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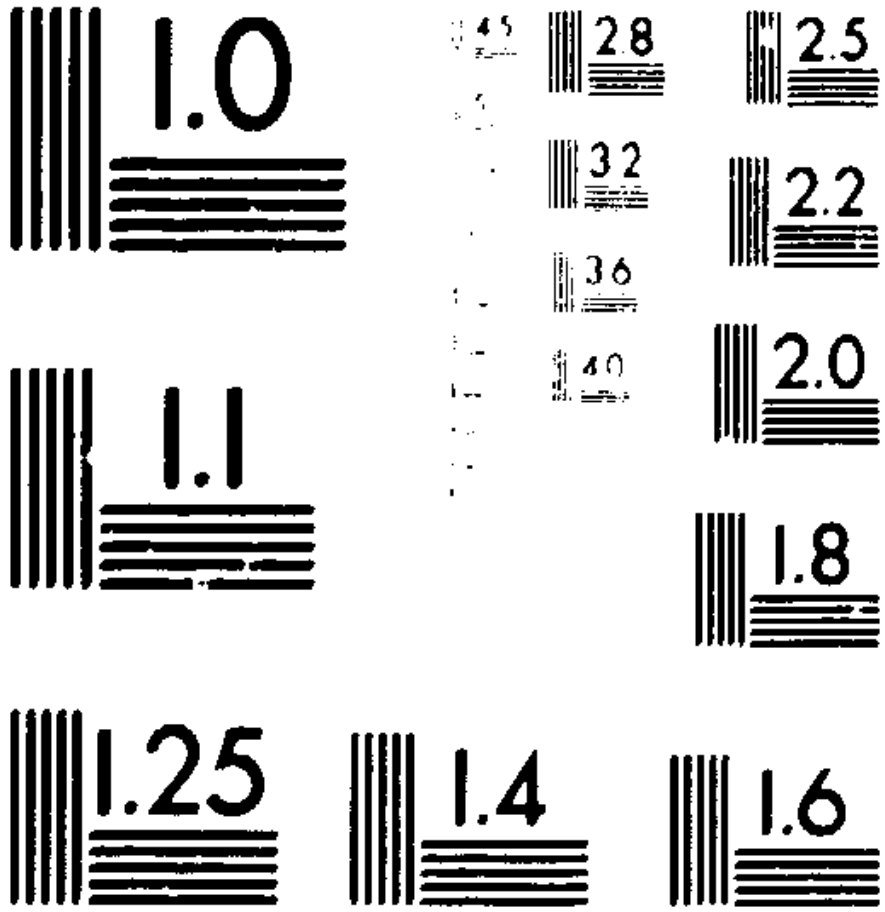

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# THE USE OF PUBLIC PURCHASING AS A TOOL TO DEVELOP TECHNOLOGICAL COMPETENCE IN MICROELECTRONICS**

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# CHAPTER 1 - BACKGROUND

## 1.1 INTRODUCTION

Most Governments participate in a major way in the economic activities of their countries. Spending by federal, state and local government amounts to a substantial percentage of the nation's expenditure The degree of State involvement in the provision of services varies significantly over a wide spectrum from the centrally planned economies in which the State provides many services as a matter of principle, to market economies, where the State may seek to minimise its involvement, also as a matter of principle.

The range of services includes:

- Security (civil and military)
- Communications (person to person, broadcast)
- Transport (road, rail, sea, air, space)
- Energy (electricity, oil, gas)
- Health
- Education
- Housing

  etc,

which may be organised nationally or at regional levels.

In order to provide these services, the State must itself purchase materials, products and services. Thus the State will purchase (from public or private sources):

- construction materials, products and services (for housing, schools, hospitals, roads, airports, harbours etc);

- instruments and equipment (for hospitals, vehicles for transport, military and space systems, telecommunications systems, computers and office systems, electricity generating plant, oil, gas and minerals exploration, processing and distribution equipment etc.);

- pharmaceuticals (for the medical service) etc.

The sums of money spent by Governments in buying in these materials, products and services are large, constituting a sizeable fraction of GNP. This substantial purchasing power of

Governments gives them great leverage in the relevant markets. Some Governments will deliberately use this purchasing power in an attempt to develop the capacity of national (public or private) industries, firstly by supplying the goods and services in question, and then using this as a base for penetrating markets other than the Government one either at home or abroad.

This can be done either in a defensive or offensive manner. A defensive approach would be, for example, to protect national firms from foreign competition. An offensive approach would, for example, involve a deliberate attempt to build a strong national company by providing it with experience and by building competence. The objective might be to develop national companies sufficiently strong to compete successfully with foreign companies on the home market (import substitution) and to capture a share of foreign markets (exports).

## 1.2 SOME PITFALLS

Although there would appear to be an obvious prima facie case for Governments to sustain and develop local industry by awarding them public supply contracts, there are nevertheless some significant difficulties of practice and principle in implementing such a policy and it may be useful to state these at the start.

### Administrative Difficulties

No Government is a monolith with all power and decision taking located at one central point. Rather, administrations are normally structured into Ministries with assigned sectoral or horizontal functions, and State agencies with assigned missions. The realities of the 'pecking order' of power will vary from country to country and within each country, over time. The Minister for Industry may wish to develop national firms by giving them State contracts, but in many cases he will not have the authority to award these contracts and he may be unable to persuade the relevant authority to do so. Thus, he may not be able to persuade the Minister for Communications that the order for PTT telecommunications equipment should go to a certain national firm or to any national firm. Furthermore, the Minister for Energy may find it difficult to (or he may not wish to) persuade the electricity utility to

purchase nationally-manufactured turbines. The Minister for Finance, who may have a role in all public contracts, and may, in fact, be the most powerful Minister, may refuse to approve the extra expense of supporting a national firm where an imported product would be cheaper. In theory, the Prime Minister or President would decide between these different points of view. In practice, he may not do so.

Service Utilities

State services e.g. electricity service, telecommunications etc. are frequently provided by para-statal organisations specifically established for the purpose. The management of the service utilities (correctly) perceive their function as:

'to provide the best possible service at minimum cost'.

They are not responsible for general industrial development. They are concerned with

- security of supply
- quality of service and
- cost of service.

They would naturally be hostile to an industrial policy favouring national firms if such a policy endangered their security, reduced their quality and raised their costs. These are valid concerns which must be addressed.

On the other hand, however, the overall national interest might well be more important than the sectoral interest. It may, in fact, turn out to be in that broader national interest in the longer term to absorb the additional costs involved in developing an effective national supplier, than simply to import the equipment.

The management of this conflict between national interest and sectoral interest is not easy in practice.

Competition, Protectionism and Distortion of Trade

It is a widely observed phenomenon that protectionism promotes inefficiency. If a utility supports a monopoly national supplier, protecting it from competition from other national

and foreign firms, the experience normally is that that firm will, over time, provide inferior products of poorer quality with poorer after-sales service at higher prices. On the other hand, competition from other national firms and, where possible, from foreign firms, can provide the dynamic to combat these inefficiencies.

It is a common and powerful criticism of public purchasing based industrial development policies that the associated practices result in a protectionist ethos which breeds these inefficiencies.

Developing countries, however, whose industries are in early stages of development, are presented with a serious dilemma in this regard. Even if the beneficial dynamic of competition is recognised, the reality might be that free competition on their home markets with foreign suppliers could simple destroy the entire indigenous industry. For developing countries, therefore, the judgements as to when to encourage competition and on what terms is extremely difficult.

The prevalent declared view of developed economies is that the liberalisation of trade between countries leads to greater growth of world trade and that national protectionism inhibits such growth. In international fora promoting the liberalisation of trade, public purchasing-based industrial development policies are identified with protectionism leading to a 'distortion of trade'. This is of more than theoretical importance since 'free trade' countries can retaliate against 'protectionist' countries by refusing to allow certain imports from the 'protectionist' country and/or refusing to export necessary materials, components and products to the 'protectionist' countries.

Whenever the goal of industrialisation or the goal of economic diversification is identified as a priority, as it is for many developing countries, the case for using public purchasing power is nevertheless both appealing and perfectly defensible, even to the most strident advocate of free trade. Tariffs or 'direct protectionism' are defended as giving time and space to infant industry to develop economies of scale, skills of management and workers and familiarity with technology. This defence applies with equal force to the 'indirect protectionism' of public procurement preference.

## 1.3 SOME OPPORTUNITIES

Despite the identified difficulties and pitfalls, public purchasing can be a very powerful tool available to Governments to develop their industries.

One of the basic preconditions for successful industrialisation is the development of local indigenous competence. This competence in, for example, manufacturing practices, technology, management, marketing etc., cannot be bought 'off the shelf'. It has to be learned and the learning process is not quick. This presents a fundamental problem for developing countries.

This document concentrates mostly on developing technological competence. It is primarily directed towards the needs of developing countries. The industrial sector arising from microelectronics technology receives major attention.

It will be shown that public purchasing policies, carefully conceived and skillfully implemented and managed, can provide developing countries with an effective means of building their microelectronics technological competence. Chapter 4 presents the elements of such a policy and associated practices. The applicability of the proposed policy and procedures goes beyond the microelectronics sector.

## 1.4 THE MICROELECTRONICS INDUSTRY

As this paper will discuss in some detail the use of public purchasing in the microelectronics industry a brief background to that industrial sector is provided here.

