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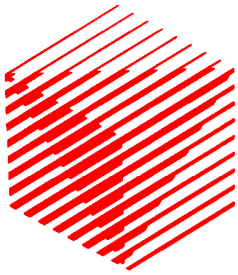

Evaluation of the Tunisian Research in Information Technologies

1 March 1997

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Executive summary

Following a request by the EC and in agreement with the Tunisian "Secrétariat d'Etat à la recherche scientifique et à la technologie" (SERST), ERCIM performed an evaluation of the Tunisian research in information technologies (IT).

Tunisia has a strong and diverse scientific community based on three universities with science and technology activities, 18 national research institutes (NRIs) and a small but expanding private R&D presence including a growing number of international joint ventures. Most of the Tunisian research is carried out at the universities.

This evaluation was based on a visit to six institutions:

-Institut Régional des Sciences Informatiques et des Télécommunications (IRSIT)
-Ecole Nationale des Sciences de l'Informatique (ENSI);
-Département des sciences de l'informatique de la Faculté des Sciences de Tunis (FST);
-Ecole Supérieure des Postes et des Télécommunications de Tunis (ESPTT);
-Centre National de l'Informatique (CNI);
-Ecole Nationale d'Ingénieurs de Tunis (ENIT).

and on written documents provided by them. These institutions were designated by the SERST and they cover the main research laboratories in IT in Tunisia. So, although it is mainly an evaluation of a few institutions, some conclusions can also be drawn for the whole Tunisian research in IT:

a) Tunisian research in IT is rather small but generally speaking of a good quality:

- the staff is highly qualified and the training delivered by the universities and engineering schools is at the level of European standards.
- the relationship with the economic activity and the social demand of the country is rather good and some institutions are working on contracts with the private sector

b) However, in spite of recent improvements, the general context for research remains more difficult than in most European countries:

- although research funding has been increasing recently, it remains low compared with European standards;

- for a long time, administrative procedures have been rather cumbersome for some institutions;
- due to the lecturing pressures in the higher education system, the number of full time researchers is rather limited;
- in particular, it is still difficult for a young PhD student to prepare his thesis full time in Tunisia;
- the scientific orientations of the laboratories suffer from a lack of focusing;
- access to information is still too difficult. Most libraries need to be improved and access to Internet remains problematic for most institutions.

As the importance of R&D and of IT is fully recognised in Tunisia, it should be possible to alleviate most of these difficulties. As a first step, a new law on research due to be applied very soon will give more autonomy to the research laboratories and facilitate their relationship with the economic world. Beyond that, it is clear that the Tunisian potential in R&D could be better exploited. In this respect, the main recommendations are:

- to set up a scheme for helping PhD students to prepare their thesis in the country;
- to take full advantage of the human potential existing in the country by encouraging all researchers to work in networks involving industry whenever possible;
- to focus the research efforts on some specific themes chosen according to their economic and social relevance and taking into account the existing scientific basis;
- to facilitate the connection of the laboratories to the Tunisian research network and to strengthen their international links.

More generally speaking information technologies are essential to the economic development of the country. Two domains appear to be particularly convenient for an action to be undertaken by the Tunisian Government:
- the strengthening of the competitive position of the Tunisian industry in the perspective of the free trade agreement concluded with the EC in 1995,
- the modernisation of the education system which will have to face a huge demand in the near future.

Setting up a special inter-ministerial task force in order to define an action plan in these fields and to follow its execution could be useful. The action of this task force could be supplemented by the establishment of an advisory working group made of experts coming from various horizons and in charge of thinking on the major societal and economic issues raised by the transition towards the information society in Tunisia.

Moreover, a wider involvement of the Tunisian teams in EU R&D activities would be most useful and full advantage should be taken from the facilities resulting from the MEDA programme. This would be facilitated by ranking Information Technologies among the Tunisian priorities in the bilateral dialogue between Tunisia and the EC which has been established in this framework.

Contents

I. Introduction

1. Economy

Economic growth of Tunisia has been quite impressive during the last 20 years: between 1975 and 1995, the GDP rose from 4.3 to 17.5 billions US $. Now, with a GNP per capita of about US $1860 in 1995, Tunisia ranks above the mean of the Middle-East and North African countries (US $1700). However, due to a series of bad harvests and to the stagnation of the European markets, real growth which averaged around 4% in the recent past (1985-1995) was kept at 3.3% in 1994 and 2.6% in 1995.

Table 1 : Key economic indicators for Tunisia

	1975	1985	1995
Gross Domestic Product (US $ billion)	4.3	8.3	17.6
Structure of the economy (% of the GDP)			
- Agriculture	21.0	17.3	13.5
- Industry	29.4	34.1	32.6
Manufacturing	10.3	13.5	20.5
- Services	49.7	48.6	53.9

Source: World Bank 1996

Table 2 : Long term economic trends (average annual growth)

	1975-84	1985-95	1994	1995
GDP	5.2	4.0	3.3	2.6
GNP per capita	2.5	2.0	1.2	0.6
Export of goods and non-factor services	5.2	7.2	14.9	1.3

Source: World Bank 1996

Tunisia's economy is dominated by services (53.9% of GDP in 1995 cf. Table 1), within which tourism plays an increasing role, with about 3.6 million visitors

per year. The banking and financial services sectors have also grown rapidly to the point where Tunisia has become a financial centre of Mediterranean importance, being ranked as the first banking centre in North Africa and one of the largest in the Arab World.

