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MONOGRAPHY

THE ELECTRONIC SECTOR IN TUNISIA

PRESENT SITUATION AND PROSPECTS FOR GROWTH

SEIFEDDINE BENNACEUR

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GLOSSARY OF ABBREVIATIONS

AFI	: Agence Foncière Industrielle
API	: Agence de Promotion de l'Industrie (formely Investissement)
CAD	: Computer Aided Design
CEPEX	: Centre de promotion des Exportations
CETIME	: Centre d'Etudes Techniques des Industries Mécaniques et Electriques
CKD	: Completely Knocked Down
CNEI	: Centre National des Etudes Industrielles
CNI	: Centre National de l'Informatique
DRAM	: Dynamic Random Access Memory
ENIS	: Ecole Nationale des Ingénieurs de Sfax
ENIT	: Ecole Nationale des Ingénieurs de Tunis
GDP	: Gross Domestic Product
IC	: Integrated Circuit
M \$: Million US \$
NC	: Numerical Control
OCT	: Office du Commerce Tunisien
PAXB	: Private Automatic Branch Exchange
PC	: Personal Computer
PCB	: Printed Circuit Board
SB	: The author of this report
SKD	: Semi Knocked Down
TD	: Tunisian Dinar
UTICA	: Union Tunisienne de l'Industrie du Commerce et de l'Artisanat
VCR	: Video Cassette Recorder
VLSI	: Very Large Scale Integrated Circuits

PART ONE THE GLOBAL SITUATION

Tunisia is located in North Africa and has a population of 7.5 millions. The GDP per capita was 1200 \$ in 1986 with an increase rate of 3.5% per year from 1979 to 1986. Its traditional sectors were Agriculture and Handicrafts when it started its industrialization less than 30 years ago. Tunisia has few natural resources, mainly Phosphates and a small production of crude oil.

The country has gained many places in the developing countries ranking for added value in the industrial sector from 43 in 1965 to 28 in 1985 doubling its share. The mining sector with phosphates and crude oil is still important today in the Tunisian economy. The manufacturing sector has a modest but increasing share in the industrial sector (around 40%) and in the GDP.

The trade balance has always been negative by one third. It is due to the continuous need of capital goods for its investments. Major clients and suppliers are EEC members which buy 72% of its exports and sell 67% of its imports. (France is by far the first partner with 28% and 23%). Tunisia is an associated member of the European Community and has with its countries special trade agreements on quantities and on customs tariffs.

The external debt is 5.2 billions \$ i.e. 62% of GDP which is a medium level in developing countries (110 % for Morocco and 130 % for Egypt). There were no re-negotiation of this debt.

The national currency is the Tunisian Dinar with the present exchange rate:

1 TD = 1.2 \$ = 7 FF = 2.06 DM

The minimum monthly wages are 84 Dinars or 95 Dinars depending on the number of worked hours (40 or 48 hours per week). A foreman is paid 300 Dinars per month and a beginning engineer 500 Dinars.

Main milestones in the recent history are:

1956 - Independence

1958-69 - First period of industrialization (import substitution in food and building materials industries and heavy investments in chemicals related to fertilizers) with collectivization of Agriculture and commerce and a large development of Tourism.

1970s - Liberalization of the economy and attraction of foreign investors. The whole country was eligible as a free zone.

1985-88 - Low oil prices, heavy deficit, devaluation and start of export oriented policy.

The shape of the economy has changed with an increasing share of industry and decreasing of agriculture. Food industry and textile are the strongest industries and textile is considered in the country as a healthy sector, started with foreign investors attracted by the low wages and now strongly controlled by Tunisians and exporting a very large part. It is a liberal economy but with an important public sector.

Since 1956, the Tunisian government has put a big stress on basic education, spending more than one third of its budget in Public schools. The literature rate has reached 56% in 1985 and almost every children goes to school till the age of fourteen. The number of children reaching the end of high school is still low which is due to the low income of a large part of the population and only 6% goes to the university.

TABLE 1 - TUNISIA - BASIC INDICATORS IN 1986

		UNIT
AREA	163 600	km2
POPULATION	7 500 000	Hab
DENSITY	43.3	Hab/km2
TOTAL GDP	8900	M US \$
GDP PER CAPITA	1201	US \$
AVERAGE GROWTH RATE 79-86	3.5	%
BRAKEDOWN OF GDP IN 1985 (1965)		
- Agriculture	17 (22)	%
- Industry	34 (24)	%
- Services	49 (54)	%
Inflation rate 80-85	10	
MANUFACTURING ADDED VALUE		
- Agro-food	1375	M US \$
- Textile	24	%
- Machinery and Transport	21	%
- Chemicals	8	%
- Others	10	%
	37	%
IMPORTS	2890	M US \$
EXPORTS	1760	M US \$
EXPORTS/IMPORTS	61	%
BALANCE OF PAIEMENTS 1985 (1970)	-536 (-53)	M US \$
DIRECT FOREIGN INVESTMENT	107	M US \$
EDUCATION % of the class of age		
- 6-11 years	87	%
- 12-17 years	53	%
- Third degree	6	%
- Literature rate	56	%

Source : The World Bank

PART TWO THE ELECTRONIC SECTOR AND ASSOCIATED SERVICES

I. GENERAL DESCRIPTION

The first electronic company was started in 1965, assembling radio and TV sets as an association between Thomson (France) and Tunisian investors. It was a typical import substitution company with a low added value, buying CKD collection from the mother company, assembling and servicing the final products.

The Investment Law of 72 called "loi de 72" and the starting of API (Agency of Promotion of Investments) gave a new breath to this sector. The 72-law gave foreign investors very attractive incentives which were at that time very innovative. French and German firms with production cost problems in their home countries settled assembly facilities and after a few years employed many hundred of workers for off-shore production.