Dramatic advances in semi-conductor technologies since the Second World War have resulted in the development of integrated electronic circuits of great power and complexity, low energy and materials costs and high reliability. These integrated circuits, sometimes in combination with 'software' (computer programmes) form the basic inputs to a vast industry of microelectronics based products and services.

Included among the range of products are:

- consumer products such as T.V.'s radio, video recorders, electronic games etc.

- office equipment such as computers (mainframe, mini, micro), word processors etc

- telecommunications equipment for public and private voice and data networks

- industrial equipment such as process controllers, automation equipment etc

- electronic instruments for medical, scientific purposes etc.

- military equipment for communications and weapons systems etc.

The world turnover of this industry is now in excess of US$400 billion and is expected to be at least US$500 billion by the year 1990.

World production and consumption of microelectronics products are dominated by the USA, Japan and Western Europe. The USA produces substantially more than it consumes and Western Europe and the rest of the world consume more than they produce. Production in the developing countries is largely confined to 'offshore' production of multinational firms based in developing countries. The newly industrialised countries of Asia are the only developing countries with a significant presence in the market.

Tables 1 and 2 give consumption figures for electronic equipment in the USA, Japan and Western Europe for the year 1984 and projections for the USA for 1987.

TABLE 1 U.S. Consumption of Electronic Equipment (US$ billions)

| | 1984 | 1987 |
|---|---|---|
| Data Processing and Office Equipment | 79.0 | 125.0 |
| Software | 15.0 | 24.6 |
| Consumer | 21.3 | 23.8 |
| Communications | 11.5 | 15.3 |
| Industrial and Military | 57.1 | 70.6 |
| TOTAL | 128.0 | 239.3 |

Source: Electronics, January 1984

The anticipated high growth rates in D.P. and office equipment and in software are particularly noteworthy.

TABLE 2 Western European and Japanese consumption of Electronic Equipment in 1984 (US$ billions)

| | W Europe | Japan |
|---|---|---|
| Data Processing and Office Equipment | 60.5 | 41.8 |
| Consumer | 15.8 | 11.2 |
| Communications | 12.8 | 3.0 |
| Industrial and Other | 15.8 | 21.6 |
| TOTAL | 104.9 | 77.6 |

Source: Electronics, January 1984

The microelectronics based industries are highly technology intensive and the underlying technology continues to undergo rapid change and development. New and improved products are constantly being introduced into the market and existing and older products become rapidly obsolete. The investments in research and development are very high (as much as 10% of the value of sales).

In summary the industry is largely dominated by strong firms from the developed world with developing countries lagging far behind in production, development and application.

# CHAPTER 2 - POLICIES OF GOVERNMENTS

## 2.1 INTRODUCTION

Traditional Government policies for industry and for science and technology are gradually giving way to 'innovation' policies which seek a new and more constructive fusion of the elements of these long-standing policies. Certain instruments of innovation policy affect its supply, some stimulate the demand for it and others seek to facilitate the necessary interaction between supply and demand which is the hallmark of successful innovation. The choice of policies and instruments appropriate to a particular country will depend on a variety of factors including the general level of industrial and technological development and the greater or lesser interventionist stance of Government vis a vis the industrial sector. Successful innovation policies require a sound understanding of the innovation process in the targetted sectors or firms.

Public procurement has been used in varying degrees by many countries as an element of traditional public policy to favour indigenous industrial activity. Such empirical studies as are available suggest that public procurement can also, under certain circumstances, be a powerful instrument of 'new style' innovation policies. The risk arising from the uncertainty of effective future demand for the output of innovation activities is one of the major constraints on would-be innovators. A strong and clearly expressed Government demand has the effect of diminishing this uncertainty and its attendant risk. Innovation-demanding public markets were a major factor in weapons development, and in the development of synthetic materials, radar and many nuclear innovations. They are widely held to have been the single most crucial factor in the proliferation of new technology based firms in the US semiconductor industry in the 1950's and 1960's.

The capacity to manage technical change efficiently is widely regarded as a vital factor in international trade competition, just as important, or more important, than wage levels. Empirical studies suggest that the most powerful forms of Government influence on technical change are through the general economic climate, Government's own demand, and infrastructural support.

Notwithstanding the empirical evidence for the importance of demand factors, the general pattern of public intervention in the innovation system in most developed countries shows a predominance of direct subsidy 'supply' type supports. A notable exception has been the defence area but for a variety of reasons the successes of military procurement are not easily repeated in the non-military sector.

The expression of demand to innovators and their perception of it can take a variety of forms

- knowledge by innovators of future needs of consumers and users may be sufficient
- direct involvement of users and future customers in the innovation activity and involvement in development and trials (as in the German nuclear industry)
- procurement orders for one or many of the new products.

Governments through their public purchasing policies can influence demand in all of the above ways but the most powerful will usually be procurement orders.

The main circumstances in which public procurement has been seen to have the greatest potential for success are

- when products are in the early stages of their cycle of development
- when Government is the end-user rather than the middleman i.e. when it fully understands its own requirements and can communicate them directly and accurately to suppliers
- when Government strategies parallel the supplier firms' own product/market strategies
- when used in conjunction with other policy instruments whether of the R&D subsidy or infrastructural support type.

When Government is the sole buyer or when it can effectively act as a 'quality leader' the potential for innovation-oriented public procurement is greatest.

The market structure on the supply side is also important. The absence of competition between suppliers can blunt the effectiveness of public procurement measures. Some Governments will therefore deliberately promote competition between at least two suppliers for products or services e.g. the present British position on Private Branch Exchanges (PBXs).

## 2.2 GENERAL POLICIES OF GOVERNMENTS

Many Governments in recent times have been experimenting with their purchasing and regulatory policies to take account of both positive and negative effects on innovation. It is, however, in only a very few countries that these 'experiments' can be said to amount to a clearly articulated or seriously implemented innovation-oriented procurement policy.

Analysis of such efforts as are being pursued is made difficult because

i) for a variety of reasons (political, trade etc) elements of procurement policy are not brought out into the open or are purposely concealed

ii) there is considerable diversity between countries in terms of goals pursued, policies and background organisational structures.

Since the late 1960's a number of European countries, inspired by the impact of the US military microelectronics programme on technological innovation in US industry, began to adopt a selective industrial policy approach to high technology growth industries. Innovation-oriented public purchasing is seen as one element of the new approach but surprisingly it is nowhere accorded the attention it should receive if the lessons of empirical studies identifying the crucial role of the demand function in innovation had been learned.

Outside of the military area public procurement is more often pursued to save jobs rather than to assure the long-term competitiveness of industries. Consequently, apart from the limited evidence of certain discrete case studies and experiments, there is as yet insufficient experience of innovation-oriented procurement (outside of the military and telecoms fields) to enable the costs/benefits of its widespread application to be assessed.

Public procurement is but one of almost a dozen policy tools which are available to Governments in influencing innovation. See Table 3. In a relatively recent summary of innovation policies and policy intentions in six countries it is instructive that only 20 per cent of all the policy measures related to demand side measures, including public procurement, and then despite recognition in the background analyses of the importance of demand aspects.

Table 3. Classification of Government Innovation Policy Tools

| *Policy tool* | *Examples* |
|---|---|
| 1. Public enterprise | Innovation by publicly owned industries, setting up of new industries, pioneering use of new techniques by public corporations, participation in private enterprise |
| 2. Scientific and technical | Research laboratories, support for research associations, learned societies, professional associations, research grants |
| 3. Education | General education, universities, technical education, apprenticeship schemes, continuing and further education, retraining |
| 4. Information | Information networks and centres, libraries, advisory and consultancy services, databases, liaison services |
| 5. Financial | Grants, loans, subsidies, financial sharing arrangements, provision of equipment, buildings or services, loan guarantees, export credits, etc. |
| 6. Taxation | Company, personal, indirect and payroll taxation, tax allowances |
| 7. Legal and regulatory | Patents, environmental and health regulations, inspectorates, monopoly regulations |
| 8. Political | Planning, regional policies, honours or awards for innovation, encouragement of mergers or joint consortia, public consultation |
| 9. Procurement | Central or local government purchases and contracts, public corporations, R & D contracts, prototype purchases |
| 10. Public services | Purchases, maintenance, supervision and innovation in health service, public building, construction, transport, telecommunications |
| 11. Commercial | Trade agreements, tariffs, currency regulations |
| 12. Overseas agent | Defence sales organizations |

Source: Rothwell and Zegveld, Page 61 (See references)

The next Chapter deals specifically with public purchasing policies and practices in microelectronics. We shall however illustrate the experience of a number of developed countries using public procurement as an instrument for industrial innovation generally.

## The United Kingdom

For almost twenty years successive UK Governments have been urged in a variety of studies and reports by influential bodies to adopt an enlightened industrial development approach in their public procurement policies. And Governments, in at least one White Paper in 1967 and in various other pronouncements right up to recent times, have committed themselves to operating purchasing policies which would stimulate new technology and desirable technical change.

The practice however falls considerably short of the avowed intention. A recent appraisal of the policy concluded that the expectations from a policy which is based mainly on advocacy must remain open to doubt. The Department of Trade and Industry which is responsible for promoting the policy mainly seeks to influence attitudes and practices. The Department does have a small fund with which to promote certain schemes

associated with the policy, e.g. micro computers in schools, 'office of the future' project, special railway track maintenance equipment, medical equipment. This fund is not, however, regarded by the Department as the main promotional instrument for the policy.