But the most striking feature is perhaps the expansion of the manufacturing sector (20.5% of GDP). With about one third of the output of this sector traditional industries such as textiles, shoes, leather remain very strong but newer activities such as electronics, automobile components, manufacturing services... are also rapidly expanding. Of the nation's 2000 manufacturing plants, half are either joint-ventures with, or owned by, foreign companies, and this external investment and the associated technology transfer has played a major role in Tunisia's economic growth as well as in the growth of its exports.

On July 1995, Tunisia became the first country in the Middle-East and North Africa to sign a free trade agreement with the EU. As the EU is the main trade and commercial partner of Tunisia with 75% of its imports and exports this agreement will set the stage for the future economic development of the country. In particular this will imply a continuous effort to strengthen its industrial basis and to adapt it to the international competition

2. Higher Education

Tunisia's population of 8.8 million which has grown 2.3 per cent per year during the past 10 years is very young: 36% under 15 years of age. At tertiary level of education (20-24 years), the enrolment ratio has grown from 7,3% in 1983 to 12,4% in 1996 and it is expected to reach 15% by the year 2001. This reflects a national policy priority of investing heavily in the higher levels of education. As a result of this policy and of the demographic growth, the total number of students in tertiary education in Tunisia has grown from around 30 000 in 1980 to reach 120 000 in 1996 and, although a slower demographic growth is expected in the next decade (1.5%), it should follow the same trend for some years to come. This will mean a considerable pressure on the teaching staff to devote more time to their teaching activities at the expense of research. On the other hand this could be a good opportunity to develop new forms of teaching such as telelearning

Table 3. Third Level Students and Teachers, 1980-1996

	1980	1985	1990	1993	1994	1995	1996
Students	31827	41595	68535	87780	102791	112634	120000
Teachers	4031	5194	4550	5360	5979	6481	6800
Student : Teacher Ratio	7,9	8	15,0	16,4	17,2	17,4	17,6

Source : UNESCO, 1994. World Bank, 1996

All the Tunisia's tertiary level students are in the 89 higher education institutes within the six universities of Tunis I, Tunis II, Tunis III, Zitouna, the University of the Centre at Sousse, and the University of the South at Sfax. Just under a third are studying in the S&T areas: engineering, agriculture, medicine and dentistry. These areas account for nearly 56% of teaching staff because of the higher teacher : student ratios typical of science and technology areas internationally.

Table 4 : Registered undergraduate and post graduate students, and teaching staff in Tunisian higher education, 1995

Subject Area	Students		Teaching Staff(1)	
	Number	%	Number	%
Humanities and Social Sciences	31871	31	1280	21,5
Law, Economics and Management	33641	32,8	1013	17
Education	3426	3,3	346	5,8
Sciences	12710	12,4	770	12,9
Medical and Dental Studies	9330	9,1	1090	18,3
Engineering	9556	9,3	1105	18,6
Agriculture	2148	2,1	340	5,8
All S&T Subjects	33744	32,9	3305	55,6
All Subject Areas	102682	100	5944	100

Source : SERST, 1996
Note : (1) Full-time and part-time

3. Science and Technology policy

Tunisia has a strong and diverse scientific community based on three universities with science and technology activities, 18 national research institutes (NRIs); and a small but expanding private R&D presence including a growing number of international joint ventures.

The total number of researchers in public sector NRIs was 587 by late 1995, Assuming that the teaching staff in the S&T faculties of the universities spends half of its time on research this suggests a current national research base of around 2 300 full-time researchers in the public sector, and perhaps 3 000 when private sector researchers are included.

Tunisia's S&T policies is now perhaps the most developed and sophisticated in the Maghreb. A number of ministries and national agencies are directly involved in Tunisia's S&T policy framework, the most important actors being:

a) Secrétariat d'Etat à la Recherche Scientifique et à la Technologie (SERST)

The key central agency in administering and co-ordinating national S&T programmes is the SERST which was set up in 1991 and is directly linked to the Office of the Prime Minister. It collaborates closely with other Ministries through the "Conseil Supérieur de La Recherche Scientifique et de la Technologie (CSRT)" in formulating and managing national S&T activities. SERST's prime remit is to undertake the strategic planning, co-ordination and evaluation of all Tunisian RTD funded by the state budgets. It has direct management responsibility for 8 NRIs, for the National University Centre for Scientific and Technological Documentation and also plays a lead role in the commercialisation and valorisation of S&T research results. SERST is also charged with developing and encouraging international scientific and technological co-operation for Tunisian institutions.

b) Ministry of Higher Education

The Ministry has an important role to play in Tunisian S&T policy through its responsibility for the 89 faculties and schools in the nation's six universities, and for two (non S&T) NRIs within its remit. The Ministry's General Director for Scientific Research and Technology has responsibility for R&D co-ordination between the three universities with S&T activities, and for funding their S&T teaching, research and building programmes and initiatives.