From 1973 to 1978, six companies of that type started and the biggest one had 850 people in 1978 (from which 750 were basic workers). The type of production assembled in Tunisia were components, loud speakers, electronic boards and a few products such as car radio, memory telephones....

In 1976, three new consumers goods (TV and radio) companies were created to compete with the old one and quickly gained market shares.

From 1978 till 1986, many companies were created but none has today a large size. No world leader opened a production or R&D facility and many companies, specially in offshore production, have strongly reduced their activity. The employment increased slowly and the Table 2 shows how the electronic sector changed between 1978 and 1986.

TABLE 2 - EVOLUTION OF THE ELECTRONIC INDUSTRY BETWEEN 1978 AND 1986

	1978			1986		
	Local	Offshore	Total	Local	Offshore	Total
Number of companies	5	6	11	18	19	37
Employment	830	1220	2050	880	1645	2525
Sales (M\$)	22	24	46	37	38	75

Sources: CNEI, SB

From 1980 on, the production was diversified with three telecommunications companies, various consumer goods and PCB companies: in 1986, there were 37 companies with total sales of 75 millions \$ and 2525 employees.

The development of the electronic sector was much slower than the rest of the Tunisian Industry. If we compare the share that has Tunisia in the world manufacturing sector (in added value) and the share it has in the electronic industry, we find that Tunisia specialization ratio is very low. In Table 3:

- . % MAV is the share of the country in the added value of the electronic industry of the world manufacturing sector.
- . % EAV is the share in the added value of the electronic industry.
- . SPR is the ratio between %EAV and %MAV which is called the specialization ratio.

TABLE 3 - SPECIALIZATION RATIO OF SELECTED COUNTRIES IN 1986

	%MAV	%EAV	SPR
USA	26.68	45.00	1.68
Japan	16.93	23.00	1.36
Ireland	0.17	0.56	3.25
Portugal	0.22	0.07	0.32
Singapore	0.16	0.63	4.08
Tunisia	0.06	0.006	0.10

Source : various market studies

This means that compared to the more advanced countries and those with comparable population such as Ireland or Singapore, the electronic sector seems "neglected" or has a low priority in Tunisia. The average Tunisian produces 170 times less than the Singaporian and 25 times less than the Korean.

One of the more striking aspects of the electronic industry in Tunisia is the "wall" between the off-shore companies and the local ones (by local we will always mean working for the local market). Except for the PCBs, the custom legislation is very strict: all the product goods must leave the country and the scrap either destroyed or exported which in some case lease to cost problems. An off-shore German manufacturer must send by air his metal scrap when a neighbour Tunisian metal manufacturer needs that kind of scrap but cannot buy it. There are numerous cases of products, manufactured in Tunisia, exported and coming back with high margins and this because of the strict custom authorities.

A law of 1987 allows off-shore companies to sell 10% of their output to the local market, after paying all the normal taxes but the application procedures have not been published yet.

What is true in term of products is also true in the know-how transfer field: very few people go through the wall and the same for production machines. Things are starting to change as natives are starting companies, with or without foreign associates which is a general tendency in the world of subcontracting.

II. SUB SECTORS ANALYSIS

We will analyze thereafter the situation in each sub-sector of the Electronic industry and associated services, in terms of production, market, added value, technology and finance.

I. Components

There are two types of companies in this sub-sector:

- Off-Shore Companies with mainly passive components (switches, loudspeakers, cables) and a small firm assembling hybrid components.
- PCB manufacturers: for the local market and partial export that started recently and produce only low grade boards for consumer products.

A few other Companies have small shops producing transformers for their own needs and antennas for the TV market. This production is not significant.

Off-Shore companies have generally a very low investment: they install used or second hand equipment. They provide about half of the sector jobs but they count only for 10% of the total investment. They rent their plants and have generally a very good margin (ratio 1 to 4 from operating cost to selling price).

The control by local investors has started very recently and two companies are completely owned by natives. Two of the biggest firms in the early 80s suffered from financial problems of their mother company. It is obvious that local operations of foreign firms are completely dependant on strategic choices and also the health of the mother company and for many years, local authorities encouraged local investors to take the control of foreign companies. This works sometimes well but it could not avoid the shut down of operations in two or three cases.

This type of companies are generally happy about the situation in the country but still suffer from lack of integration or isolation from the local industry and they insist very much on the weight of bureaucracy which improved but is still heavy compared to what it is in Singapore or Ireland.

2. Industrial Electronics

2.1 Communications

The local PTT have in Tunisia a very strong position in terms of legislation and are directly or indirectly by far the first customer.

Compared to many equivalent countries, Tunisia has started an early modernization of its public network. Already half of existing exchanges and every new one are digital and this technology replacement started in 1981 whereas countries such as Portugal and Turkey still install cross bar exchanges. The density of lines is relatively high with five lines for one hundred persons, compared to 1.5 in Morocco and 3 in Algeria.

Two public systems have been chosen: Alcatel E10 and Ericsson Axe and the PTT studied a few years ago, the feasibility of a local production but came to the conclusion that the minimum size of production exceeds by three times the local needs and it could only be foreseen at the Maghreb level. Another conclusion was the feasibility of PABX and terminals production.

They issued a tender for five years supply of PABX with local production after two or three years. The tender was won by a consortium of a French company (JS) and local financial groups, and the first Telecommunications company was started with a high investment and up-to date production equipment. This company is producing small size digital PABX, Telephone sets and intends to start other telecommunications products.

Two other companies for key systems, small PABX and terminal equipment were started a short time after the first one.

