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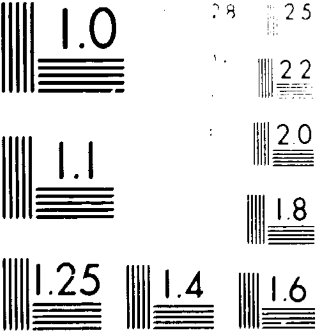
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MICROELECTRONICS AND TELECOMMUNICATIONS IN LATIN AMERICA*

by

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CHAPTER I - GENERAL INTRODUCTION

A - GENERAL FRAMEWORK

It has become almost impossible to refer to microelectronics and to telecommunications without first quickly reviewing the most relevant facts relating to electronics.

This science has impinged on society and on the economy in such a way that it would not be right not to point out some facts which characterise its evolution. The present century started with the famous experiment of Marconi who, in 1901, succeeded in communicating between Europe and the United States. A few years later, in 1907, de Forest invented the thermionic valve (triode) which really represented the active element which allowed the enormous growth and influence of electronics up to the 60's. Its use made broadcasting, more powerful receivers, international telecommunications (through short wave and submarine cables), radar, television and remote control possible and extended to the first computers.

However, although an important factor, it required considerable energy for its operation and, in some equipment, heat dissipation became important. The ENIAC computer required power equivalent to that of a locomotive for its operation. In this context, one of the significant steps in the history of electronics occurred in 1948. The transistor was invented in the Bell laboratories, and although much smaller than the valve and using much less power, it fulfilled the majority of the active functions of the latter. However, the transistor was hundreds of times smaller, consumed much less energy and had a longer useful life. To these physical characteristics was added a very considerable reduction in the price of the component. It was at this point that a veritable revolution occurred within the already revolutionary trajectory which electronics was undergoing.

It is from this basic event that we shall make a rapid survey of the growth of semi-conductors until we reach microelectronics. The first transistor had germanium as a basic component in its structure, an element which responded to operating conditions because of its semi-conductor characteristics. The first important advance in the transistor was produced with the introduction of silicon as a replacement for germanium. This element is much more "resistant" to the operating parameters and ensures a long useful life for the component. The artificial growth of crystals of silicon, with a high level of purity, enabled the quantity of "chips" per slice to be increased, thus starting the precipitous fall in prices resulting from mass production. This factor allowed the introduction of this active component into all aspects of electronic technology, cheapening its products and leading to its explosive distribution in society. In the 60's there was an extraordinary consumption of small portable radios, cassette recorders and other products which were impossible to produce using electronic valves. During this period also appeared solid state discrete component computers, with volumes reduced by the order of 2 or 3 magnitudes and energy consumptions very much less than those using valves. The proper attributes of these components: low price, small size, high reliability and mass production, permitted their rapid diffusion into all fields of human activity. It was then that microelectronics burst onto the scene of semi-conductor production. Since the middle of the 60's and during subsequent years development has proceeded in an astonishing succession, from hybrid circuits to integrated circuits at a low level of integration (a few transistors and other passive components), to components of medium scale integration (a few hundreds), to large (a few thousands) and to very large scale integration (from tens of thousands to hundreds of thousands). This phenomenal concentration of components (active and passive) on a single chip allows unsuspected reductions in the size of the final products.

Because of the importance which they have acquired, we shall make a special study of the microprocessors:

The first charge integrated circuits began to appear in 1969.

It occurred to some manufacturers to create a processing unit which would serve for various applications with slight modifications in the driving hardware. Thus were born the INTEL 4004 (with 4 bit words) and 8008 (with 8 bit words) microprocessors. Both employed the slow PMOS technology. In 1974 the same manufacturer produced the 8080 made using NMOS technology (faster than PMOS) which had many advantages over its predecessor, the 8008.

One of these is that the last named could only address 16 k-bytes (byte = 8 bits; k-byte - 2^{10} bytes) of memory while the 8080 could address up to 64 k-bytes and control up to 256 input/output ports. The CPU group (Central Processing Unit) is formed from 3 integrated circuits and requires 3 sources of voltage at 12V, 5V and -5V. All in all, this microprocessor, together with the MC6800 from Motorola, has been the most popular. The latter came onto the market in 1975 with the advantage over the 8080 of requiring only a single source of 5V; it uses 2 integrated circuits for the CPU, several addressing modes, 2 accumulators in place of the one of the 8080 and 2 interrupt inputs(*) (the 8080 has one).