In addition, other ministries are directly involved in Tunisian RTD activities and the funding of S&T:

-the Ministry of National Defence, for example, has funding and policy responsibility for the Centre National de Télédétection;

-the Ministry of the Environment and Communities is both evolving a funding and policy role in a number of important S&T areas and involved in controlling environmental impacts through the "Agence de Protection du Littoral".

-the Ministry of telecommunications which is responsible for the "Centre d'Etudes et de Recherche des Télécommunications" and the "Ecole Supérieure des Postes et Télécommunications de Tunis".

National expenditure on RTD activities in Tunisia has grown sharply over the five years of the 8th plan (1992-1996) from 39 million of Tunisian Dinars (TD) to 110 million of TD.

Table 5. Expenditure on RTD Activities in Tunisia under the 8th National Plan by Source, Sector and Purpose, 1992-1996, Million Tunisian Dinars.

	1992	1993	1994	1995	1996
Gross Domestic Product (GDP)	13 706	14 649	15 904	17 256	19 239
Expenditure on RTD	39.0	47.0	54.0	62.0	67.0
RTD as % of GDP	0.29	0.32	0.34	0.36	0.35
Public Sector Expenditure on RTD	37,5	45.4	51.0	57.5	61.7
Private Sector Expenditure on RTD	1,5	1,6	3.0	4.5	5.3
Public Sector NRIs					
- Science and Technology	4.6	4.7	5.0	6.3	6.6
- Agriculture	8.5	10.0	10.7	11.1	13.1
- Health	2.2	2.4	2.3	2.3	2.5
Public Sector RTD Components					
- Personnel	21.6	23.7	26.6	29.9	31.4
- Activities	8.6	9.3	10.2	11.3	11.3
- Equipment	4.0	4.2	4.1	4.6	4.8
- Programmes	3.7	8.0	10.2	12.0	14.1

Sources : SERST

Despite the policy priority being given to S&T activities in Tunisia, the 0,3% of public sector expenditure devoted to RTD activities is significantly below that achieved in most European Union member States. Private sector expenditure on RTD, as far as can be determined from the limited data available, only accounted for around 7% of total expenditure, principally reflecting the relatively small size of the private sector.

The largest component of current RTD expenditure within the NRIs is within the agriculture, fishing and environmental protection sectors, which together accounted for some 21%, with public health NRIs accounting for 12%. As can be seen from table 5, nearly half of RTD expenditure was in personnel salaries and associated costs (in 1994) a quarter on operating and overhead costs, 6% on equipment, and 16% on RTD programme initiatives, which have grown rapidly throughout the early 1990s.

4. Telecommunications and access to Internet

Telecommunications are run by a state monopoly called "Tunisie Telecom" and the Tunisian government places a high priority on the provision reliable phone services. The telecommunication infrastructure is well developed and includes a number of advanced services varying from normal phone lines, to leased analog lines, mobile phones and X25, numeric and fibre optic leased lines. However, although investments were multiplied by 3 during the last seven years, Tunisie Telecom has some difficulties to cope with the backlog of connection requests and the continued strong growth in demand for new phone connections.

Table 6 :Demand for telephone connections
(thousands of requests)

	1991	1992	1993
New demands	76.7	85.8	92.5
New connections	45.5	54.7	63.4
Waiting	141.1	143.4	125.0

Since the early nineties Tunisia has developed a National Packet Switched Network X25 called TUNIPAC. This network is being expanded and its capacity should reach 3500 lines with speed lines varying from 64 kb/s to 2 Mb/s. However, users remain reluctant from using it due to the high cost of data transfer.

Quite recently, at the end of 1996, due to high demand by the business community, a new public body called "Agence Tunisienne Internet " has been set up, aside to Tunisie Telecom, in order to provide Internet services.

Research centres and universities are connected through the Tunisian Academic and Research Network the "Réseau National de la Recherche et de la Technologie (RNRT)" and will be given special privileges such as low communication rates. The RNRT was initiated in 1992 by the SERST and is managed by the Institut Régional des Sciences Informatiques et des Télécommunications (IRSIT).

IRSIT has had a pioneering role in this area especially in developing international connectivity. The first e-mail connection was set up in 1987 using a phone line to Montpellier, France on the BITNET network. In 1990, a permanent connection was established between IRSIT and INRIA in France through the X25 network. Today Tunisia is connected to the rest of the world via a 256 Kb/s line. The traffic has tremendously increased from 50 Mb/month in 1991 to 1.3 GByte/month at the beginning of 1995 and is currently increasing at the rate of about 100% every six months. This traffic is mainly generated by applications such as e-mail, FTP and Gopher.

II. The institutions

1. Institut Régional des Sciences Informatiques et des Télécommunications (IRSIT)

IRSIT is one of the 8 NRIs reporting to the SERST. It was set up in 1987 and, under the direction of Dr. Karima Bounemra Ben Soltane, it gathers about 55 full time researchers with an annual budget of the order of 1 650 kECU. It performs R&D in three major areas :

(1) Telecommunications and Networks
- (a) Interconnection of networks
- (b) Telematics
- (c) Multimedia
- (d) Space technology

(2) Decision Support Systems
- (a) GIS and resource management decision support systems
- (b) Decision Support for industry

(3) Arabisation and Man-Machine Communication
- (a) automatic translation of documents
- (b) natural language translation
- (c) synthesis of Arab words

The basic data related to IRSIT activities are given in Annex IV. They also suggest the general comments underneath:

(1) Telecommunications and Networks

(a) Interconnection of networks : the team have been involved in the interconnection of the "Reseau National de la Recherche et la Technologie" (RNRT) with the agriculture and the PTT ISDN networks and externally to Internet. They have monitoring and performance assessment skills.