In the PABX area, the choice was to concentrate on small configuration and associated service.

Services seem to be an important field in Tunisian telecommunications though all the potentialities are far from being exploited. The national PTT have created a private firm for installation, maintenance and various services. This firm was, during more than twenty years, the sole company in the country. It gained a very good technical experience but its monopolistic situation made it inflexible and non aggressive on international markets. It was associated with European firms in contracts for the Middle Countries but never was a project leader.

Other installation companies were created these last years and the first one still controls two thirds of the local market as it serves major administration and public contracts.

Another good point is the school of PTT which provides scholarship and training from the postman to the Telecommunications engineer and has good relations with many foreign institutions. The teaching level is kept up-to-date as any new contract signed with a telecommunications company includes the installation of pilot equipment and the training of teachers in this school.

In Radio-Communications (for military, police or civil uses), no industrial activity has been started. There is a good know how as users but everything is imported. The same situation is true for TV and Radio-Broadcasting and for transmission equipment for all type of uses.

2.2 Data processing

During the five last years, many people tried to start a company for PC or terminal manufacturing, none but one succeeded to begin manufacturing. The aborted projects were done with small companies in Europe or in America and the time they completed all the formalities either the foreign company was dead, or the market conditions changed... A small company was started one year ago as a venture between Tunisians and Canadians and it is now assembling PC compatibles and selling to local and near by markets. It is planning to sell around 500 systems this year and the employment varies from 10 to 20 people depends on the work load.

The situation of software is rather different: The Total Software Market is about 25 M\$ from which 40% is done internally by the end users and 60% by external firms. This means that a large number of users, from which large customers such as administrations, banks, large corporations, have settled software departments and buy very few services from outside.

The second peculiarity is the existence of a large national organization, the CNI (Centre National pour l'Informatique) which plays many roles in the area: It is a certification agency responsible for the quality of the products sold on the Tunisian Market and trying to avoid too large members of brands on a small market (5 to 20 M\$). It is a "Service Bureau" selling computer hours and it is a software house. It has around 250 people and it is much bigger than the private software houses (under 30 people).

On the "Open Market" Software, computer companies representatives have a large share (2/3) and independent software houses have total sales of 4.5 M\$ from which 50% is made by the CNI. The whole picture is presented hereafter.

TABLE 4 - THE SOFTWARE MARKET IN TUNISIA IN 1986

Computer Companies (IBM, Bull, NCR...)	5.0
Distributors	5.6
CNI	2.2
Private Software Houses	2.2
TOTAL	15.0
In House Software	10.0
GLOBAL MARKET	25.0

Source : CNI

Private Software Companies are generally small (from 1 to 30 people and only two of them have more than twenty employees and four have between 10 and 20). A large number are one person companies.

Except a few "Packages", all software products are custom made which gives a very low limit on quantities and prices remain high. Small company management, hotel administration and medical care are the noticeable fields where Tunisian Software Companies have some efficiency.

The level of computerization (in terms of PC/workers or screen per worker) is very low: it is 1/200 of the USA and 1/50 of Western Europe and that means that the market is far from being saturated and large potential users (Banks, Insurance Companies, Tourism...) are computerized at a very low level.

2.3 Automation

The situation of the automation sub-sector is curious:

- There are many industrial users for all types of processes (continuous, batch, discrete piece manufacturing)
- Engineers schools in Tunisia provide a good level of teaching in this area with good connections with French, German and Eastern institutions.
- End users has usually a good staff for repair and maintenance
- There is no industrial or service company working in Tunisia and no accumulation of know how except for very few fields.

There are many explanations to this phenomenon. One of them is the way factory building contracts are conducted: there is a project leading company which is responsible for a turn-key project and which chooses the subcontractors for every field. The Automation part of Industrial projects is an important one in terms of value (5 to 20%) but it is frequently the backbone of the factory and is involved in Engineering, process design, installation tuning and maintenance. If automation is not well synchronized with the rest of the installation it can lead to a large delay and a big loss of money.

So, project leaders use local companies for low level jobs of wiring and partially in installation but very seldom for instrumentation choice, process control configuration, programming and tuning of the process.

The repeatability within an industrial sector (from a cement plant to the following one) is low (call for tenders are done better) and from sector to another one non-existent which is normally done by automation companies.

The areas with a fair level are programmable controllers and NC programming which is helpful in discrete piece manufacturing, especially for small units.

3. Consumer goods

Seven companies, with 40% of the sector output and 80% of "local" manufacturers, produce consumer goods, mainly TV sets, radios and Audio-equipment. The bigger segment (two thirds of consumer goods sales) is in Color TV sets in which four companies operate. These companies were started either as a venture or with technical and license agreement with European TV manufacturers (Thomson, Grundig, Telefunken, Saba). They produce 80 000 to 100 000 sets a year all together and this quantity depends on an Annual Authorization License given by the ministry of Economy and broken down by company depending on past market shares.

It is a very curious situation as the potential market is not fully satisfied (a color TV set is one of the first thing a family buys) and every set produced is sold. The selling prices are not free but negotiated with the government on a cost plus basis with a roughly fixed margin.

Another curiosity is that custom duty is lower for CKD collections than for components bought separately with a very strict control of the custom: when you buy 100 collections you have to spend a valuable time counting components to see if the number of individual components matches with 100.

All these legal factors explain the present situation of the TV companies: fixed margins, fixed quantities and CKD collections. The companies have no incentives to buy from the cheapest sources because of the margin and the difference in duties between collection and components. They have no more incentives to design their own sets which is not a very hard job and at the same time to hire engineers for any purpose.