The Department's efforts so far have had most impact on the purchasing activities of central Departments of Government, limited impact on the purchasing policies of nationalised industries and very little impact on the purchasing arrangements of local authorities. A joint committee of local authorities (the LAMSAC - Local Authority Management Services and Computer Committee) has for some time been advocating the uptake of the principles of enlightened public purchasing and trying to promote at local level the Government's public purchasing policy but reactions at the operational level are apparently not enthusiastic. There is also evidence that the financial difficulties being experienced by the public sector in recent years have led to a preference for simple short-term 'cheapest' solutions. This approach is usually inimical to the adoption of the strategic long-term view required for an 'enlightened' public procurement policy.

The difficulties facing any Department of State in effectively influencing the behaviour of purchasing offices in other Departments and in autonomous regional or local agencies are enormous. Even within a single Departmental area of influence such as the Department of Health and Social Security (DHSS) in the UK the task can sometimes seem daunting. The process of developing an optimum purchasing policy for the health service which as yet only aspires to 'also encouraging a strong and innovative healthcare industry' has already taken more than three decades.

One of the principal contributory factors to the slow pace of progress is that, notwithstanding the 'national' in its title, the health service remains a fragmented one. Even after recent rationalisations there are no less than fourteen separate regional procurement agencies. The coordinating supply council has advisory and other functions which are contributing to certain improvements but it has no executive powers with respect to the purchasing function. Its inability to act as a professional, efficient, central purchasing organisation, responsible to and demanding of its suppliers is seen as severely limiting its function of encouraging a strong and innovative UK health-care industry capable of satisfying the needs of the national health service and of building-up a successful export market.

The United States of America

The general American stance is to adopt measures to improve the domestic market environment including the removal of weaknesses in the supply of technical and financial inputs to innovation, with only limited attention to the demand side aspects.

The National Science Foundation and the Massachusetts Institute of Technology have spearheaded the analyses of issues relating to economic performance and technological innovation in the USA. Particular concerns have been expressed in recent years about the declining positive balance of trade in technology based products and the unused potential in commercial application of technology already provided through the mostly military R&D procurement.

In relation to the successful impact of US military procurement on industrial innovation most commentators note the mix of financial support for R&D, procurement incentives and creation of a favourable climate for innovation. Uncertainty on the demand side was reduced by the military, declaring readiness to purchase new high technology products. Furthermore endorsement by the military led to an acceleration of the diffusion process in the electronics industry. Similarly, inclusion of 'technology utilisation' clauses in relation to metal manufactured products led to speeding up the diffusion of certain manufacturing processes in that industry e.g. numerical control, CAD and CAM.

In the 1970's the US National Bureau of Standards began a series of innovation oriented procurement experiments as part of its Experimental Technology Incentive Programme (ETIP) to enhance technological innovation in the civilian sector.

ETIP applied a number of approaches to public purchasing in a variety of product groups and user circumstances, e.g. in healthcare, in energy, and in transport. The approaches included the use of

- life cycle costing
- value incentives clause
- performance specifications
- sliding scale rating used in conjunction with performance specifications
- two step procurement (technical proposals prior to cost proposals)
- prototype purchasing.

Most of the products selected were based on technology already well in hand where the public version lagged behind the commercial version. There were considerable political pressures on ETIP to produce fast results and several organisational problems were underestimated in the course of events. The experiments were not altogether successful in terms of influence on private industry but they did have a valuable impact on the public purchasing practices particularly those of the Federal Supply Services and the Veterans Health Administration. They moreover represented a unique learning process not only for the US but for others. A number of European procurement experiments followed the ETIP example.

Canada

The ETIP experiments in the USA outlined above gave rise to certain experiments also in Canada notably in the use of value incentives clauses by the Department of Supply and Service. There has been a well established principle in the DSS of favouring Canadian companies by Government purchases unless the price difference between Canadian and foreign suppliers is more than 10 per cent. The DSS controls almost one quarter of total Canadian Government procurement, and is trying to use its purchasing power to effect markets - by aggregation of local and provincial demand for drugs and electronic products especially for the military and space sectors.

The promotion of innovation through procurement is pursued by the Science Centre of the DSS which

- for federal bodies, puts out all R&D and feasibility studies to contract, increasingly to industrial concerns
- actively communicates its R&D requirements to 'tune' suppliers to public sector demand
- encourages unsolicited proposals for R&D with potential benefit to the public sector.

Federal Republic of Germany (FRG)

Also influenced by the US experiments the FRG investigated public procurement and technological innovation in a project started in 1978. Learning from the US experiments this one sought to establish in advance a more thorough conceptual framework for an innovation-oriented public procurement policy. It sought to identify the most promising fields, and the constraints, to clarify the risks involved and the determining

factors to be taken into account in using the public purchasing instrument. As in the case of the US ETIP experiments the fields chosen were those where the technology already existed at least as prototypes. Final conclusions have not yet been drawn from the investigations but the findings so far seem to suggest that

- the legal and administrative regulations surrounding procurement are a major hindrance
- compliance with federal regulations, a necessity for federal Government subsidies, are a barrier to innovation
- obsession with cost minimisation by management hinders the longer term view of 'value for money'
- purchasing agencies who do not have their own in-house technical competence and who depend on say engineering consultants will be hide-bound by the usually conservative nature of the consulting advice.

## 2.3 THE SPECIAL POSITION OF MICROELECTRONICS

The microelectronics based industries have certain characteristics which make them of particular importance and interest to Governments. They, more than other sectors, attract State intervention through public purchasing and other measures.

Firstly there is the strategic importance of microelectronics based products and services. Governments recognise that information is power. They assiduously protect the capability and means to control both internal and external communications. They appreciate the value of the capability to capture, process, analyse and use data and information. Increasingly microelectronics is the technology underlying communications and information handling. Governments are therefore for these strategic reasons concerned to ensure that they have under their control an adequate national capacity to develop and use this key technology.

The scale and economic importance of the microelectronics based industries was mentioned at the end of Chapter 1. Most Governments see this growth sector as an area of opportunity and would wish to encourage the development of a national industry capable of supplying their home market and also capable of capturing a part of the rapidly growing world market. Both import substitution and exports are specifically targetted.

It is fundamental to the understanding of the 'microelectronics revolution' that it is not only the microelectronics products themselves that are of importance but also the use to which they can be put. Microelectronics can be applied throughout the entire range of economic activity - industry (manufacturing and service), commerce and administration. The beneficial results of the timely and appropriate use of microelectronics are of major importance. New products can be developed, and the functionality, quality and reliability of existing products can be improved. The capability and reliability of industrial processes can be improved and their costs reduced. Overall microelectronics can contribute significantly to increase the productivity and efficiency of an entire economy.

There is in fact a well developed practice of the Governments of developed countries using public purchasing to develop their microelectronics based industries. The debt which private industry in this sector in the USA owes to Government military and space electronics procurement is incalculable - and now that industry to a large extent dominates world markets. European Governments have for a long time developed and protected 'national champions' supplying their P.T.T. administration as a basis of attacking larger markets.

It is important to realise, however, that much of this type of activity has been in response to implicit rather than explicit Government policy - and indeed it is frequently seen to be at variance with stated Government policies. For this reason Government policies in this regard can better be inferred from concrete initiatives undertaken rather than from an analysis of the stated policies themselves. The next chapter is devoted entirely to public procurement in microelectronics and a number of such concrete initiatives will be analysed with a view to identifying approaches which might be adopted in other countries in particular in the developing world.

# CHAPTER 3 - PUBLIC PURCHASING IN MICROELECTRONICS

## 3.1 POLICIES OF GOVERNMENTS

As has been discussed in the previous chapter Governments intervene in support of industry using a variety of measures - some directed towards the supply side of the sector and others toward the demand side. This is very much the case for the microelectronics industry in which some mix of the following policy instruments is generally employed:

- support for R&D and training (grants, loans etc)
- support for plant and equipment (loans and grants)
- Government procurement
- regulation of the structure of the sector (encouraging mergers, anti-trust enforcement etc)
- foreign investment controls
- tariffs and trade policies.

This section will review the policies of selected developed countries in support of their microelectronics industries, with an emphasis on public procurement but not neglecting the broader policy context involved.

### The United States of America

The United States has never sought to develop a consistent systematic set of policies directed towards industry. Numerous Government measures have direct or indirect effects on US firms but the overall approach is acknowledged to be ad hoc.

In analysing US policies for the microelectronics industry it is useful to make a distinction between the Department of Defence and the rest of the Government.

On the non military side the thrust has been largely non-interventionist. There has been no great need for Government to create 'national champions' since companies like IBM and AT&T etc have attained dominant positions without such support. The Government therefore seeks to promote the freest possible world trading environment in the belief, largely

justified by results, that US firms will win in international competition. In fact, the strongest Government intervention into the industry is on the regulatory anti-trust side aimed at preventing large companies becoming too powerful on the home market.

The military side is different. Throughout the 1950's and 1960's the Department of Defense stimulated developments in microelectronics by purchasing semi-conductors for military and space purposes as well as by supporting R&D. During this period the Government purchased a large fraction of US semi-conductor output - e.g. for the Minuteman II missile. In 1965 the D.O.D. accounted for about 70% of US I.C. sales. This figure has now dropped to less than 10%.