(b) Telematics: this area is concerned with videotex systems. ALFICOM is a videotex presentation system and has related systems ARRASSEM for page

composition / editing and the system is used in project T.A.P. for videotex access to the databases (in Arabic) of Tunisie Agence Presse. The work is clearly motivated by the PTT and has been done competently.

(c) Multimedia :
(i) Virtual Aquarium: a joint project with INSTM (Institut National des Sciences et des Technologies de la Mer) which provides easy-to use educative multimedia presentation of the information of INSTM. This project has an excellent user interface for education or information and presents the information in a well-structured and lively way. It is comparable with EU projects.
(ii) Audio-visual examination of the Highway Code: a project using structured multimedia with audio questions to collect multiple-choice answers and provide a scored proforma. Death and injury from Road Traffic Accidents is costly and this project has demonstrated a route for reduction. The techniques are similar to those in EU countries although there is no educative (feedback using AI) function - however, this was not specifically required.
(iii) OCSAD: a Medical Diagnostic Support System: this is a well-engineered system with multimedia (multiple windows, scroll-boxes, buttons and graphical representations) based on two levels of knowledge: medical knowledge with scored relationship strengths (Bayesian network style) and individual patient information. The system allows controlled and mediated interaction between these two and guides the clinician in diagnosis (stating why certain diagnoses do not fit the medical knowledge, for example, and indicating where additional information would help). The project seems to ignore much previous EU work in the field and is built from scratch with home-built software - because the cost of packages (e.g. expert system shells) would preclude its widespread deployment throughout Tunisia.

(d) Space Technology : this area is just taking off. The team have organised conferences and exchange / collaboration relationships with CNES (France) and others. The team participates in project COPINE - Eurafrican satellite communication. This is clearly an area for future development with both telecommunications and multimedia (image processing) aspects.

(2) Decision Support Systems (Salah Benabdallah)

(a) GIS and resource management decision support systems: there are several projects sharing the utilisation of the ARCINFO GIS software but extending it in different dimensions.

One project concerns socio-economic thematic mapping of Tunisia with point and click access generating a window with a database table displayed with information relating to the area or point (region or village); the information concerns sizes and costs (e.g. of healthcare or education). The database has annual versions so time-trends can be detected. A similar project concerns the Golfe de Gabes and its ecology, especially its fish stocks. Marine seabed mapping (using sidescan sonar among other techniques) is providing detailed information used by the Fisheries ministry and the Environment ministry.

These two projects have relatively little research but are clearly productive and useful. Detailed printed cartographic maps are produced on paper using their own CAP (Computer Aided Printing)system.

A large project (Majed Khalfallah) concerns decision support with GIS in telephone distribution networks. The GIS gives the visualisation but the major resource is the database which is manipulated and navigated using genetic algorithms to find optimal routing of pipes or cables. The genetic algorithms are developed in the INCO project ISC-MED-35 EGOIST (2 years 150 kECU). Project GOLD (Genetic algorithms for Optimisation of Looped water Distribution networks) uses the same techniques. Project Mathusaleh concerns raster to vector transformation including tidying of the generated vectors. The 3 major projects are novel and well-performed research applying and developing the latest IT techniques to real-world problems.

(b) Decision Support for industry: The team demonstrated and described GRAM, a system for optimisation of preventative maintenance on the Tunis trams of one of the co-operating partners. The demonstration had some technical problems and there was no clear explanation of the underlying operational research technology - it appears to be linear programming rather than the more modern constraint logic programming. Nonetheless, the system appears to be satisfactory but (except for the modern Windows interface) reminds of Operational Research programs from the seventies. It is not clear exactly which technique is being used - there is a possible link with genetic algorithms in the GIS part of the team.

The team also presented Equinium: a production optimisation system for the textile industry. The system optimises production by decomposing overall tasks, allocation to workstations (person plus machine) and rescheduling for optimal throughput. The algorithms were not described in detail, but again it appeared that linear programming rather than constraint logic programming was being used. There is some similar work (on logging for paper production) at VTT in Helsinki. There are plans to develop the system also for the Chemical Industry.

(3) Arabisation and Man-Machine Communication

(a) Automatic translation of documents (Torjoman): an excellent demonstration summarising the components described below into one system. Torjoman (developed from 1989 and ported to PC / Windows in 1994) is capable of translating not only words (with correct grammar) between Arabic and English but also handles successfully verb phrases, proper names (such as countries) and even proverbs. Behind the system are complex dictionaries (essentially thesauri since they extend beyond synonyms) but performance is impressive. This work is equal to or better than anything in EU.

(b) Natural language translation: basically components of the Torjoman technology used as an assistant, coupling the dictionaries to a helpful human-computer interface for translation assistance.