Engineers count for 3 to 5% of the employees, a very low ratio compared to industrialized countries or semi industrialized such as Korea (15 to 30% in the Electronic Industry).

We analyzed the cost structure in the TV companies and we found the following figures:

TABLE 5 - COST STRUCTURE IN TUNISIA AND IN EUROPE FOR A COLOR TV SET

	TUNISIA	EUROPE
Component	57	28
Direct labor	5	3
DIRECT COST	62	31
Overhead	10	29
TOTAL	72	60
Gross margin	8	15
EX FACTORY PRICE	80	75
Distribution margin	20	55
RETAIL PRICE	100	130

Source :CNEI, SB

So, for an equivalent ex-factory price, the cost structure is completely different: components are paid twice as high as a sister company in Germany or in France. These components are bought, tested and put in collection by the licensee which adds to the cost of purchasing, testing, handling, packing an overhead for his R&D.

The TV company in Tunisia is in a vicious circle as it does not have enough margin to improve its bill of materials, does its own design and have an aggressive marketing policy. It has no chance to become competitive in an open international market: one can find retail prices in Taiwan, Korea or Singapore lower than the cost of components in Tunisia. That obviously means that the "National Added Value" is negative and the country is losing some of its foreign currency.

Among the four TV companies, only one has taken an original path. It developed its own chassis and started to look for cheaper components prices and went to South East Asia and Eastern Europe where it had much better prices. The result is impressive: 30 to 40% drop in prices over the competition and an increasing market share.

Very few components are manufactured in Tunisia: PCBs, external boxes, and some loud speakers. Many other components or parts that could be manufactured in the country such as tuners, chokes, transformers, power supplies do not reach the minimum size for a normal production.

A recent law, which allows no limit on imports if more than 15% of sales are exported, led to some subcontracting for foreign companies for TV sets or sub-parts assembly. The effects of this law are not very visible today.

The production processes are very classical: components handling is made by hand, no surface mounted technology, no income testing. Inventories are often very high as well for finished products as for components or semi-finished products which have an effect on financial expenses.

The balance sheets remind those of commercial firms with low fixed assets, low share holders equity, high inventories and high short term debts. This type of situation does not make a big development easy.

PART THREE LOCAL MARKET, PRODUCTION, IMPORT AND EXPORT

Next table gives the main figures of the Tunisian Market Industry. They are given for 1986 but they are corrected from the actual figures in correlation with the normal trend 1981-1987 as 1986 has been very peculiar. The automation Imports figure is an author's estimate as an additive of the declared import and the hidden equipment.

Table 6 - Production, Imports and Exports of Electronic Products

	Production	Imports	Exports	$P/(P+I-E)$
1 Components	38.8	40.2	32.5	0.82
2 Industrial Electronics	7.2	32.2	1.2	0.19
2.1 Communications	5.0	15.2	0.0	0.25
2.2 Data Processing	0.0	10.8	0.0	0.00
2.3 Automation	2.2	16.2	1.2	0.13
3 Consumer Electronics	29.0	4.9	1.9	0.91
TOTAL	75.0	87.3	35.6	0.61

Source :CNEI

These figures show that there are three types of situation:

- **components with an apparent good trade balance but in fact with completely separate flows.**
- **Industrial Electronics with a very low production level compared to Market and absence of Exports.**
- **Consumer goods with a typical "Import Substitution" situation, no imports, no export, only assembling.**

What could be the market figures for the five next years?

The Potential Market in Consumers Goods is about twice its present level if components are imported without restriction and if prices are lowered to be at an international level.

The Market for Communication could also be much higher with the extension of the number of lines (100 000 new lines per year) and a good market for private communication (PABX and various terminals).

Data Processing Market could be multiplied by 3 or 4 if the large users in the country decide to computerize their work.

The size of the Tunisian Market could be from 250 to 300 millions \$ depending on the government policy in its external trade laws.

North African Market (Algeria, Morocco, Lybia, Tunisia) is about eight times the local market and on the other side of the Mediterranean sea, EEC Market is about 1000 times the Tunisian one. This gives very large potentialities of export in the area.

Tunisia is an associated member of the EEC and this means that it can sell goods with no limit and with low custom tariffs at the condition that more than half of the product is originated from the EEC or Tunisia.

This condition of origin could be a serious limitation if the components are bought from South East Asia or Japan or USA which are today an important source of components.

Tunisia has many bilateral trade agreements with african countries which simplify trade procedure.

PART FOUR THE INDUSTRY ENVIRONMENT

I. THE INSTITUTIONAL ENVIRONMENT

In the short history of the Tunisian Industry, the first step of import substitution was mainly accomplished by the Public Sector which remains today comparatively high compared to the private sector.

In 1972, the API started with the law 1972-38 that been very successful in the first ten years to attract foreign investors to settle export oriented plants. These plants has highly contributed to job creations (more than 30% in the 70's.

Today, we can talk about a success story in the textile industry which was progressively backward integrated and Tunisian Investors have taken the control of most of this industry and the local managers have invested in marketing and technology and fight with the international competition.

The case is very different in the electronic industry:

The Tunisian plants have no autonomy in marketing and they are a small part of global strategies of foreign firms and no efforts were made to push the integration in the local economy. There was a legal barrier and there was a mentality barrier that is still predominant in this type of industry: Tunisia has one major comparative advantage and it is its low labor cost.