Developments currently supported by the US D.O.D. includes the VHSIC (Very High Speed Integrated Circuit) project and the STARS (advanced software) project.

It is now believed that the procurement practices of the US Government in the 1950's and 1960's were of primary importance - providing perhaps an ever greater spur to US industry than R&D support. By providing a guaranteed market growth in the industry was stimulated at a crucial stage in its development. Much of the present dominant position of US firms in the sector may be ascribed to these policies.

Japan

Japanese industrial policy in this sector may be characterised by the following observations:

a) Government supported programmes are multiple but are well coordinated with each other and together they amount to an integrated and coherent national strategy
b) they are orientated towards facilitating the activities of industry rather than telling industry what to do
c) they are well planned with long term time horizons (up to ten years and more).

A major influence in the system is the Ministry of International Trade and Industry (MITI) which has sponsored many important development projects dealing with, for example, VLSI Circuits, Advanced Software, Robotics, Super Computers, Fifth Generation Computers etc. A remarkable aspect of the Japanese approach is the degree of cooperation that is achieved

between Government, Industry and Research Institutes on these projects during the development phase. Once products are commercialised the competition - even between previously cooperating firms - can be fierce.

Public purchasing policies have been systematically pursued as part of the overall mix of measures. The Nippon Telegraph and Telephone (NTT) public cooperation has been most influential in this regard. NTT has purchased sizable amounts of communications and electronics products over the years, thereby providing a significant leading edge market to encourage the growth of Japanese firms. In more recent times Japanese restrictive trade practices have come under pressure from the US and Western Europe. Despite a degree of liberalisation recently introduced the NTT market is proving very difficult to penetrate by non-Japanese firms.

France

France has had for some time the most consciously planned and nationally coordinated set of policies to develop the microelectronics sector in Europe. For the last two decades this sector has had a consistently high national priority and a number of specific plans have been prepared and pursued.

Le Plan Calcul during the 1960's attempted to develop the French capacity to compete with IBM in the computer field. A New French company CII was formed and heavily supported. When it became apparent in the mid 1970's that the Plan would not succeed a merger with Honeywell-Bull was arranged. The new company CII-HB with majority French equity, and now essentially nationalised, received massive Government Aid. Le Plan des Composants initiated in 1975 aimed to develop French competence in semi-conductors. The Plan promoted the build up of selected French companies, sometimes in association with foreign technology. The crash programme for the development of the French telecommunications system in the 1970's rationalised the telecommunications equipment industry through mergers and nationalisation. The new Plan d'Action Filiere Electronique of the present Government is injecting since 1983 more than US$1 billion a year into the electronics sector.

Each of these plans puts a heavy emphasis on public purchasing as a tool for developing the industry. It is notoriously difficult for foreign suppliers of computers, telecommunications equipment, and electronic components to supply French public markets in areas where French firms have any presence. The various French Plans have been by no means uniformly successful. There is nevertheless evidence that the lessons of past mistakes are being learned and a new dynamism is evident in the French microelectronics industry.

United Kingdom

In contrast to France with their reliance on centralisation and Government action, British industrial policy has been close to the United States - largely ad hoc and not well coordinated. On the military side the strong commitment to R&D support and public procurement support has helped grow an industrial sector of significant size. Unlike the USA however that industry has not achieved a significant degree of international competitiveness and its world market share is small and diminishing.

On the civil side the position is roughly the same. The public market provided by the British Post Office - now British Telecom - preferentially supported a number of British firms. These firms have also been losing international market shares in recent years.

In the computer sector the UK has consciously developed International Computers Limited (ICL) as a 'national champion' (similar to CII-HB in France). This firm has been constantly supported by the British Government with R&D funding, investment, and procurement preference. Despite this, ICL has not emerged as a viable competitor in the world computer industry. It supplies more than one third of the UK market (largely as a result of public purchasing preference) but has little penetration elsewhere.

West Germany

The West German Government has been generally less interventionist in sectoral policies than other countries. Public policy has emphasised macroeconomic measures aimed at creating the best environment within which industrial firms can succeed.

German mechanisms to coordinate interaction between Government, Industry and users appear to work well.

Specific intervention in the electronics sector is largely restricted to support for R&D to which the German Government commits substantial resources. The result of those investments can be seen in the strength of Siemens in the semi-conductor field, where its market share is continuing to grow. Siemens may be the strongest semi-conductor company in Europe. On the other hand the next most successful German company Nixdorf has developed its strong presence in business-oriented microcomputers largely by its own efforts and without significant Government assistance.

Apart from the P.T.T. sector, public purchasing measures appear to be less employed in Germany than in some other Western European Countries.

The European Economic Community

There is a growing appreciation among the Member States of the EEC (France, West Germany, UK, Italy, Ireland, Belgium, Holland, Luxembourg, Denmark and Greece) that the industries in each country separately are not strong enough to compete with the USA and Japan in the world market place - or even on the home market. The European Commission has been promoting Community-wide cooperation for a number of years with the objective of building a smaller number of stronger firms in Europe which would be in a position, over time, to challenge the US and Japanese domination of markets.

Progress on cooperation has been increasing in recent times. A major programme on precompetitive research on microelectronics - ESPRIT - is underway. A substantial new programme on telecommunications - RACE - is in preparation.

The European Commission has consistently emphasised the importance of exploiting the purchasing power of Governments to develop their industries. Their emphasis is however on community-wide purchasing since it is apparent that the markets of individual Member States are too small to develop sufficiently strong companies particularly in large system segments such as mainframe computers and public telecommunications switching systems.

## 3.2 EXAMPLES OF INITIATIVES

It will be seen from the last section that the Governments of developed countries have understood the importance of exploiting their purchasing power to develop their microelectronics based industries. Some countries have been more successful in this regard than others. There is in fact little official published analysis of the success or failure of these policies for at least two reasons:

i) many of the more important initiatives have been taken in the military sphere and a large measure of secrecy is maintained and
ii) on the civilian side most of these countries are supporters of free trade and are reluctant to expose to too much scrutiny their restrictive practices in this regard.

For the purposes of this paper it will prove more useful to draw conclusions from an analysis of certain concrete initiatives taken by Governments in this area rather than from an analysis of the policies themselves. This section will therefore discuss a number of these initiatives drawn from several countries and dealing with projects of varying size from the very large to the very small. The approach adopted is illustrative rather than exhaustive.

### Example 1 Digital Public Switching System

#### - a large contract in a small country

In 1978 the Irish Department of Posts and Telegraphs decided it would henceforth, to the extent feasible, install only digital electronic switching equipment in the Irish public telecommunications networks. This decision had far-reaching consequences which will be pointed out shortly. At the same time, however, other important events were occurring in Irish telecommunications.

In July of the same year the Minister for Posts and Telegraphs appointed a Review Group to advise on the appropriate form of organisation to run the nation's telecommunications services. The Minister subsequently accepted the recommendations of the Group and established a new State Company - Telecom Eireann - to run the telecommunications services on commercial lines

thereby freeing it from the bureaucratic, political and financial constraints under which the service had hitherto laboured.

At the same time the Government announced a crash programme to develop the telecommunications service from a position of low telephone penetration (16 phones per hundred of the population) and much unsatisfied demand to much higher penetration rates for telephony and other services and the availability of these services on demand. A sum of IR£650 million (1978) prices was allocated to the five year crash programme.

The 'digital decision' had far-reaching consequences. The existing equipment was electro-mechanical cross bar equipment, much of which was manufactured in Ireland. The new equipment would be a combination of microelectronic hardware and computer software and it was not manufactured in Ireland. The digital technology could be expected to result in reduced costs, more sophisticated and better approaches to network management and to facilitate the introduction of new facilities and the provision of new services (data, videotex etc) on the network. Because of the low telephone penetration level at that time and the commitment to the crash programme using digital technology it was expected that in a reletively short number of years the Irish public telecommunications network could be among the most advanced in the world.

It was not however only the opportunity to create an excellent telecommunications network which was seen to be of importance at that time but also the new industrial opportunities which could be exploited by a judicious use of the large sums of public money involved. The creation of a new digital telecommunications manufacturing sector in Ireland was seen to be vital for two reasons:

i) to create jobs to replace those that would be lost due to the discontinuation of the electro-mechanical manufacturing and

ii) to build local competence in digital technology which was seen to be of a strategic value far greater than the particular investments then to be made. This technology, digital electronics and software were seen to be the basis for a wide range of new industrial opportunities. It was argued that Ireland could not afford not to be part of the new microelectronics revolution and the P.T.T.'s digital decision offered a serious opportunity to begin to develop the necessary national capability.

In February 1979 the Department of Posts and Telegraphs issued Calls to Tender to the world's leading suppliers of telecommunications equipment for the provision of the first batch of digital switching equipment. Accompanying the Calls to Tender was an invitation 'to make proposals for the manufacture of equipment of the type offered in Ireland .... to the Industrial Development Authority' (the body charged with responsibility for industrial promotion in Ireland). This was the first time that the equipment provision was tied so explicitly to local manufacture of telecommunication equipment in Ireland. The initial contract was ultimately shared by L M Ericsson (LME) of Sweden (who had up to then manufactured the electro-mechanical cross bar equipment in Ireland) and CIT-Alcatel of France.