(c) Synthesis of Arab words: two projects were presented. The first demonstrated speech synthesis from Arabic script and has potential applications in Tunis Air and some banks. The second demonstrated the complex software required to manage OCR (optical character recognition) of Arabic words from Arabic script. The detailed use of height above and below the (detected) writing line, of associated diacritic marks (together giving horizontal segmentation) and of gaps in the writing line (giving vertical segmentation) with complex use of probabilistic and Markovian reasoning is very impressive. The detection of font style and size and the fallback position (should character position detection fail) of overall script word shape is practical and effective. This work is leading edge on any international scale.

Finally, it is worth noting that the IRSIT library, although small, contains the most important material (including journals) related to the fields of interest of the Institute. Clearly IRSIT is a major IT R&D site in Tunisia which has the necessary infrastructure to participate in international projects as well as competent and motivated researchers.

2. Ecole Nationale des Sciences de l'Informatique (ENSI)

ENSI was created in 1984 by the University of Tunis II with the mission of providing undergraduate and graduate instruction in Computer Engineering. Undergraduate curriculum spans 5 years and begins with a preparatory biennium which is not run by the ENSI. Students enter the ENSI in their third year, being admitted by national selection. This curriculum was introduced nation-wide in 1994; students which were enrolled before continue with the previous curricula of 4 or 6 years. The total number of undergraduate students is 279 and the number of new enrolments has been 80 in 1996/97. It is planned that this number will be doubled in the next few years.

Graduate studies, which closely follow the French model, include "DEA", and a biennial curriculum (CESS) aimed to training high school teachers. The "DEA" is jointly run by ENSI and the Faculté des Sciences de Tunis in the framework of the "Cycle de formation doctorale en informatique" (CFDI). The present number of graduate students is 82 (50 DEA, 32 CESS).

The Director of ENSI is Prof. Farouk Kamoun. There are 34 faculty members, of which 4 are Professors, 21 are "Maitres Assistants" and 9 are "Assistants". Members in the last category are at the same time graduate students at the ENSI. All faculty members are involved in both teaching and research, which accounts for about 50% of their time. The research staff also includes 17 graduate students which are not faculty members. As in the preceding case, the fraction of time devoted to research is about 50%. The reason for their part-time involvement is that there are no grants to support graduate students and those which are not faculty members live out of part-time jobs outside ENSI. A

limited contribution to research also comes from students working in the final project of their undergraduate studies, which spans over a full term.

Essentially, the research at ENSI is organised in the following laboratories, or projects:

(1) RSR (Networks and Distributed Systems), headed by Prof. Farouk Kamoun, with a staff of 11 (part-time). Main activity is in modelling and evaluation of networks and real-time distributed systems, electronic data interchange and multi-domain data security.

(2) PGL (Programming and Software Engineering), also headed by Prof. Farouk Kamoun, with a staff of 7 (part-time). Main activity is in methods and tools for software production and reutilisation. The team briefly demonstrated a tool (named TASMIN) to develop data and process models in a graphic environment, within the frame of the method MERISE. This tool was also demonstrated by the CNI (Centre National de l'Informatique), which contributed to its final development.

(3) RIADI (Arabisation of Software and Text Processing), headed by Prof. Mohammed Ben Ahmed, with a staff of 18 (part-time). Main activity is in arabisation of software and interfaces, in linguistic applications and in data bases and knowledge-based systems. Although research in these and related themes is widespread in other Tunisian Institutes (particularly at the IRSIT), there is no evidence of co-ordination or co-operation.

(4) LASSAS (Synthesis and simulation of VLSI architectures), headed by Dr. Abdeljelil Farza, with a staff of 3 (part-time). This small laboratory is active in the design and simulation of VLSI systems, design for testability and testability measures.

(5) LAIAAI (Artificial Intelligence and Industrial Applications), headed by Dr. Maledh Marrakchi, with a staff of 7 (part-time). Active in artificial intelligence, pattern recognition, expert systems.

For the future, it is planned to consolidate the above research areas, with some strengthening of image processing, and to begin activity in multimedia systems.

The output of research, which essentially consists of publications, is low by EU standards but may be rated appreciable considering the limited resources. The total of referred publication has been 27 in the past 5 years, 5 of which appeared in 1996 or will appear in 1997. Technical reports are not produced on a regular base.

Research funding is difficult to evaluate. Equipment and general expenses such as housing, power, telephone, etc. are accounted for in the general budget which covers teaching and research indistinctly. Salaries of faculty members are paid directly by the State. Graduate students are not paid for research and live out of part time jobs with the ENSI itself or with external employers.

This considered, there is nevertheless evidence that financial resources available for research are very limited. Funds specifically destined to research have been of the order of a mere 60 000 $ per year on the average over the past 5 years. The total funding available for investment has been a similar amount, with a tangible contribution from the World Bank. The contribution of research contracts has been negligible.

Beyond the lack of funds, major obstacles to raising the effectiveness of research at ENSI seems to be:

-the lack of grants enabling full-time engagement of graduate students in the research;
- the poverty of the libraries as well as the difficult access to Internet.

An effort to increase engagement in international projects and co-operation is also advisable. This goal appears within the reach of the ENSI, considering that research themes are well tuned with the international trends, and several faculty members have good connections with universities in Europe and America, due to their graduate studies abroad.