The picture is worsened when we realize that many products sub-contracted in Tunisia are in the end of their life cycle. This explains the numerous lay offs in this plants (the biggest ever had 850 employees ten years ago and have 50 today: it was manufacturing mechanical rotators and push buttons)

Main Promotion Institutions are:

. The new API (Industrial Promotion Agency, formerly Investment Promotion Agency) which is the merger between its predecessor, the CNEI (National Center for Industrial Studies) and the AFI (Industrial Estate Agency). CNEI was formed with the help of UNIDO and strong relations were maintained. It conducted market and technical studies primarily to be used by the local industry. The API was responsible of the relations with investors, acted as a promotion institution with a few representations in Europe and many participations in Trade Fairs. One of its roles was to attract foreign investors, helping them in their relations with the Tunisian Administration and giving them incentives. Another role was an approval certificate that for some people meant an acceptance of the feasibility study and for other people a regulation mechanism not to let too many people do the same project.

This approval certificate was required for every step as well with the Banking System, the Customs or the Estate Agencies. Some banks even understood this approval as a guaranty for their loan given to finance the investment and has some surprises when the projects they financed was shut down for non-profitability reasons.

. The API is now more than 500 people working in various types of fields; studies, public relations, Information Center, Industrial Estate, Assistance to the Industry.

. The CEPEX and the OCT which act as export promotion institutions helping to sell Tunisian products and giving assistance and information to the local Industry.

. The UTICA (Union Tunisienne de l'Industrie, du Commerce et de l'Artisanat), the Employers Association provides also information and assistance but probably much less than its sister associations in Europe. This is a result of the too weak position of the private sector.

The New API first action was to have the investment law deeply modified by the government . The main aspects of the new law are presented in the next table.

INDUSTRIAL INVESTISSEMENT IN TUNISIA
(Main incentives)

<u>CATEGORY</u>	<u>EXPORT ORIENTED INDUSTRY</u>
SETTING UP CONDITIONS	No restrictions on investment
FISCAL INCENTIVES	Tax exemption for 20 years (10 % after) except for: <ul style="list-style-type: none"> - personal cars - cleaning and maintenance - employer contribution to social security (possible exemption for 6 years) Foreign employees pay a fixed 20 % income tax
FOREIGN EXCHANGE	Total freedom of transfer of investments and profits
COMMERCE	No limitation on capital goods importation for manufacturing No custom taxes on inputs and machines 20 % of the production can be sold locally
INVESTMENTS FOR INFRASTRUCTURE	Outside industrial areas the Government pays: <ul style="list-style-type: none"> -100% of infrastructure costs in main living areas -50% in smaller towns areas
CONFLICTS SOLVING	International Arbitration

This new law, even if all the application texts are not yet published is largely welcomed by investors and will probably give a new breath to investments in many fields.

This will partially simplify (but it is still a long way) the complex administrative procedures and regulation agencies which seems to be a justification of the existence of many administration departments.

The results for the Tunisian Electronic Industry are very weak and few significant projects work.

The non-realization ratio for electronic projects is high meaning that the sector is not that easy. Project identification is not enough and even the availability of money do not help much in project executions.

The Technology and Marketing aspects, with or without foreign assistance, have to be seriously addressed. We must note also a positive action made by the API which is the organization of sub-contracting fairs, first step in establishing a large data base to make links between companies selling and buying services in sub-contracting.

II. EDUCATION, R&D AND INNOVATION

Education in Electronics has had very little attention in Tunisia. The Industry does not hire many electronic engineers so a large number is either working in Industrialized Countries or works incompletely different fields (banking, commerce...). Education is not at all specialized and stays most of the time at the basic level and the level of equipment is very often 10 years old or older which is very inadequate in a fast moving area.

Only 30 to 40 electronic engineers are turned out by the University or schools of Engineers (ENIT, ENIS) and the School of PTT which is a very low number compared to industrialized countries. An equal number of engineers studies abroad but only few come back to Tunisia.

There is a small number of Research Labs working in classical fields such as Signal Processing, Solar Cells, Image Processing but the amount spent is very low. Two Research Institutes (INRST and IRSIT started a few years ago but they are far above their initial targets in number of research workers or in equipment.

R&D expenses are very low: for all sectors the average Tunisian spends 1\$ per year to be compared to 8\$ in Portugal, 50\$ in Singapore, 250\$ in Japan and 350\$ in the USA. In this dollar, less than 10% goes to Electronics which gives an idea of the level of R&D in the country. A public organization, the CETIME (Centre d'Etudes Techniques des Industries Mecaniques et Electriques) has started a laboratory in Electronics a few years ago. This Center is aimed to provide support to the local industry in their technical problems and it has started to buy a CAD equipment for PCB and schematics, Development tools and a small PCB unit. The strategy and objectives of the CETIME are not very clear and have to be specified.

III. FINANCIAL RESOURCES

The importance of the public sector in many industrial activities have slowed down the growth of the private sector which did not acquire enough financial resources to invest in new sectors. Private entrepreneurs are mainly present in building, food industry and textile.

Many investment banks have been created these last ten years. The oldest one (BDET) is still the most important one but many joint ventures between Saudi Arabia, Gulf Countries or Maghreb have led to about ten Development Banks which are growing steadily. The Tunisian Partner is mostly the Government but Banks act as private ones. The main goals of these banks are project financing in infrastructure, tourism, building and various types of industrial and agricultural projects.

These Banks work with API to identify and carry out industrial opportunities. The strength of these Banks is their financial means and the weakness, especially in the case of Electronics, is that they act in a very classical way with the maximum of guaranties: they often ask for a firm selling contract for the output of the factory besides classical mortgages. This explains that they have much more invested in Hotels than in Software or Hardware projects in the Electronic Sector.

