractor is one of hierarchical dependence, for the latter it does nonetheless contain a number of dynamic elements and positive aspects. It offers him access to new markets, know-how, experiences in the production of a given product, the quality control and product evaluation. International literature in the field has many examples to show of sub-contracting businesses which developed into dynamic companies, gradually adding upstream and downstream production processes and eventually emerging on the international market as autonomous and competitive entities. Examples ranging from small electronics companies in south-east Asia to garment industries in central Italy show how companies which began as sub-contractors dependent on large industrial complexes have achieved autonomy on the production as well as the market level.

Production contract work is an established practice in Central Macedonia. It is mainly a form of collaboration between local and foreign companies, but also occurs between regional businesses. The questions we were particularly concerned related to the nature of the contract work, and to the type of technology transferred and its contribution to the evolution of the technological level of local businesses.

A survey of 108 companies in Central Macedonia, undertaken within the framework of the FAST Programme, found that the firms which give out were very varied indeed.

- 50% of the companies studied give out in a variety of industrial branches, both traditional and more modern: 83% to clothing firms, 62% textiles, 50% wood and furniture, 32% food and beverage, 33% non-metallic minerals and finished metal products, 43% electrical and other appliances.
- Contract work is addressed to smaller businesses: 65% of contract work went to companies with fewer than 50 employees, and 35% to larger ones.
- The proportion of work contracted out varied according to the reason for sub-contracting. Thus, traditional businesses, being generally less technologically advanced than more modern ones, tend to contract out more. A second factor is the size of the principal. 75% of companies contract out up to 25% of their production, while the remaining 25% contract out 25% to 50%.
- Work is contracted out for one of three principal reasons: (1) lack of proper equipment, (2) to achieve rapid production response in periods of high demand, and (3) in traditional sectors, to reduce the cost of extra employment at peak periods. In this type of sub-contracting, the production designs and raw materials are supplied, while in rare instances know-how is supplied as well.

Looking now at the other side of the picture, 25% of the companies surveyed had accepted contract work.

- Most of these were located in prefectures other than Thessaloniki: in Imathia, Kilkis, Halkidiki, Pella and Serres, and belonged to traditional industries (25%) rather than to more modern ones (18%).
- For 66% of companies undertaking contact work, it represents 1-25% of their total production, while for those located outside Thessaloniki the proportion of total production is generally larger (up to 100%).

- This category of businesses includes large clothing manufacturers most or all of whose production is absorbed by foreign companies. These businesses differ from smaller sub-contractors in their more advanced technology and better organised production.

Contract work in Central Macedonia is largely concentrated in the clothing and footwear sector. The garment industry alone accounts for more contract work than all other sectors put together. Clothing companies contract out part of their production because of limited production facilities and lack of appropriate machinery. In this sector the principal form of sub-contracting is that developed between Greek companies or between Greek and foreign companies, and is of a type that precludes specialisation and innovation and does not lead to a more developed enterprise. In this type of contract work, the sub-contractor produces consumer goods using designs and raw materials supplied by the principal, and is dependent on him in the spheres both of production and commerce, which limits his possibility of achieving greater autonomy.

In general, the conditions in which the sub-contracting system has functioned in Central Macedonia have done nothing to improve the productive and technological potential of the companies accepting the contract work. The production process is labour intensive and the potential for the sub-contractor to extend his activities into the field of design and autonomous production are extremely limited.

Collaboration between companies and technology transfer

Collaboration between companies is a consequence of the fragmentation of the product cycle (design, funding, manufacture of samples, production, marketing) among a number of different businesses. In this type of collaboration each company seeks the benefits accruing from economies of scale (cost reductions through volume of production), economies of scope (cost reductions through differentiation of production), but most important of all from external economies (cost reductions through interaction with other companies).

For companies in Central Macedonia, collaboration extends to many countries and geographical areas, and is associated with (1) product development, (2) production, and (3) promotion, distribution and marketing through commercial agents and wholesalers.

Collaboration in the development of new products is rather marginal. Companies select target products for production either through purely competitive logic or through established channels between parent and subsidiary companies or central and branch plants. Collaboration in production, on the other hand, is more extensive, especially in its conventional form of sub-contracting; other forms, in the rare cases when they occur, are the result of technical requirements associated with production (e.g., collaboration between food and packaging industries) rather than of a deliberate strategy for the enhancement of a competitive advantage. Equally limited are joint endeavours to combine the capacities of existing companies into a new venture.