3. Département des sciences de l'informatique de la Faculté des Sciences de Tunis (FST)

The "Département des sciences de l'informatique" of the "Faculté des Sciences de Tunis" is part of the "Université des Sciences, des Technologies et de Medecine Tunis II". It is headed by Prof. Mohammed Moalla and performs R&D in three major teams :

(1) Equipe de Recherche de Programmation, Algorithmique et Heuristique (ERPAH) which was founded in 1984 and is now under the direction of Prof. Ali Jaoua. With 2 Professors, 30 researchers and 15 PhD students this team is strong in several areas:
(a) Software Engineering (Logic of programming): modularisation, specification, conceptual modelling, verification, formal methods, reuse;
(b) Information science: extraction of knowledge from data, information abstraction, symbolic learning, relational fundamentals of information, document database, algorithms and heuristics for knowledge extraction, natural language;
(c) Database: minimisation of redundancy, deductive and object-oriented databases;
(d) Distributed Systems: fault tolerance

(2) Algorithmique et Programmation Parallèles (APP). This team formed in 1988 has 1 Professor (Zaher Mahjoub) and 10 researchers and works on:
(a) parallel computing to support GIS in co-operation with IRSIT and under DGIII funding using the work is based on transputer technology;

(b) a project with a French group PRISM funded by the French Government ;
(c) VOLVOX: a parallel database system funded by the Tunisian Government.

For the future, the team plan to work on reconstruction of missing data values and further parallelisation of databases. This team is well-connected to European (especially French) R&D.

(3) Productique et Informatique d'Entreprise (PIE). This is the newest team with 1 Professor (Mohammed Moalla - also Head of Department), 11 researchers and 3 PhD students. The aim is to marry together production systems and IT systems. The main topics are:
(a) conceptualisation and modelling of production systems (especially real-time)
(b) tools for specification and analysis of parallel and real-time systems (in co-operation with two French teams: MASI (Paris) and VERIMAG (Grenoble) and funded by the French Government);
(c) temporal databases.

There is much expertise in advanced use of Petri nets and a large number of publications. For the future they plan more application to production systems.

Overall it is clear that the three teams at FST work together, complementing each other. The work is clearly of national standard and some of it fully international in quality. They have good international contacts (especially with France) and participate in many conferences.

4. Ecole Supérieure des Postes et des Télécommunications de Tunis (ESPTT)

The main ESPTT mission is to train technical and administrative staff for the telecommunication sector and under the direction of Prof. Ahmed Mahjoub, they have started to develop research in the field of telecommunications. There are 37 researchers , 2 University professors and 18 students preparing a PhD thesis (cf. Annex II). The annual budget allocated to research is difficult to estimate since teaching and research activities are interwoven

The telephone switch laboratories are well equipped with full working models of all main types of switches used in the Tunisian public telephone network (Alcatel, Siemens, Ericsson, Northern Telecom and Daewoo). One laboratory is devoted to small private telephone switches.

ESPTT has all the facilities to offer excellent training to technicians and field engineers in the area of modern telephone switching. There are several teaching laboratories and four research laboratories:
- Telecommunication Systems
- Distributed Systems
- Engineering
- Mobile Radio

Unfortunately at the time of the visit the laboratories were closed and there was no opportunity to meet the researchers so that it was difficult to evaluate the research work currently being performed at ESPTT. However, the number of publications per researcher per year is similar to other research units in Tunisia and ESPTT seems to work in good connection with other Tunisian institutions like ENIT or FST.

5. Centre National de l'Informatique (CNI)

CNI was created in 1975 as a National Centre referring to the Prime Minister. It is responsible for:

- advising National Departments on Information Technologies;
- developing software projects on demand of the National Departments, central and local administrations, and public enterprises;
- running a computing centre, based on a Bull DPS8. Although it is mainly dedicated to administrative data processing, this facility is also available to public administrations and enterprises;
- providing hardware and software maintenance service to National Departments and other public users;
- training the personnel of National Departments and other public subjects.

The National Departments and the central administration rely almost exclusively on CNI for support and expertise in information technology and computing. As a few examples, the contribution of CNI has included:
- software and data processing needed to support the national economic and financial planning,
- software and data processing to manage the careers and salaries of public servants;
- technology and software for data and document exchange inside the public administration;
- several administrative data bases.

CNI has been quite effective in playing this role, which accounts for the largest part of its activity. The rest of its activity is essentially technology acquisition and development. Research, which is limited, is on the edge of technology development. There are about 20 researchers (including PhD students) and the annual budget has been of the order of 100 000 TD during the recent years. In particular, the CNI has benefited from the help of the EC in the framework of the programme TEDIS for a project on EDI and arabisation.

The CNI has good connections with technology sources in France, Belgium and Canada In turn, institutions in several Arabic, Maghrebian and African countries rely on CNI as a source of technology.

Areas of technology development include:
- Arabisation of man-machine interfaces and information retrieval systems;
- Videotex development
- Data and document interchange;
- Quality issues in software production,
- Software engineering. In this area, CNI has co-operated with ENSI in the development of TASMIN, a tool for defining data and process models in a graphic environment, within the frame of the method MERISE. This tool was demonstrated both by ENSI and by CNI.