PART FIVE PROSPECTS FOR GROWTH

The Electronic Industry is the fastest growing industry and among this industry, Data Processing (Hardware and Software) is already number one. In absolute terms, given the small size of its electronics industry, Tunisia has important opportunities, as well in the region or in European Markets. None of the surrounding developing countries has reached a significant size in this industry and Europe is losing many parts of its industry at the benefit of new industrialized countries, Japan and the USA. But each of the four dragons which were at the same stage than Tunisia twenty years ago has reached a significant share in the World Industry (more than 1%).

Korea has started with low grade consumer goods mainly for export and have made giant steps in improving product quality, in technology (it is competing with USA and Japan in DRAM markets). Now Korea have four strong electronics groups that have enough means to invest in R&D, marketing and sales organization. Taiwan followed followed the same path, but with smaller companies and no one can say today that Taiwanese products have a poor quality. Singapore has developed its industry by attracting foreign firms in a country with a high standard of efficiency and openness and now many local firms are selling products and services all around the world.

There are many choices for Tunisia, but given the present delay, a significant growth (multiply by 10) will not be free of charge. The price will be expensive as the electronic industry is not anymore the cheap investment area as it used to be twenty years ago. Samsung has invested 600 Millions \$ just for DRAM chips manufacturing. The risk is not absent and if the country decides to put a lot of money in this sector, it must be aware of the inherent risks. On the other side, it has many comparative advantages such as the level of education, the openness of people and its geographical situation and it does not have large natural resources so this sector is one of the best opportunities.

Many questions have to be answered:

- 1. Can the development be autonomous or foreign firms have to be associated ?**
- 2. Is the main objective the local market , sub-contracting or exports.**
- 3. What is the ideal share between service and hardware production.**
- 4. What are the best niches for the local industry.**
- 5. What are the conditions of success and major effort areas.**

We will try to answer these questions within each category of products before summarizing for the whole sector and see what other environment conditions are required.

I. SUB SECTORS ANALYSIS

1. Consumer Electronics

Consumer type of products has been in many countries that have successfully developed its Electronic Industry one of the basic industries: the market is permanent, the international demand is always growing and the technology barrier is not very high.

From a strategic point of view, there are two types of segments in Consumer Electronics:

- Low-end products such as Radio-Receivers, Cassette Recorders, B&W TV, Calculators, Watches and some other Audio-Equipment. In this type of products, series are high, margins are low, the technology barrier is low and given a fair quality, the only parameter is sales prices. This means that a company that does not have all the required conditions to have very low prices (size of production, low salaries, access to low prices sub-contracting in PCB, plastic, loudspeakers...) has no chance to succeed in this area. Even if it satisfies those conditions, the low margin will make it hard to go to higher margin segments. In this segment six countries, South Korea, Taiwan, Singapore, Brazil, Hong-Kong and India have about 60% of market share.

We consider that Tunisia has no chance to succeed in this Area. The only exception that could be raised is B&W TV and their relatives, monochrome monitors for personal computer.

South Korea has 33% of market share (probably increasing), India 13% and Taiwan 10% and the World Market is decreasing. (-50% from 1981 to 1987). It is still a low margin segment: a Korean TV is sold less than 50\$ in the US Market and a monochrome monitor around 80\$ and these prices include distribution margin and many in between margins and we consider this segment as very risky but not impossible.

- A Medium and High End products such as Color-TV, Video Recorders, Hi-fi Equipment and new consumer products such as home satellite receiving equipment, home automation...

The markets for these products are still growing: more than 60 millions color TV are sold every year and 30 to 40 millions VCRs.

For color TV major shake ups have occurred these last years leading to a new market division. Japanese Companies control, in their home country or through subsidiaries all over the world more than 40% of the World Market. Koreans have now about 15% and started opening factories in the US and in Europe.

In Europe, Philips and Thomson (after its GE acquisition) have about 30% of market share.

New countries such as Malaysia, Thailand, Turkey and many others started exporting TV sets. The Major Companies are trying to concentrate their efforts on the high end portion of the market with digital TV, high definition and later flat screens but these new technologies will be predominant only in the years 1993 or later. They face tough competition with new comers specially in the medium and low range that sell at discount prices through volume distribution channels.

The normal production size has grown and the minimum size to be competitive and to stay on the market is from 200.000 to 300.000 sets a year.

The four Tunisian companies produce 70 to 80 000 sets a year all together. Their process is manual, they have only one shift and they have a low rate of use of their installed capacity. Our estimate is that they can produce at least four times their present output.

This market is the only reachable market in Consumer Electronics but it is today a "volume" and investments are becoming high. If the local manufacturers want to export, they must sell at an international price level. They have to invest in learning how and where to buy at the best prices with the requested quality. Quality is essential today and the supply is so wide that bad quality products cannot stay a long time on the market. They have to invest in modern production processes such as automatic insertion, test equipment and surface mounting technology. They have to invest in marketing.

This investment, from which a large part is in human resources, could partially be subsidized and it seems very hard for these companies to take from their profits enough money to finance this move towards another size of industry. The first thing to do is to liberalize imports and market prices so that local price become closer to international prices.

The association with a world leader or a medium size company could be helpful in lowering the investments and the risks.

The VCR Market is a very hard one as Japan supplies 80% of the World Market. Only South Korean Companies have succeeded to enter this market with much lower prices and have a market share of 10% . Few manufacturing plants are scattered around the world but most of them are assembling from SKD collections with a very low added value. Technology is essential in this field and the entry fee is today very high and productions sizes are very large.

In the new areas of cable TV, satellite dishes and related equipment, all the cards are not drawn and they are huge potential markets all over the world. Every country is a special case and the spreading of these techniques among customers depends on the "software" i.e programs, number of channels and prices. On the other hand, technology is also changing with direct TV broadcasting, digital TV and fiber optics. We believe that this field is interesting if a solid association with a technology holder and a cable operator is possible. Two or three new small companies were recently created for satellite dish production and this means that it could be a good opportunity.