In 1976 Zilog produced the Z80, also of 8 bits, having many advantages over the 8080 and the 6800. It has twice as many registers as either.

Interrupt input:
(*) An input by means of which it is possible to produce a hardware interrupt of the program which is being executed.

The programs written for the 8080 can be run on the Z-80. The CPU contains a built in refresh circuit(**) for dynamic memories.

In a short time INTEL produced the 8085, better than the 8080. This has 5 interrupt levels and operates with a single 5V source.

Motorola likewise improved the 6800 into the 6802 with 128 bytes of RAM memory(*) on chip, 32 of which can be fed permanently by means of a backup battery, which thus converts them into non-volatile memory.

There subsequently appeared single chip microcomputers (MCU). 6801 from Motorola: (8 bits) which has 2 k of ROM(**) (there is a version with EPROM(***), 128 bytes of RAM, a maximum of

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(**) Refresh circuit: dynamic memories require to be rewritten ("refreshed") (by hardware) every x clock cycles to prevent them being erased. The refresh circuits are used for this.

(*) RAM: (Random Access Memory). In fact, this should be called read/write memory. It requires the supply voltage so that the data is not lost.

(**) ROM: (Read Only Memory). Is non-volatile. It is recorded and cannot be erased since the method of recording is by destruction of part of the circuit. It may be recorded by mask or this is done in the works.

(***) EPROM: (Erasable Programmable ROM). These are ROM type memories, but they may be erased with ultra-violet light. Otherwise, they are non-volatile, because the recording principle is by means of capacitive charges (with practically infinite discharge times, in reality of about 10 years).

29 parallel I/O control lines, programable timer and a full duplex serial communication interface. The INTEL 8049: (8 bits) with 2 k x 8 of ROM; 128 x 8 RAM; 27 I/O lines, timer, memory and expandible I/O.

The INTEL 8039: the same as the foregoing but with external ROM or EPROM. Extends to 11 MHz. The foregoing are up to 2 MHz.

The MOSTEK 3870: 2 k x 8 ROM; 64 bytes of RAM; 32 bits of I/O and programable timer.

The MOSTEK 38P73: Like the preceding but has EPROM (1 k-byte or 2 k-byte) mounted on top (piggyback version).

As all of these microprocessores are, in general, slow, there was a switch to TTL technology which is faster. Thus Monolithic Memories produced the bipolar AM 2900 and 6700. The first has an instruction execution time of 100 ns and the second of 200 ns.

The arithmetic and logic unit (ALU) of both is with chip slice technology (4 bit modules). This allows them to be stacked and amplified as necessary.

Under development is the AM 29116, which is a 16 bit bipolar microprocessor. The objective of this design is to achieve a microcycle time of 100 ns maximum for all instructions and it will be used for digital modems, communication controllers, etc. Soon will appear the 16 data bit microprocessors: the MC 68000, Z,8000, etc. Synthesis of the state of the art at 1.3.82.

Four 32 bit microprocessors are likely to make their appearance in 1982:

The INTEL 432 micromainframe:

Is a combination (in HMOS) of 3 chips allowing programming in a high level language (ADA), the hardware is being used in 3 main areas: memory organisation; data handling and object code programming. This results in a system which is transparent to the software; that is, it is possible to add or remove processors from the basic system without making changes in the software. Thus higher speed is obtainable since various processes can be carried out in parallel. The system hardware also takes into account the IEEE rule on floating point.

A HEWLETT PACKARD single chip micro (in NMOS) with 450,000 transistors, designed for a maximum value of 18 MHz and dissipating about 7 watts. It has a processing speed like that of high performance minicomputers or mainframe computers.

The Bellmac-32 from the Bell Laboratories:

This is a single chip microprocessor (with up to 20,000 transistors) made with CMOS technology which dissipates less than 1 W by using new "domino" circuits which can reach twice the speeds of the classical CMOS due to the use of a single clock which activates various circuits simultaneously.

The designers of this hope for an internal clock of about 32 MHz for the final chip.

The CMOS microprocessor made by NIPPON TELEGRAPH AND TELEPHONE in a single 12 mm^2 chip which will include 20,000 components and dissipate 750 mW.