With the exception of exports, the existing institutional framework does not promote either collaboration or the development of networks from below. Where collaborative formations exist, they tend to focus on exploiting state subsidies rather than on the development of strategies and actions related to production, products and competitors' strategies.

Collaboration is generally limited, and this is due to the competitive mentality of enterprises, which is a result of their small size, their family-based organisation and the similarity rather than complementarity of companies belonging in the same cluster. In each instance, collaboration was also a channel for the transfer of both information and technology. However, technology transfer through this channel is extremely limited, and confined mainly to companies that by their position or operation have a broader field of information and view of the market. In these cases the collaboration involves large companies, suppliers of machinery and production systems, and companies which already implement new technologies.

Licensing and technology transfer

Greek industry has covered most of its technology needs through purchase from abroad. Throughout the entire post-war period it has followed a policy favouring the import of capital goods, direct foreign investment, and licensing agreements.

While Greek industry's total expenditure on licensing may be small, it is nonetheless significant. Average expenditure on technology purchase amounts to 0.40% of the value added of industrial production (1988). This expenditure is significant, because it covers the bulk of industry's technology requirements, and is many times the sector's expenditure on research and development.

At the beginning of the 1980s, expenditures on R&D constituted 0.03% of the total value of industrial production, while expenditure on the purchase of technology (royalties) amounted to 0.14-0.21%: that is, 5-7 times more was spent on purchasing technology than on in-house development and adaptation of technology. By the middle of the decade this ratio had improved, but expenditures on technology purchase are still triple expenditures on research and development.

The sectorial distribution of expenditure on royalties, presented in Table 9.3, is unbalanced. It is particularly heavy, for example, in such sectors as electrical machinery and appliances and chemicals while, at the other end of the scale, a whole group of producers of consumer products (wood, furniture, paper, publishing, leather) have virtually no outlay on royalties.

Table 9.3
Sectorial distribution of expenditure on technology purchase (1988)

Industrial branch	% expenditure on royalties	% of added value	royalties/added value
Foods	3.6	12.6	0.29
Beverages	5.1	4.8	1.06
Tobacco	1.2	2.4	0.49
Textiles	2.8	17.9	0.16
Clothing-footwear	2.0	6.5	0.31
Wood	0.0	1.6	0
Furniture	0.0	1.0	0.01
Paper	0.0	2.8	0
Publishing	0.6	2.2	0.25
Leather and hides	0.0	0.9	0

Plastics	5.7	3.4	1.68
Chemicals	16.8	8.6	1.95
Petroleum products	0.0	3.1	0
Non-metallic minerals	3.0	7.6	0.39
Metallurgy	5.6	5.6	0.99
Metal products	0.1	6.2	0.01
Machinery	0.1	1.6	0.07
Electrical products	52.8	4.5	11.72
Vehicles	0.6	6	0.10
Other	0.2	0.8	0.25
Total	100	100	1

Source: T. Yannitsis - D. Mavri (1993)

This Table reveals three readily distinguishable categories of industry:

- Those with exceptionally high expenditures on royalties (chemicals, electrical products).
- Those with low expenditures on royalties (foods, beverages, textiles, clothing-footwear, plastics, metallurgy, non-metallic minerals).
- Those with virtually no expenditure on royalties (wood, furniture, publishing, leather, petroleum products, metal products, machinery, vehicles).

Furthermore, in many of the sectors with high levels of expenditure on research and technology, in-house development of R&D and royalty payments for the purchase of technology are comparable (foods, tobacco, textiles, chemicals, non-metallic minerals, metallurgy). In some branches, there is considerable R&D activity, but virtually no expenditure on the purchase of technology (clothing and footwear, paper, metal products, vehicles). By contrast, sectors such as plastics and electrical products show heavy expenditures on the purchase of technology and very little on R&D. Finally, in a number of sectors (wood, furniture, publishing, leather, petroleum products, machinery and other industries), expenditures on both technology purchase and R&D are either minimal or non-existent.