2. Industrial Electronics

2.1 Communications

Potentially it is a very interesting field for Tunisia, but not for everything. The local infrastructure has a good quality and the Tunisian technical Know How is high compared to many other regions.

Public Switching is a technology intensive area and R&D investments are huge: the design of each of the main systems that are present on the market has cost more than one billion dollars and many Telecommunication: Companies went out of the Market or were bought by more successful companies because they missed their public switching systems development. Even for an assembly plant the minimum size for digital switching is 200.000 to 300.000 lines and this is not far from all the North African Market.

In PABX systems, the high range products have the same complexity than Public Switching Systems and their market is relatively small: there are few potential users needing 500 lines or more. Small PABX and Key Systems have a good potential market in Tunisia and in North Africa. The three small companies that operate today have a good technological level and could be a good basis of development for this area. Different types of terminal equipment starting from the single telephone set to the facsimile or complex data terminals could be economically manufactured but their export is very problematic as production lines exist almost everywhere and competition is tough.

Services are an important field to develop for the local market and for export. They can range from classical services such as installations, programing and maintenance to new added value networks such as Teletex or others.

Radio Communication, Transmission and Paging Systems are potential areas for the local industry but there must be more than 50% of exports and probably a strong association with a good partner that is not present in this region of the World.

A major point in this specialized field is the capacity of R&D and this capacity is too low at the present time: local Telecommunications Companies have no means to invest in a long term policy of R&D even if it is partially subsidized by the government or by the PTT as it is everywhere the case. A good solution would be to settle an independent R&D Center working for the Telecommunications Companies, the PTT and other potential customers. This Center could be also a training area for new (or less new) engineers. This type of solution must be approved by its potential users and must have good confidentiality rules. Many countries have adopted this solution as a first step before the companies reach a size where they can afford to have their own R&D facility.

Another point is the role of Public Authorities in the development of this sector. First, they are a major customer and they can potentially set the market size. The way they choose their suppliers is essential. Their tenders can be oriented to favor local firms or foreign firms by the configuration types, Technology choices...

It is evident that the favor to local producers must not mean that the Authorities will buy anything at any price: local products must comply with international standards and the difference in prices must be small. Third aspect is R&D contracts which was the way this sector was developed in many countries.

2.2 Data processing

With the current situation of competition on the International Market, does a small country need to assemble or produce personal computers and related equipment. Today it is quite impossible to reach the prices of many PC components coming from Taiwan or Korea so is it worthwhile to have an assembly plant in Tunisia. Our answer is yes if the prices and qualities of the products are noticeably improved. We noticed that market prices are extremely high because large companies distribution channels go through a complex path to cascade margins.

Personal computers are a way to introduce many improvements in all types of activities. If you can divide by four the price of a PC, four more students (or more) could have one and computing is not only needed in software classes, but also in science, medicine and many other fields. Local assembly is worthwhile when it is a source of supply mastering and a guaranty against many problems when its supply is diversified.

The other aspect is that the market for "Add On" products is much more profitable than those of basic ones. So a small capacity of R&D and Marketing as it was done in Taiwan and connections with foreign markets could lead to interesting projects.

Software is a very important field where local companies could have a strong position but they must concentrate on a few fields, specialize their products and try to go out of the country by associations with specialized sister companies in other countries.

There has been a specialization by brand of equipment (IBM, HP, DEC...) which was interesting on the paper: the big companies always try to find third party software houses that write packages for their machines. These packages are marketed by them and it is a way of promoting their equipment. This policy leads only to some subcontracting and Tunisia and it seems to be much more successful in Advanced Countries because of the size of software houses and their capabilities to maintain and follow up their products.

Subcontracting by itself can lead to dead-end when there is no marketing and R&D that can catch the Know How and is able later on to sell their own products on the Market.

2.3 Automation

Every progress that could be done in this field must be welcomed. As we stated earlier, Automation is essential for productivity and quality improvement. It is also a very difficult field as only a few products are produced in big quantities, reliability is extremely important (a failure in a small component can lead to a big loss in production) and many associated services are needed.

We don't think that many hardware products could be profitably manufactured in Tunisia although many boards are subcontracted by French and German Companies. The country should concentrate on Software and system integration for small processes. These processes could be continuous, batch or sequential.

In many countries, and it is true in Tunisia, users have a good Know How of their process and the way it better be automatized, and we think that they must be special incentives for technical people in industrial companies to start companies in automation and process control.

Another important market aspect is the way factories are built and contracts are written: the Turnkey solution is a bad solution for the development of an automation activity. A best solution is the Multi-lot solution where the buyer cuts his projects and can choose the supplies for every part.

We must also talk about a vital part of Electronics products manufacturing which is testing for every step: Incoming Inspection, Bare Boards, In-situ and Functional Testing, finished products. Testing is becoming a major issue in manufacturing as products get more and more complex and the chance there is a failure somewhere is high if no test is performed.

For components, testing is also important if local manufacturers want to stop buying CKD collection and have the complete control on where and how to buy. This issue must be addressed either in an independent test house or within manufactures production lines. Independent test houses are now very common in developed countries and they can be public or private.

The test activity involves sometimes very costly machines but also test programing or test programs converting from one machine to another one.

As products become more complex, they must be designed in such a way that they are possibly and economically testable. Designers today have to worry very early about testability and test program generation. To give an idea about the importance of testing, an IBM expert said that they spent three times more money to write the test program for the PC CPV than to design the board itself.