6. Ecole Nationale d'Ingénieurs de Tunis (ENIT)

ENIT, created in 1968, is the oldest engineering school in Tunis (and in Tunisia). It offers first degrees in civil, electric, mechanic and industrial engineering and postgraduate degrees (DEA and PhD) in the same fields and also in Applied Mathematics, Hydraulics and Environment. It is a medium large school with 130 teaching and research staff and 1150 students, of which about 500 postgraduates. The annual budget allocated to research in IT can be estimated to around 150,000 TD.

The main research activities in the fields of informatics and telecommunications are organised as follows:

(1) Telecommunication Systems Laboratory

This unit has about 60 researchers (including teaching staff and postgraduate students) and works in:

Digital Communications:

- Adaptive filters (in co-operation with the French engineering school SUPELEC) Information coding and modulation (in co-operation with the Institut de Recherche Informatique de Toulouse)
- Channel modelling for mobile communications
- Modelling of variable bit rate sources for ATM network planning

Microwave Communications:

- Design of planar circuits (in co-operation with the Laboratoire de Microondes de Toulouse and the Ecole Polytechnique de Montréal)

Optical Communications:

- Filters for mode balancing in multimode polymer optical fibres (in co-operation with the IRCOM Limoges)

- Non linear optical structures (in co-operation with the Laboratoire d'Optique et Microondes de Grenoble)

(2) Signal Processing Laboratory

This unit was created in 1982 to contribute to postgraduate training. It has 2 professors and 23 postgraduate students. Its activities are in the fields of:

Speech signal processing:

- Use of mathematical morphology techniques
- Speech synthesis (in co-operation with IRSIT)
- Speech analysis, by fractals and wavelets

Biomedical signal processing:

- Shape recognition, lately applied to the analysis of Arabic writing

Network modelling:

- Use of genetic algorithms in conjunction with Geographic Information Systems (GIS) (in co-operation with IRSIT)

(3) Teledetection Laboratory

This is fairly young (5-6 years old) multidisciplinary laboratory with 13 researchers, including 5 teaching staff. Its activities may be grouped along two axes:

Optic and radar image analysis:

- Data classification
- Texture analysis

Geographic Information Systems:

- Modelling
- Decision Support Systems, for water and land conservation
- Water management with the help of satellite images

(4) Electric Systems Laboratory

This unit groups 8 permanent researchers and is active in the fields of:

- Electric machines and transformers
- Power electronics
- Digital control of electric machines

Although the time was too short to enable a proper evaluation of the research carried out at ENIT, it is clear that ENIT is actively pursuing research into

relevant topics, namely in the field of telecommunications, and must be counted as a potential important partner for any R&D work in this field in Tunisia.

7. Other Institutions

Beyond the six institutions described above, other selected research activities should be mentioned either under the responsibility of various Government Departments such as:

- the Ministry of Defence with the "Centre National de Télédetection" (geographic information systems);

- and the Ministry of Telecommunications with the "Centre d'Etudes et de Recherche des Télécommunications (CERT)"

or in other higher education institutions:

- Ecole nationale d'ingénieurs de Monastir; software engineering, Arabic script recognition,

- Faculté des sciences économiques et de gestion de Sfax: natural language and arabisation, man machine interface,

- Faculté des sciences de Sfax: parallel algorithms,

- Ecole Nationale d'ingénieurs de Gabès: software engineering,

- Ecole Polytechnique de Tunis: mathematical modelling,

- Institut Supérieur de Gestion (ISG) at Tunis: Electronic Data Interchange (EDI)

- Faculté des sciences de Monastir (FSM): natural language and arabisation, EDI, real time systems.

The teams involved in IT in these institutions are rather small but it should be noted that ISG, FSM, ENSI and CNI are working together in the framework of a joint laboratory called RIADI on EDI and arabisation.

III. General remarks and conclusions

The Tunisian research in IT is rather small. Altogether the number of researchers can be estimated at 300 including teaching staff and PhD students. This is about one fourth of the staff of a large research institute like INRIA in France with 500 full time researchers and 600 students! However, the quality of research is at the level of European standards. Most of the Tunisian researchers have been trained abroad, in the best European or American laboratories and they maintain good relationships with these laboratories.

The main drawback of this situation is a wide variety in the themes of interest and a lack of focusing in the scientific orientations of the laboratories. For example, at least 5 different institutions, namely ENIT, ENSI, IRSIT, CERT and ESPTT are working on networks and telecommunications. In the Tunisian context, one could have expected that arabisation benefits from a lot of efforts and in fact there is no doubt that Tunisian research is at the best international level in this field but the theme is dealt with almost everywhere.

In spite of an overall relatively good situation, the Tunisian research suffers from some long lasting difficulties which hamper the full realisation of its potential:

- although the cost of labour is lower in Tunisia than in Europe and that it is often difficult to isolate research from other activities (teaching and services for the Government in the case of CNI), it appears that research funding remains low compared to European standards. The "Programmes Nationaux Mobilisateurs (PNM)" funded by the SERST have been most useful in focusing the additional means on priority areas but they have led to an increased instability in the funding of the laboratories ;
- up to now, administrative procedures have been rather cumbersome for some institutions. These problems should be alleviated by a new law on research due to be applied very soon;
- due to the pressure of the higher education system, the number of full-time researchers is limited. They can be found in only two institutions: IRSIT and CNI. The situation is particularly difficult for young PhD students wishing to prepare their thesis full-time in Tunisia and who, most of the time, have better to go abroad;
- access to information is still too difficult. Most libraries need to be improved and access to Internet although it should not raise any difficulties in principle remains problematic for most institutions.