LME converted their existing electro-mechanical manufacturing facility to digital manufacturing and CIT established a new Irish firm Telecom Alcatel. Telecom Eireann has not given exclusive long term contracts to either or both firms. The equipment supply is competed for on a tranche by tranche basis and competition between them (with the possibility also of third parties competing) is maintained.

Example 2 Transmitters and Receivers

- how monopoly supplier arrangements may almost defeat the technology-update objective

The example spans the period 1969-1977.

The objective of the French administration was the development and manufacture of a new generation of equipment for civil and military centres for radio communication with aviation. The civil and military requirements differed on specific aspects.

The two administrations evaluated their market as: 2000 sets for the military and 100-200 sets for the civil side. The two administrations decided to pursue a concerted purchasing policy notwithstanding the differences in their requirements. The military took the leading role due to the scale of their requirement.

At that time no French company manufactured equipment of the type required. The administration normally purchased from French companies. They sought to stimulate local interest in the new products and three firms, S,T and R responded.
S had been in the business for some time, it had advanced technical competence and had supplied earlier generation equipment to the Marines. T had previously successfully supplied the military with earlier generation equipment. R was a firm of less than 100 employees with some experience of transmit/receive equipment of a different kind. Following a first phase of consultations in 1969: T undertook research and development on its own account, S did nothing and R dropped out.

T benefitted from its research which enabled it to renew its acquaintance with its principal contacts in the military administration. In fact T made inputs to the definition of the technical specifications which became part of the call for tenders. T was satisfied that its research costs could be amortized by subsequent sales on national and international markets.

The first call for tenders came from the civil side who urgently required 10 models. The contract was given to T in 1971. T was determined to capture the entire market. It considered that its close relationship with the military was a sufficient guarantee of this and therefore failed to take advantage of a proposal from an American company in 1973 for a new component which could seriously improve the product. R on the other hand starting from scratch took up the offer and in 6 months had developed a transmitter five times more powerful and less expensive. The equipment manufactured by T was thus technologically out of date before it left the factory. R's equipment began to make inroads into the civil side of the market and a period of competition ensued.

At the end of 1975 R and T entered into an agreement (approved by the administration) to export R's transmitter using the commercial/marketing network of T. The national monopoly position of T was progressively eroded, with R increasing its market share. R even began to win military orders every time that strict military standardisation was not absolutely necessary. Furthermore the whole programme was cut back and T finally ended up supplying only 650 sets.

Example 3 European Communications Satellites

- case of regional cooperation

The European Space Agency (ESA) is an organisation set up by eleven European countries (Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland and the United Kingdom) for the purpose of providing exclusively for peaceful purposes cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems.

An important consideration in its establishment was the realisation that many space projects were beyond the financial and technical resources of even the largest European country, while at the same time the commercial potential of space activity was growing.

ESA spends in excess of US$1 billion a year on projects. The agency operates an industrial policy which is designed to ensure the distribution of work equitably among the industries of its Member States. Large projects are awarded to consortia of companies which will normally have involvement of firms in each of the participating countries. The smaller member States are equally (in proportion to their GNP) involved as the larger countries. The technological value of the work for industry is of major concern in addition to the volume of that work.

With the increasing maturity of satellite and launching technology, satellite systems are playing an increasingly large part in telecommunications and broadcasting. Future national and international communications systems will be a combination of satellite and ground based terrestrial elements with the balance between each part depending on the cost competitiveness of the different elements at different times. Satellite systems will, however, always have a major role to play.

At the end of the 1960's Europe was far behind the USA in this field and it looked as if US industry would capture all the growing market in the western world. At the beginning of the 1970's the ESA Member States agreed to undertake a long term European Community Satellite Programme which is now coming to fruition. The programme had a number of phases.

The first phase involved the design, development, manufacture, launch and operation of a proto type satellite - the Orbital Test Satellite OTS. The objectives of this phase were

- to test the (new) satellite concept before an operational system was put in place
- to develop and validate new communications technology
- to study a variety of technical problems concerning operation of the system and
- to develop industrial competence in this field.

OTS was successfully launched on 11 May 1978 and fully met the objectives set for it.

Two operational systems were then developed using OTS technology - the ECS system and the MARECS system.

The European Communications Satellite System ECS will provide international trunk telephony within Europe managed by EUTELSAT an association of European P.T.T.'s and an exchange of television programmes between member organisations of the European Broadcasting Union (EBU). The ESA procures, launches and maintains the satellite system. The services are provided by the above service organisations. ECS-1 and ECS-2 were successfully launched in 1981 and 1984 respectively. ECS-3, 4 and 5 are planned for 1985, 86 and 87 respectively.

The European MARECS programme is a contribution to a world system of maritime communication satellites providing a service to ships at sea. The satellites which are procured and launched by ESA are managed from a service point of view by an international organisation INMARSAT. MARECS A was successfully launched in May 1982 and MARECS B2 in November 1984.

The development and manufacture of this series of satellites was entrusted to the MESH consortium of industries led by British Aerospace Dynamics and comprising fourteen companies from 10 countries.

Although the satellite systems are only now beginning operational service it is already clear that the venture has been a considerable success, involving significant technological development, significant industrial competence building and a valuable new service medium of European origin.

Example 4 The Cable Purchasing Practices of the French DGT

- 'enlightened' procurement policy needs 'enlightened' procurement practices

Whereas the French authorities managed their digital telecommunications switching procurement efficiently during the 1970's, the purchasing of cable for distributing the telecoms services was not dealt with at the same level of sophistication. Purchasing agreements with French cable suppliers - about a dozen different firms - were subject to considerable volume fluctuation due to apparent inability of DGT to forecast accurately its future requirements. These agreements included 'export incentive' clauses which were conceived without any strategic international analysis of the cable sector. As a result French cable companies outbid each other in francophone Africa-markets which were in any case protected by technical norms and privileged financing arrangements.

There appears to have been a failure to synchronise the industrial policies being pursued by DGT with the strategies of the firms themselves. There was also a failure to communicate clearly the implications of the industrial policy for the purchasing practices of the cable procurement section of DGT.

The net outcome of was that the firms became significantly dependent on the D.G.T. Technically they followed rather than led. There was little or no technological innovation. In 1979 the sector was seriously shaken up by the advent of fibre-optics - a new technology - for which the French cable sector was not at all prepared. At the same time the P.T.T.'s needs for cable declined. Admitting the inadequacies of their policies to date the DAII in 1981 restructured the cable industry around three major industry groupings.

Example 5 A Microcomputer for Schools

- case of a volatile market

In 1981 the British Broadcasting Corporation began broadcasting a television series on computer usage directed primarily at young people. A competitive tender was organised to provide a suitable microcomputer and suitable software for the course.

The ACORN company won the contract and the BBC micro was born; in addition the BBC Basic language was developed. The television series was a considerable success with many schools and individuals using it.

The British Government at the same time had a scheme of subsidies for microcomputers in schools. Only micros of British manufacture were eligible for subsidy. The ACORN machine was the big success in the schools and following the winning of the BBC contract in 1981 the company found its turnover increasing from £8.82 million to £42.4 million in one year. In 1983 ACORN was capitalised at about £140 million.

The motivation behind the Government's computers for schools subsidy was primarily educational with a view to raising young peoples' awareness of new information technology. It was in addition hoped to develop strong British firms in the microcomputer business. A clear strategic approach in this latter regard was not however consistently pursued by the British authorities.

The result of the Government's intervention was dramatic. Within one year Britons had twice as many home computers per head as America and one and a half times as many as Japan. The high growth rates could not however be sustained as markets became saturated and as the euphoria wore off. A shake out occurred in the industry and a number of companies failed.

The battleground for home computers is predominantly the Christmas period when over 70% of the business is done. At Christmas 1984 ACORN did very badly and SINCLAIR was the big success. The market remains very volatile, technological obsolescence is rapid and despite the flying start British public purchasing gave to the ACORN company, other British companies or American companies or, as analysts are increasingly forecasting - Japanese companies - may capture the British market in the next year or two.

Example 6 An Electronic Telephone Directory

- a case of technology push

In 1978 the French administration announced plans to replace the paper telephone book by computer terminals in the subscribers houses. There were a number of factors motivating this decision including

- the French were persuaded of the imminence of the 'information society' and considered that the population as a whole should become familiar with computerised equipment, and

- by creating such a large (public) market for this particular terminal plus associated software they sought to develop the technological competence and price competitiveness of the French terminal and software industry.

The idea was that these terminals would be provided free to telephone subscribers and that they would be financed out of savings in the printing and updating of telephone books.

To date 150,000 terminals with 9 inch screens and alphanumerical keyboards have been installed in French homes. By the end of the year there should be 600,000. There are, however, 22 million telephone subscribers in France.

The results of the programme to date are not encouraging. In fact the terminals will add about US$200 to the cost of a subscriber line. Even worse, it would appear that those who have the equipment installed are not using it. In the pilot area of Brittany where 70,000 terminals are installed only two people in ten use the terminals.

Despite these discouraging indications it is too early to judge if the experiment will be a success or a failure. If the technology gains more acceptance by the public a variety of new services could be offered such as home banking and home shopping. A number of institutions are in fact offering these services now. In addition to this there does appear to have been significant advances made in relation to the project by French software houses.