Another area which is sometimes classified in automation is the Power Supplies area. Power Supplies can be internal or external (such as UPS). They can be custom made, standard or semi-standard and they are becoming a significant part of systems costs. Companies manufacturing power supplies generally specialize either in standard or in custom made products. In each case, the shape of the company is either heavy production oriented or custom design oriented with a large engineering department. This area is not at all addressed in the country and should be studied in connexion with foreign companies.

3. Components

3.1 Passive and mechanical

It is an important field as well in terms of local integration as an activity with potential export market. PCB is a basic area that was not very well developed in Tunisia: the first unit started three years ago with a small capacity and producing only single sided boards.

For consumer goods, their quality is often enough, but professional electronics need mainly double side through holes and often four or six layer boards. The production of professional boards is not any more a reserved activity for sophisticated manufacturers. We believe that this field is a priority and a modern unit of at least 50 square meters per day, a CAO facility and Electrical Testing.

A specific action should be undertaken for PCBs: the standardization of specifications and even design rules with compliance with the most common international standards. This action could lead to productivity and quality improvements.

Loudspeakers is another good potential area and an integration of foreign companies technologies and the development of new capacities could be profitable.

Manufacturing TV Yokes, Flybacks, Tuners and other TV subparts could be economically feasible at quantities about three or four times the present market.

In quartz crystals, the custom made type can also be interesting to manufacture as it is a precision and manpower consuming activity. There are many potential customers in the Army, Police or Civil Radiocommunications. Standard quartz such as those used for watches, TV or computers are manufactured by hundred millions a year and it is hard to enter this segment.

The antennas activity could much more developed than it is today. Beside satellite antennas which started to be manufactured, there are a lot of home antennas and fashion antennas with their small amplifier or related electronics that replace roof antennas in many town areas. It is an easy to learn technology with a mixture of plastic, metal and electronic and can be typically well integrated in Tunisia.

Transformers are also a good opportunity but their weight and volume make them hardly exportable. This economics of this activity home have to be evaluated.

3.2 Semiconductors

Almost all segments of Semiconductors are today high volume and high investments areas. Most of discrete components are produced by millions a day and the path and profitability conditions are narrow.

Few exceptions are in Power Transistors and Thyristors which involve a high R&D capacity for an area that is on the edge of technology.

In integrated circuits, ten years ago, the minimum investment for an IC facility was 10 M\$. Today, we talk about 50 to 100 M\$ for a start. VLSI Plants for memories can go to one billion\$ and more.

The only areas which could be studied are custom and semicustom design and specialized packaging. These activities must be technologically and economically tied to users and technology resources. Small design centers can be easily settled, but technology and human flows must be continuously held (cf Turkey in linear and Israel in VLSI)

3.3 Tubes

Cathodic ray tubes minimum size of production is between 500 000 to 1 000 000 which is too much for the local market. It could be feasible at the Maghreb scale but the Algerian experience in R&D tubes is not very positive. This segment has to be discussed in conjunction with Consumer Electronics Strategy.

II. CONDITIONS OF SUCCESS

All the feasible segments we talk about could easily multiply by ten or more the production of the Electronic Sector but they are too diverse for a small country and a small market.

The choices can be described in dividing these segments by families:

- High volume consumer products
- Specialized products such as communication
- Small scale industries types of products (components for instance)
- Subcontracting for foreign markets
- Service areas (Software, Installation, Maintenance)

These families require different skills and different investment sizes and they have different market conditions. The development of the Electronic Sector usually needs some basic conditions, which are common to all segments and then for each segment these conditions must be pushed further on. The basic, and necessary conditions, are:

- 1. Improvement and extension of the Industrial Infrastructure.** We mean by industrial infrastructure the set of skills and small scale companies that manufacture plastic parts, metal parts, PCBs and all types of basic subcontracted products. We have to add new developing skills such as testing, surface mounted technologies or even chips on board and hybrid. These types of production or services must absolutely be at an international level of quality and prices. They can be later on, a source of international subcontracting as it is in Singapore or Taiwan. They must have (or have an access to) modern production such as CAD and NC machine tools.

- 2. Modernization of University Education in Electronics.** The level of education is one of the weak points in Tunisia where Universities and Engineer Schools suffer from very low budgets and a low specialization in the different areas of Electronic Engineering. The development of Research activities in the University with enough means would be a major plus as it can keep good teachers from leaving in many cases to go abroad. The project of an International Institute of Technology, financed by private funds would be a very good thing and will emulate Public Universities if they get enough budgets for equipments and Research.

- 3. Extension of R&D Activities.** It is vital today to develop R&D and one of the best solutions is to have specialized centers of departments, working as well for private firms or for public organizations. In the case of Tunisia, specialization could be in Communication, Data Processing, Consumer Products and IC Design. The examples of Taiwan, Singapore and Portugal are interesting to study. Financial Resources could be provided half and half by the Public and the Private Sector. These activities could be associated with Industrialization Centers such as CETIME which must be more focused on production methods organization and relations between R&D and Production.

4. Modification of Market Conditions. The integration in the International Market implies that local companies are able to provide products with international price and quality levels and not necessarily at the expense of local customers. We suggest that limitations be removed and the difference of taxation between collections and individual components suppressed or even inverted. This will probably shake local companies as they always worked without any latitude and with heavy protections.

5. Special Incentives for the Electronic Sector. These incentives should be directed towards innovation and integration in the International Market. These incentives could be tax reliefs or subsidies for:

- training and education
- R&D activities
- Improvements of procurement conditions
- modernization
- exports

We believe that this vital sector should be treated in a specific way. Recovering the present delay will mean a certain cost and the Government must be aware that this sector will not seriously take off without a very voluntarist policy.

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