The payment of royalties is principally associated with product development and production processes. However, recent royalty agreements have included consultancy services in such fields as management, marketing, personnel management, etc. The study of 675 agreements from the period 1960-1987 shows that the major technology flows resulting from these agreements are related to: (1) the leasing of equipment, (2) turnkey projects, (3) concession of trademarks, (4) technical backup in methods, consultancy, organisational services, (5) staff training (see Table 9.4).

Table 9.4
Distribution of licensing agreements by content (1960-87)

Category of technology purchase	Number of contracts	% distribution
Leasing of equipment	8	1.18
Turnkey projects	9	1.33
Concession of trademark only	3	0.44
Technical backup - methods, consultancy	298	44.15
Processes and trademarks	311	46.07
Other combinations	46	6.81

Total	675	100

Source: D. Mavri, Technology transfer contracts in Greece 1960-1987

These trends are reflected in the figures on technology purchase in Central Macedonia. They show that in the 1980s a large proportion (25%) of companies acquired production technology and created their products by means of licensing. An even greater percentage (32.5%) used licensing as an external source for the acquisition of technology in general, while other sources of technology were collaboration with other companies, with a parent plant and with the country's universities and polytechnics.

Most of the factories purchasing technology were located in industrial clusters around Thessaloniki and in neighbouring prefectures. Of the industries in Thessaloniki, only 18% reported having imported know-how. By branch, the rubber, plastics and chemical industries occupy the top place, followed by foods and beverages, textiles, clothing and machinery.

Foreign investment and technology transfer

The attraction of foreign direct investment to a region, especially investments intriducing innovations and new production practices, is a major factor in its growth and development. Foreign investment, apart from its cumulative effect on investment activity and on the product produced, in many instances acts as a catalyst for the overall modernisation of the area. In many regions of Europe, especially in the less developed ones of Southern Europe, in Ireland and Scotland, the attraction of large companies or research institutes has given a boost to the general development of the area, to the local innovation system and to the creation of positive multiplier effects. Here, the capacity of regions to attract investments, research institutes and companies has been a critical parameter in their development.

The characteristics of attractiveness of a given region have changed over the past few years, just as the factors affecting the selection of an installation site have become much more complex. Nevertheless, the classical factors, such as market proximity, availability and quality of labour, appropriate infrastructure (transport, telecommunications), cultural or linguistic affinity, continue to be important.

Research into the attractiveness of Europe's regions to multinational companies shows that the less developed countries such as Greece and Portugal are rarely preferred as sites for new investment. When they are preferred, the reasons are related to low labour costs and high investment incentives. One reason for the low preference rate of these two countries is their marginal geographic position, which is associated with increased transport costs, insufficient infrastructure, low labour productivity and the lack of specific skills on the labour market.

In Central Macedonia, after a period of considerable foreign investment in the 1960s, foreign direct investment has remained very low. During the 1960s, direct foreign investment contributed to the establishment of the region's productive fabric, especially in intermediary industrial products. At the same time licensing was closely associated with foreign investment, while purchases of capital goods had increased sharply. In this sense, all three channels for technology transfer from abroad (direct investment, licensing,

purchase of equipment) were functioning in tandem. Later, during the 1970s and 1980s, direct international investment dropped considerably.

Foreign direct investment is centred on Thessaloniki and the neighbouring prefectures of Imathia and Kilkis. It is concentrated in such traditional sectors as food, beverages, tobacco and clothing, wood and cork products, non-metallic minerals and metal products, and to a lesser degree chemicals and electrical machinery. In general foreign investment appears to demonstrate a preference for the traditional sectors of foods and beverages as well as that of electrical appliances.

Figures from the Directorate for Regional Development on investments approved in the 1995 in the context of development law 1292, reveal that foreign direct investment in the 1990s in Central Macedonia's industrial sector has been very limited. As in the past, the investments that have been made are concentrated in the prefectures of Thessaloniki, Imathia and Kilkis. An exception to this was the single biggest industrial investment for many years (200 million dollars) which, after years of discussion, was at last finalised in 1996: this was the investment realised by the Canadian company TVX GOLD to acquire and re-open the historic Cassandra Mines in Halkidiki, long owned by the Bodosaki Foundation's Hellenic Chemicals and Fertilisers Company.