Example 7 A Telephone Call Charge Monitor

- a small firm start up

The purchases of P.T.T's are by no means limited to large and expensive systems and multi million dollar contracts. On the contrary there are requirements for a significant number of small specialised electronics devices within exchanges and elsewhere. This example is concerned with one such item.

In 1977 an engineer, formerly employed by the Irish P.T.T. set up a small firm (less than 10 employees) supplying the P.T.T. with a number of products. In the course of their interaction the P.T.T. identified to the firm its need for a device to monitor the charges of phone calls. A number of variables were involved: distance within the country; tariffs for different countries; duration of call; special tariffs for weekends and other special days; night versus day charges etc. The firm working closely with the technical arm of the P.T.T., developed a microprocessor based device to address this requirement. The firm invested significantly in this development substantially increasing its engineering and design work force. The development was successful.

Once the product was ready, however, it became clear to the firm that the orders it could expect to get from the Irish P.T.T. were insufficient to amortize its investment and sustain the growing firm. The firm was forced to consider exports. In 1980 the export drive was successful with a number of administrations, but most notably, the British P.T.T. purchasing the product in significant numbers. To conform to British requirements the firm established a wholly owned UK subsidiary to manufacture the products.

The revenues from this product enabled the company to grow and it has now diversified into other products exported to a range of P.T.T. administrations around the world but still primarily the British P.T.T.

The firm now employs 165 people.

Example 8 Energy Demand Manager

- a case of Product Promotion by a Utility

In 1976 the Irish National Board for Science and Technology funded a University/Industry cooperative research project between University researchers and the Irish Electricity Utility, the ESB.

The objective of the research was to develop a device for continuously interrupting and reconnecting selected appliances within a house, for example, to match the electrical load to the capacity of the supply and to achieve a smoothing of the notoriously intermittent electrical load pattern.

The ESB intended to promote widescale installation of the device enabling increased use of the supply network to be achieved. Energy saving was envisaged by a possible reduction in the running hours of less efficient peak load generating stations.

Effective cooperation between the engineers in the College and in the ESB resulted in a successful outcome and a commercial product was developed. This product, the 'Demand Manager' is a low cost micro processor based system employing the motorola MC6802 as its central controller and on-board resident software with a comprehensive switching algorithm to control load shedding. Eight switching circuits are available with ascending switching priority.

An Irish firm took up the manufacturing of the Demand Manager. The product is sold in Ireland and overseas. It can cut electricity bills by up to 30% for industrial and commercial users. It achieves this by monitoring power consumption over a demand period, and switching out certain non-essential loads, thus keeping the demand below a pre-set target level. Since industry and businesses receive a demand charge from the ESB in addition to a charge for units consumed, lowering the maximum level achieves considerable savings.

The product is now widely used. The invention received the Irish Research and Innovation Award in 1981. The role of the Electricity Utility was crucial in the development and subsequent promotion of the product.

## 3.3 ANALYSIS

In order to gain an appreciation of where, and to what extent Government purchasing can be influential in the development of the microelectronics industry, Table 4 illustrates which classes of products are purchased by which Government administrations and the relative importance of Government purchases as compared with the total market.

The table requires careful interpretation. It relates to a large model developed economy. Smaller developed economies and LDC's will show significant variations from the position illustrated. These variations will result from such factors as

- o scale of internal markets
- o scale and importance of military activity
- o stage of industrialisation
- o state of technological competence etc.

The product segments identified are broadly in the 'professional' sector. The influence of Government purchasing on the 'consumer' sector is normally small. Only broad categories of professional segments are identified, many thousands of products are available in each segment to meet an enormous range and variety of needs. More details on products will be given in Table 5 below.

Two things are particularly noteworthy about Table 4. Firstly it is quite clear that Government purchasing is deeply influential in the various market segments identified. Secondly the horizontal spread of impact should be noted. It is quite clear that no single Government department or agency controls by itself the market for a product segment (military component procurement can in special circumstances be an exception as are the purchases of P.T.T.'s for certain categories of telecoms equipment). This statement is emphatically true of comput. s, office equipment and software, but it is also true of instruments and certain categories of telecoms equipment. The resulting need for interministerial coordination of purchasing in order to avoid fragmenting the public market is emphasised below.

Table 4 Public Purchasing in a large Developed Country

| Purchaser / Product Segment | Military | Telecoms Admin | Health | Energy | Transport | Education | Other Government Offices |
|---|---|---|---|---|---|---|---|
| Components | ● | · | | | | | |
| Computers, Peripherals Office Equipment | ● | · | ● | · | ● | ● | · |
| Telecoms Equipment | ● | ● | · | · | · | · | · |
| Instruments and Industrial Control | ● | · | · | ● | · | · | · |
| Software | ● | ● | ● | ● | · | ● | · |

Key ▮ Large ● Medium · Small

The lessons to be drawn from an analysis of the operation of general Government policies in this area and from the individual case studies presented above may be analysed under three headings

- o Technology
- o Markets
- o Management.

Technology: The microelectronics based industrial sector is fundamentally technology intensive. The pace of technological change is rapid. The rate of innovation is high. The technology is 'advanced' and expensive and the rate of technological obsolescence of existing products and services is high.

Public purchasing policies, where they have been successful, have recognised this and have been explicitly technology innovation oriented - US military semiconductor procurement, US and European space activities and Telecommunications procurement around the world provide numerous examples. Where technology and innovation are neglected and where underlying technology trends are not understood the policies fail as is illustrated by the French cable example and the Transmitter/Receiver example above.

It is most important to recognise that the technological barriers to entry into this sector are very high. The R&D (and capital) investments in developing the next generation of integrated circuits are enormous. Only the USA, and Western Europe with an outside chance, can compete with emerging Japanese strength in this sector. As a further example it is estimated that the cost of developing a new digital public telecom switching system is of the order of US$1 billion. These development costs would not be amortised by sales in even the largest Western European country. A market the size of Western Europe as a whole would be required.

Apart from the costs involved the availability of adequate technological competence in a country is an obvious pre-condition for entry. Such is the nature of the technology and the world market structure that it would be futile and enormously wasteful of resources for most countries and especially the LDC's to attempt to compete with market leaders in certain advanced market segments. That is not to say that market opportunities do not exist - there are on the contrary a wide range of opportunities - but to be successful Governments must be selective and choose areas where their technological capacity of manpower, equipment and R&D facilities offer a realistic chance of success.

Markets: It is a truism to state that the marketplace will ultimately decide the success or failure of a commercial venture. It is remarkable however how frequently this truism is forgotten. Technology, although absolutely necessary in this sector, is by no means sufficient. The attempted introduction of Videophones into the US market two decades ago and (possibly) the French electronics telephone book case are examples of technology-push meeting inadequate market demand.

The nature of the market structure is important. Most military markets are closed and entry is difficult for newcomers. Public telecommunications market in Europe and Japan are also largely closed with corresponding difficult entry for new companies especially if they are foreign. On the supply side, the industry may be cartelized. On the other hand the supply side is in certain instances dominated in certain segments by one large firm. Such a firm can, because of its strength, set de facto industry standards. Smaller firms may then be forced to comply with these standards and they may ultimately be wiped out if, as has happened, the dominant firm changes the standards.

Public purchasing policies aimed at developing indigenous firms must therefore take full account of the market opportunities, the market structure and the nature of existing competition. Once more for the vast majority of countries a selective approach is recommended. Market niches should be selected where market supply and demand structures and local technological competence can lead to the development of competitive advantage which may be exploited.

The existing technological and market barriers to entry severely limit the scope for new entrants to certain segments of the market. Table 3 summarises the present position in about 30 segments of this very large and diverse market. The emphasis is on identifying segments which offer some scope for new entrants. The judgements involved are necessarily over simplified and special local circumstances may result in variations.

Whereas Table 3 represents a first step in finding niches for new entrants it is quite clear that significant additional analysis would have to be done identifying local technological competence and market opportunities before embarking on specific product development. This process is brought a little further in Chapter 4. In addition an Appendix also provides an outline methodology for particular product/market analyses in specific local circumstances.