As the importance of R&D and the information technologies is fully recognised in Tunisia, there is little doubt that these issues will be dealt with in the near future. In particular, a scheme for helping PhD students to prepare their thesis in the country and some mechanisms for inciting the researchers to work more closely in networks involving industry whenever possible or to go abroad for thematic conversion would be most useful.

International co-operation could also play a significant role in this respect. The links with the international scientific community (specially with France thanks to the help of the French government) are already strong and this should facilitate a broader involvement in the EC R&D programmes. Up to now, the Tunisian participation in the Framework Programme has been very small but it should increase in near future, in particular since the next INCO call for IT will be focused on the Mediterranean region.

Moreover, the emphasis on the strengthening of the co-operation between Europe and the Mediterranean countries resulting from the Euro-Mediterranean conference held in Barcelona in November 1995 should provide new opportunities. The MEDA programme which was adopted then for a total of 4 685 MECU aims to support the reform of economic and social structures of the Mediterranean countries. Among the measures considered in this programme are the development of the telecommunication infrastructure and the improvement of human resources and of the potential of scientific and technical research.

This could be a key element in eliminating some of the obstacles to the development of R&D in Tunisia and to allow it to contribute more efficiently to the solution of some of the main issues that the country will have to face in the coming years, namely:

-the strengthening of the competitive position of the Tunisian industry which is the sector of the economy which has been creating the more jobs during the recent years. This is specially urgent in order to take a full advantage of the partnership agreement concluded with the EC in 1995. In this respect, it is encouraging to note that some institutions (FST, IRSIT,ENIT) have already started working in relation with the private sector;

-the modernisation of the education system which, as a result of the demographic growth and of the evolution of the ratio of enrolment, will have to face a huge demand in the near future. The new IT tools for education should contribute to alleviate the pressure on the researchers which otherwise run the risk of being submerged by the educational tasks.

Setting up a special inter-ministerial task force in order to define an action plan in these fields and to follow its execution could be useful. The action of this task force could be supplemented by the establishment of an advisory working group made of experts coming from various horizons: industry and services, social sciences and IT researchers, content producers, network operators... It would be in charge of analysing the major societal and economic issues raised

by the transition towards the information society in Tunisia and of identifying the technologiy needs and the markets for tomorrow.

In conclusion, it should be emphasised that, in spite of all its difficulties, the Tunisian research disposes of enough strength and stamina to contribute to the development of its country and that, in the short run, it could play a significant role in the European research programmes.

Evaluation of the Tunisian research in information technologies

Annexes

13 March 97

ANNEX I

The ERCIM evaluation team

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ANNEX II

List of the institutions visited by the ERCIM team

1. IRSIT

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Tel: 216-1-800-122
Fax: 216-1-787-827
IRSIT http://www.irsit.rnrt.tn/

Visit by the ERCIM team: 29th January 1997

2. ENSI: Ecole Nationale des Sciences de l'informatique

Director: Prof. Farouk Kamoun
Address: 16, Rue 8010 Montplaisir,
1002 Tunis le Belvédère
Tel: 216-1-784-032, Fax: 216-1-785-659

Visit by the ERCIM team: 30th January 1997.

3. Département des sciences de l'informatique, Faculté des Sciences de Tunis

Director: Prof. Mohammed Moalla
Address: Faculté des Sciences de Tunis, Département des sciences de l'informatique,
Campus Universitaire,
Le Belvédère,
1060-Tunis
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Visit by the ERCIM team: 30th January

4. ESPTT: Ecole Supérieure des Postes et des Télécommunications

Director: Prof. Ahmed Mahjoub
Address: Ecole Supérieure des Postes et des Télécommunications de Tunis
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2083 Cite El Ghazala, Tunis
Tel: 216-1 762-499
Fax: 216-1-762-819

Visit by the ERCIM team: 29th January

5. CNI: Centre National de l'Informatique

Director: Dr. Mohammed Naceur Chemam
17, Rue Belhassen Ben Chaabane, 1005 El Omrane, Tunis
Tel: 216-1-782-996
Fax: 216-1-781-862

Visit by the ERCIM team: 31st January 1997.

6. ENIT: Ecole Nationale d'Ingénieurs de Tunis

Director: Prof. Hamed Khedija
Address: ENIT - Ecole Nationale d'Ingénieurs de Tunis,
BP37-1002 Belvedere, Tunis
Tel: 216-1-873-180
Fax: 216-1-872-729

Visit by the ERCIM team: 31st January 1997

7. SERST: Secretariat d'Etat à la recherche scientifique et à la technologie

On the 31st of January, the ERCIM team had the opportunity of meeting the Secretary of State for scientific research and technology: Mr Mongi Safra

Address: 10 rue 8018
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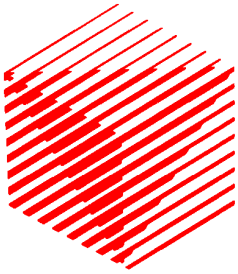
10-12 Tunis



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ERCIM presently consists of thirteen research organisations from as many countries:

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