On the basis of a survey of foreign investments located in Thessaloniki, we investigated their level of interaction with local companies and their contribution to the introduction and dissemination of innovations on the local production system.

In the food and beverage sector, where significant investments have been made by the local subsidiaries of such large multinationals as PEPSI CO - IVI SA and COCA COLA, companies import and use the technology of the parent industry throughout the production process. Requirements for skilled labour are small, and where these exist they are covered by seminars provided by either the parent company or the manufacturer of the equipment.

Many companies in intermediary industrial branches (chemicals, plastic, rubber, etc.) have been attracted to Central Macedonia by the incentives provided by the development laws. One such is the Japanese company Tosoh Hellas (principal product: electrolytic manganese dioxide and manganese oxide), which was the first industry to move into the Sindos Industrial Zone in 1973. The company was looking for a site in Europe, given that its principal market was France, Belgium (it supplies Duracell) and Germany. Between Spain and Greece it eventually chose Greece, since Thessaloniki with its port could ensure supplies of its principal raw material (from Africa), while its airlines and railway, with, in the past, a spur right to the company's site in the industrial zone, gave it easy access to its Central European market. Tosoh Hellas built a factory that is an exact replica of a Japanese plant; in-house seminars and training programmes keep its staff's skills up-to-date and finely honed. For its new plant in Sindos, the company hired Greek trainees who spent a full year understudying the Japanese operators. Nevertheless, any serious problems relating to production processes or any changes in production processes are referred to the parent company in Japan. The system, which is entirely computerised, was built by Siemens, and the production process, based on electrolysis, is considered an innovation in the field. The daily contact between production engineers and personnel promotes the company's policy of giving the workforce - even its lowest echelons - the opportunity to participate in the production process.

Turning finally to commerce and services, more and more foreign companies - banks, insurance companies, airlines, transport companies - are establishing branches in Thessaloniki. Within a very short space of time a whole series of superstores of a variety of national origins opened for business in the area: the French *Continent*, the German *Praktiker* and *Goetzen*, the Dutch *Makro*. These businesses, situated to capture a large share not only of the local market but also of that represented by the neighbouring prefectures, generally operate on the franchise system.

Another typical example of this type of investment is Marks & Spencer, the result of a franchising agreement concluded between the British company and the Greek Marinopoulos. Its general operating system is highly flexible, and it has introduced a certain number of innovations, including:

- Continuous store hours, with part-time staff (4 hour stints) employed to make up the intermediate hours. This makes it possible to have a greater concentration of staff during peak hours. The company provides staff training seminars, initially given by the parent company, to brief the staff on company rules and standards. From time to time seminars are given by other companies, usually in Athens.
- On-line connections with the company's headquarters in England automatically monitor sales, enabling ordering to be organised on this basis, so that supplies of items that sell well can be stepped up and poor-selling lines halted. The store can in this way adjust its ordering to avoid stock-piling, while the parent company has a continuous stream of direct information on markets in the different countries it supplies, enabling it to keep an eye on trends in styles, colours, etc., and thus change or adapt product design to the demand in each individual market.
- Its marketing policy requires merchandise to be displayed in such a way that customers can select items and try them on without having to ask a salesperson. This in turn imposes a more flexible interior architecture and the use of movable panels to adapt floor space as required.

These examples show that while foreign companies do introduce innovations, their interaction with local companies is fairly limited. Major investments in particular use innovative practices in their production processes and final products which are integrally imported from the parent company. Their requirements in skilled labour and personnel are covered by in-house training of local employees, in accordance with the principles followed by the company internationally. Interaction and collaboration with local companies is minimal, and is generally limited to routine processes and small-scale contract work (such as, for example, bottling or packaging some part of production), or producer-supplier contacts.

In aggregate, then, we may say that in Central Macedonia technology transfer continues to follow traditional paths. The role of the market is the stronger one, since technology is purchased with equipment. The identification of technology as a separate production factor which can be bought or exchanged as such is very recent and is not yet embedded in business practices. Institutional forms of technology transfer through collaboration with universities and other similar public policies are still very new and very limited. The market, the relations between companies, and licensing agreements are the principal means of technology transfer.