Table 5: Segment Opportunities

| | Segment | Opportunities |
|---|---|---|
| 1. | Components | |
| 1.1 | Merchant I.C.'s | None |
| 1.2 | Custom I.C.'s | Some but substantial design infrastructures required |
| 2. | Computers | |
| 2.1 | Main frames | None |
| 2.2 | Mini's | None |
| 2.3 | Micro | Some but turbulent market |
| | Micro-based systems e.g. small business systems, micros in schools etc. | Good opportunities for local customised products |
| 2.5 | Peripherals | |
| 2.5.1 | Standard peripherals e.g. printers, VDU's etc. | Possible but difficult |
| 2.5.2 | Specialised Terminals | Good opportunities for local customised and niche products |
| 2.6 | Word processor and office equipment | Standard product difficult. Some local customisation. Possible niches based on language possible |
| 3. | Telecoms | |
| 3.1 | Public Switching System | None |
| 3.2 | Private Switching System (PBX's) | Possible |
| 3.3 | Local area network (LAN's) | Possible |

| | | |
|---|---|---|
| 3.4 | Specialised equipment within public exchanges | Opportunities for a variety of equipment based on local needs |
| 3.5 | Microwave Equipment | Some opportunities |
| 3.6 | Optical comms | Difficult |
| 3.7 | Satellites | Only possible with large scale effort (including regional cooperation) |
| 3.8 | Subscribers terminal equipment | Considerable opportunities. Rapidly growing market |
| 4. | Instrument and Control Equipment | |
| 4.1 | Medical | Range of opportunities |
| 4.2 | Test and Measure | Range of opportunities |
| 4.3 | Control Equipment | Range of opportunities |
| 4.4 | Security Systems | Range of opportunities |
| 5. | Software | |
| 5.1 | Computer Systems Software | Little |
| 5.2 | Applications Software | Plenty of opportunities of system development to meet local applications needs. Possible niche areas |
| 5.3 | Expert Systems Medical etc | Difficult |
| 5.4 | Educational 'coursewcre' | Definite possibilities for local customisation and regional niches |
| 5.5 | Telecom Software | |
| 5.5.1 | System Software for Public Exchanges | None |
| 5.5.2 | Local Customisation within public exchanges | Substantial |
| 5.5.3 | Software for new specialised services | Substantial |

Management: Many public procurement initiatives to stimulate innovation prove to be disappointing due to the inadequate management of the process.

The risks involved in innovation can be reduced by a stable and reasonably long term purchasing arrangement. In many instances, particularly on the civil side, the purchaser firstly doesn't have a long term purchasing plan and secondly changes the volumes and terms too rapidly and without notice.

On the other hand there are grave dangers in the purchaser and supplier developing a relationship which is too cosy. This is frequently the case where national champions e.g. telecommunications equipment suppliers are developed and given a more or less monopoly position. The usual consequence of such monopoly arrangements is that both sides become slack and ultimately both sides lose.

Effective management of the process requires close attention to

- o the organisational and structural changes to ensure appropriate market aggregation
- o the training of procurement officers in 'enlightened' procurement practices
- o the building of adequate technical competence and understanding of markets in the purchasing agencies
- o proper planning of purchasers' requirement over the longer term
- o systems for effective interaction with suppliers including flexibility for mutual adjustment to external changes in technology and markets.

The management of the relationship between the supplier and purchaser is of primary importance. A successful relationship will contain the following elements

- adequate provision of information
- close technical interaction
- a provision for competition.

The relationship must therefore be close in certain areas and 'arms length' in others. The appropriate balance is not easy to find.

Further comments and recommendations in relation to Government management of the public procurement process are given in the next Chapter.

## CHAPTER 4 - CONCLUSIONS AND RECOMMENDATIONS

A country's capacity for innovation and for efficient management of technical change are vital factors in the development of indigenous industries and services which can withstand competition from abroad and which can sell their products competitively in world markets.

Governments everywhere use a variety of policy instruments to support the attainment and maintenance of their industrial competitiveness. Empirical research suggests that some of these instruments are more effective than other. Those which influence the demand for innovation are seen as increasingly important, viz; a favourable economic climate, innovation-demanding Government markets and infrastructural support for innovation activities.

Enlightened public procurement policies and practices have a strong record of success in the military sphere. Evidence of adaptation of the instrument to achieve similar desirable outcomes in the civilian sector is patchy but as is indicated by several of the policies and case studies outlined in previous chapters many countries continue to have faith in the potential of the instrument and are willing to back their belief by positive actions. This is particularly the case in respect of the development of microelectronic based industries given their strategic importance and the growth potential which they display.

### 4.1 ELEMENTS OF A DEVELOPMENTAL PUBLIC PURCHASING POLICY

The use of public purchasing to support the development of indigenous industry is not a straight-forward matter. On the contrary policy in this field requires careful preparation and the operational aspects require careful management if the opportunities involved are to be maximised and the drawbacks minimised. In this section we propose a series of measures which could with benefit by applied by Government or other public agencies who wish to use the leverage of public purchasing power as one of the instruments of public policy for stimulating innovation. These measures are divided into

a) Measures directed towards the purchaser i.e. those which bring about desirable changes in the behaviour and organisation of the purchasing agencies and
b) Measures directed towards the supplier i.e. those which are designed to evoke the desirable behavioural response in potential suppliers.

4.1.1 Measures Directed Towards the Purchaser

i) Coordination of Policy. As has been mentioned in chapter 1 and as can be seen by reference to Table 4, the span of control of an individual Minister or Director of a State Agency is insufficient to ensure an adequate national approach to government purchasing of microelectronics products. There will be a need for policy coordination at a national level between Ministers in order to ensure

- that there is a shared understanding of the strategic importance of Government intervention in these markets
- that a single coherent policy is adopted by all
- and that the separate elements of demand can be aggregated into a sizeable demand which can be strategically deployed to develop the industry.

Public purchasing preference is, as has been emphasised before, just one element in the mix of policy instruments at the disposal of Governments to develop industry. In addition therefore to coordinating policy and action in relation to public purchasing these policies and actions themselves must be coordinated with the broader policy environment of Government regulation, R&D funding, trade policies etc. A concrete coordinating mechanism, such as an interministerial committee may be desirable and necessary in this regard.

ii) Purchaser's Technical Competence. The procurement process for technology intensive products will be greatly enhanced if the purchaser himself has a developed technological competence. He will in the first instance be a better purchaser - being better able to write specifications, particularly developmental specifications, and also being better able to evaluate the technical offers (including prototypes) made. In addition to this, firms can greatly benefit from technological know-how transferred from an advenced user/purchaser, and active technical cooperation between the purchaser and supplier is frequently beneficial to the outcome of the project.

iii) Purchaser's Management Competence. Developmental purchasing is a skill. The history of the subject shows that many projects have not achieved their full potential because of the inadequate preparation of purchasing

officers. Experience shows that public purchasing policies work best in certain conditions e.g.

- at early stages of the product cycle and the industry cycle and when
- the strategy pursued is in conformity with the supplying firms' broader market and commercial strategies.

Ideally therefore the purchaser should be well informed on such matters as

- industrial development strategy
- markets and market trends
- technology and technology trends
- the management of technological innovation projects.

Training in these matters for procurement officers is therefore recommended.

4.1.2 Measures Directed Towards The Supplier

Broadly speaking two approaches may be adopted.

A. Developmental Specifications

This approach which is deliberately 'arms length' involves the purchaser who has an advanced requirement issuing a novel specification which without further direct intervention by the purchaser, stimulates innovative activity in the supplier (or preferably a number of potential suppliers if it is a competitive tender) and technical development results in a new or improved product. Other incentives (over and above the promise of a market) can be introduced including:

- Value Incentive Clause: Stipulation in procurement contracts that the manufacturer may share in cost savings to the government that result from innovative, efficient designs by the manufacturer.

- Quality Incentive Clauses: One technique is to reward manufacturers offering superior product performance by reducing their cost bid according to an established scale for the purposes of determining the effective low bid. Another approach is to adopt life cycle costing which determines the total cost incurred over the normal lifetime of product use and substitution of these lifetime costs in place of the initial low bid as the criterion for procurement award.

- Prototype Purchasing: A non-competitive means of allowing manufacturers to sell a limited quantity of an innovative product on the assumption that successful testing and evaluation of the product would lead to a larger government market.

This approach can usefully be employed in developed countries with strong industries.

B. Positive Technical Development

This is a more 'hands-on' approach in which the purchaser seeks deliberately to enhance the technical capacity of its supplier(s) and intervenes directly with assistance to this end. This approach is particularly relevant to small countries and to LDC's although aspects may be used in any country. The succeeding paragraphs deal with certain specific measures that can be applied in this regard.

Provision of Information. Many public authorities will not announce long term purchasing plans. Furthermore, when they wish to make a purchase (of, e.g. telecommunications equipment, computer systems, etc.) they will issue a call for tenders with a relatively short (some months) time for response. The lack of long-range plans helps nobody. The short response time favours the large, frequently international firms, and often seriously disadvantages the smaller firms which may not have the resources to respond in time.

The first requirement is, therefore, the provision of sufficient and sufficiently timely information to allow local industry to prepare their offers.

The procedure might be two-tiered. Firstly a public announcement of requirement with sufficient detail. The firms respond by stating general competence. Those firms who seem credible or whose operations might credibly be upgraded to meet the requirement are given detailed technical and other relevant information. The firm then responds with a substantive proposal and this proposal is evaluated and a face to face meeting between both parties takes place. This information should be given in sufficient time. This will normally be months rather than weeks and, in cases requiring development, could be a year or eighteen months or longer in advance of delivery.

Unbundling Contracts and Consortium Building. It frequently suits purchasers to offer larger rather than smaller contracts. This normally makes it impossible for smaller (even excellent) companies to bid. The purchaser should see to what extent he can unbundle the contract into several smaller parts (e.g. a total system could be broken up into a number of subsystems), one or a number of which might be undertaken by smaller local companies.

If no single national firm can respond to the call for tenders, it might be possible to put together a consortium of companies - a prime contractor plus a number of sub-contractors - which would have the necessary competence to meet the specification. This will require time, a modular specification and, possibly, assistance from the purchaser.

Technical Assistance. The supplier of technology-based services will frequently have substantial technical expertise in-house. In many cases, telecommunications service authorities, energy utilities, etc., have research institutes or research and development centres supporting their activities. If the purchaser wishes to develop the technical competence of its suppliers, it can make these technical resources available. Know-how can be provided, R&D facilities and equipment made available and technical personnel loaned to the firms to work with them in their factories.

Development Contracts. Firms who show the capacity to develop, over time, products required by the purchaser, could, in certain cases, be facilitated in doing so by receiving a development contract from the purchaser. This contract would provide a detailed functional specification of the product required with all necessary technical and other parameters clearly identified. The firm would undertake to develop the product to conform to the specified requirement in a certain period of time and deliver a prototype for evaluation by the purchaser. If the prototype were satisfactory, an order for the finished product could be placed. The purchaser would pay a substantial fraction of the development costs involved. The purchaser would be free to reject the product if it did not conform to the specifications.

The purchaser may also choose to initiate parallel development in two separate companies in order to benefit from the ensuing competition.

## 4.2 MICROELECTRONICS SEGMENT AND PRODUCT OPPORTUNITIES

Once the overall policy approach is adopted and general procedure worked out the next step is to identify particular segments and products offering the greatest opportunity compatible with local circumstances. In this section we shall comment on the segment opportunities identified in Table 5 paying particular attention to the needs and opportunities of developing countries. Approaches to identifying specific products which might be manufactured locally are also discussed. Finally the Appendix provides a step-by-step methodology for the detailed analysis of whether a product so identified should be developed locally using the public purchasing mechanism.

Table 6: Segment Opportunities for LDC's New Entrants

| | Segment | Comment |
|---|---|---|
| 1. | Components | |
| 1.2 | Custom I.C.'s | Possible but high risk area involving substantial Government-provided infrastructure including advanced design capability. Possibility of networking in a regional cooperation context. Possibility of regional silicon foundry. |
| 2. | Computers | |
| 2.4 | Micro based systems | |
| | i) small business systems | Aggregation of demand to build strong firms selectively |
| | ii) micros in schools | Need for strong project management and good cooperation between Ministries of Industry and Education |
| 2.5.2 | Specialised terminals | Seek market niches based on local comperative advantage possibly with a view to exploitation in international (regional) markets |
| 2.6 | Word processing and office equipment | |

| | | |
|---|---|---|
| 3. | Telecoms | |
| 3.2 | PBX's ) | Cooperation, including technical and marketing cooperation with local PTT essential |
| 3.3 | LAN's ) | |
| 3.4 | Specialised P.T.T. equipment | P.T.T. development contracts to private firms might result in export opportunities |
| 3.8 | Subscribers terminal equipment | Market dependent. Cooperation with P.T.T. desirable |
| 4. | Instruments and Control Equipment | |
| 4.1 | Medical ) | Scope for development contracts from purchasers. Room for a number of companies. Policy should be to aggregate demand sufficiently to develop a number of strong companies providing a range of products, possibly in competition. |
| 4.2 | Test and Measure ) | |
| 4.3 | Control Equipment) | |
| 4.4 | Security System ) | |
| 5. | Software | |
| 5.2 | Applications Software | Need to aggregate demand to build strong firms with a reasonable amount of standardisation of products. |
| 5.4 | Education Software | Part of larger computers in schools projects |
| 5.5.2 | Local customisation of telecom software in public exchanges | Scope for technology transfer from P.T.T. and from the supplier of major exchange systems to local firms. Such technology transfer from (possibly multinational) firms to local firms could be negotiated by P.T.T.'s as part of major supply contracts. |
| 5.5.3 | Software for New Specialised Services | Market and (possibly) P.T.T. regulation dependant. |

There are very large numbers of products within each of the above segments. The precise requirements for, and the volumes of, individual products will vary from country to country, as will the existing supply mechanisms. No general prescription identifying lists of products is therefore possible at the level of this study. Each administration will need to survey their own requirements and identify new opportunities in their special circumstances.

A variety of different approaches are employed in this regard. In Ireland the Irish Goods Council holds exhibitions where procurement agencies (e.g. the P.T.T., the Electricity Utility, etc) exhibits equipment currently being imported and invites Irish manufacturers to offer competing products. A number of new products have been developed and commercialised following this approach. Examples 7 and 8 of Chapter 3 illustrate two successful ventures. A third success is the case of an Irish firm which manufactured a modem for the P.T.T. to compete with French imports. These modems are now being sold not only to the Irish P.T.T. but also into the French market.

Exhibitions, valuable as they may be, are, however, by no means sufficient if an administration is seriously to promote innovation-oriented public purchasing. What would be required is a systematic survey of products by segment (e.g. applications software, electrical test instruments etc.) of the entire public market across all the procurement agencies involved (see Table 2). The same or similar products required by different agencies can be aggregated to get a total public sector demand. If a product looks superficially promising following such a survey, it can then be subjected to the analysis outlined in the Appendix.

## APPENDIX

## METHODOLOGY FOR COUNTRY AND PRODUCT SPECIFIC STUDIES

The analysis of Chapter 3 and 4 does not finally identify products which can be developed and commercialised in any given country. Such an identification must follow from a much more detailed study which takes full account of local conditions of technological capability, markets, administrative practices etc. We present below a step-by-step methodology which could be followed in undertaking such detailed studies.

### Step 1 Technology Assessment

When considering the feasibility of a given product development a number of issues relating to technology must be assessed:

- the level of local relevant technological competence. Public purchasing policies are more likely to succeed where they build on existing technological competence rather than trying to create such competence from scratch

- the rate of technological change. Products which are likely to become obsolete should be avoided unless local industry has the capacity to keep up to date and respond rapidly to technological change

- the appropriateness of the technology. Local economic technological and social conditions result in different product and service needs and opportunities in different countries or regions. The solution found in any given location should be 'appropriate' to those conditions. As well as avoiding the dangers inherent in a locally unsuitable choice of technology, opportunity for local adaptation or customisation will arise.

Step 2 Market Assessment

The structures and dynamics of the markets for the targetted products or services must be assessed. The following aspects should be included:

a) Supply Side

i) Structure

of indigenous firms
of MNE subsidiaries
e.g. - number and size of firms
- concentration of enterprises
- barriers to entry
- differentiation in the product/services categories
- risks associated with uncertainty of future markets

ii) Dynamics

An understanding of the objectives and strategies being pursued by firms; an assessment of their industrial performance and an assessment of the extent to which the objectives and strategies of the firms conform to overall public policy objectives

b) Demand Side

- The relative importance of the public demand in the market for the product or service
- The degree of dispersion or concentration of demand
- Analysis of the other public influences on the structures of the market (e.g. regulations or technical norms which create barriers to entry). An analysis of whether other incentive approaches can reinforce public purchasing e.g. direct R&D support, regulation etc.
- Analysis of the broader public policy context, i.e. industrial policy, trade policy, public expenditure policy, within which the demand for the product or service will arise.

Step 3 Assessment of Options

Given the technological and market situation identified in steps one and two the options for public purchasing approaches must be assessed and an appropriate choice made:

The options

- competition - open call for tenders
- pre-selection of one firm and close interworking
- limited competition between a small number of selected national firms (indigenous and or local MNE's)
- deliberate injection of foreign competition in order to strengthen competitiveness of indigenous firms who may wish subsequently to export

The choice will depend on such factors as

- strength of the firms
- stage of innovation process
- available resources etc.

Unless there are compelling reasons to the contrary an element of competition should be introduced into the process.

Step 4 Assessment of Management Procedures

In addressing the requirements for the organisation and management of the purchasing function attention must be given to the following aspects:

- the cultural and administrative practices of the country
- the particular product or service and characteristics of the buyer and the market
- whether it is possible and cost effective for the buyer to have technical competence in-house and if so to what extent
- the necessity to build in an ongoing evaluation of the results being obtained against the specific overall industrial policy objectives set
- the necessity to build in effective linkages between supplier and purchaser
- the level and nature of training and expertise of procurement officers.

Public purchasing agencies in most developing countries (and indeed in many developed countries) will have little or no experience of operating innovative procurement. Resistance and ignorance will be important constraints. The assessment in this step should seek to identify a suitable 'change agent' to mobilise the system. Such a change agent should play a promotional, educational and demonstration role in support of purchasing agencies activities. The US EITP programme is an example which has been copied by other countries.

Step 5 Assessment of Past Experience

- Identification of instances in which public purchasing policies have been previously employed to develop similar products or services
- An evaluation of the lessons which can be learned from these experiences.

Step 6 Identification of Pilot Trials

This step should seek to identify if a pilot trial would be feasible with a view to minimising the risk of a major blunder and the misallocation of resources.

## REFERENCES


Carter, C — "Industrial Policy and Innovation" edited by Charles Carter. Heinemann, London 1981.

Lalor, E — "Telecommunications and Industrial Development", National Board for Science and Technology, Dublin 1980.

Office of Technology Assessment (US Congress) — "International Competitiveness in Electronics", OTA 1983

Ponssard J-P, and de Pouvoirville, G — "Marches Publics et Politique Industrielle" Economica, Paris (1982)

Rothwell R, and Zegweld W — "Industrial Innovation and Public Policy" Frances Pinter, London 1981

Rothwell R — "Technology-Based Small Firms and Regional Innovation Potential: The Role of Public Purchasing" Journal of Public Policy Vol 4 No 4 1984

Williams R and Smellie R — "Public Purchasing and Technical Change" Technical Change Centre, London 1985