There are also new 8 and 16 bit micros which use CMOS technology, high level language and higher operating speeds. There is a tendency to multitasking by means of dedicated chips.

Peripherals for 16 bit microsystems:

New versions of the 16 bit microprocessors appeared in 1981. The most important, however, are the dedicated processors and peripheral controllers (for memory, display, discos, etc.) which have a far greater influence on the design of the overall system than the master microprocessor. There are slave chips which are controlled by messages, which contain their own stored local program and respond to highly descriptive messages, which make their operation transparent to the master processing unit. These intelligent peripherals appeared for the first time in large mainframe computer systems.

The peripherals may be divided into these basic categories:

. High speed dedicated processors.

. Memory maintenance and protection.

. I/O and display.

. Support for local and remote networks for distributed processing.

The last 16 bit microprocessors are concerned with achieving faster clocks.

The TMS 99000 (microprocessor) from Texas is available in a 24 MHz (40 ns) version. It is 9 to 12 times as fast as the TMS 9900 . The MC68000L12 from Motorola in Austin, Texas is a 12.5 MHz version of the MC 68000. Zilog has produced two 10 MHz versions of the Z8000 (70% faster than the preceding ones).

Intel has begun to produce the IAPX 286 capable of addressing 16 megabytes and capable of supporting up to 1 gigabyte of virtual memory for a similar task.

It is estimated that National Semiconductor Corp. will be able this year to offer the NS 16000 with 16 data bits at the external pins while the internal hardware handles 32 bits. It is hoped that these microprocessors will work at 10 MHz, allowing up to 32 megabytes of storage to be addressed and/or to support virtual memory in a required page up to 16 megabytes per task.

DIFFERENCE BETWEEN MAINFRAME, MINICOMPUTERS AND MICROCOMPUTERS:

a) Mainframes are the large computers used in large companies. They can manage a large amount of information at one time. They employ time sharing where a number of terminals are interconnected with the mainframe.

   They cost millions of US dollars and require very specialised operators and programmers.

b) Minicomputers are used by medium sized companies. They are used for scientific applications. They cost from about

30,000 US dollars.

c) Microcomputer: since these are small and cheap, each user may have one. For this reason they are also called personal computers.

d) Micro: abbreviation of microprocessor.

The drastic reduction in size enables the science of electronics to be introduced into areas from which it was excluded for dimensional reasons and in this way the final barrier to total diffusion in the economic and social sphere was overcome.

To the extent that measurement sensors and control of basic parameters were perfected as a consequence, microelectronics made possible the rapid development of robotics, informatics, telecommunications, etc. in their most sophisticated and complex versions.

Informatics was the first to replace human labour, since the tasks in which it could be applied on a large scale, office and administrative jobs, because of their peculiarities, lent themselves to such replacement.

Robotics is in full development towards the replacement of human labour in industrial and production jobs, since it can immitate (and sometimes improve upon) the range and precision of movement of a human being.

Telecommunications, thanks to miniaturisation, may make use of them in its repeater circuits for submarine cables; terrestrial satellites; remote control equipment, remote sensing devices, television, etc. and in space vehicles which explore other planets and space itself at enormous distances from the earth.

At a personal level, it not only makes available portable radio or audio equipment of minimal dimensions, digital watches, pocket minicomputers, etc., but also allows telecommunication equipment capable of connecting the user to the public telecommunications network and, from this, to the international network, to be produced and, in a short time, to be perfected. This small but powerful portable equipment will be able to handle telephone traffic and data. This means that the moment has already arrived when a man can have available, in almost any location, a practical personal instrument to intercommunicate with any place which has a public telephone service available and with any data centre which offers services connected to the public network, either in the same country or in any part of the world.

This means that it is not an exaggeration to say that the impact of microelectronics is CRUCIAL in telecommunications. We shall consider some aspects of this subject:

1 - TECHNICAL FACTORS:

- <u>Electronic switching</u>: It is in the area of switching that microelectronics appears to have a powerful influence. The capacity and efficiency of stored program timing electronic exchanges are distinctly superior to other types of switching (crossed bar, cross-point, semielectronic, etc.), introducing into the telephone field the treatment of information with the methods proper to computing, in such a way that the traffic is processed in timed sequences, with high speed and efficiency. With a suitable architecture, these exchanges could process data and, in this way, allow the creation of automatic digital interconnected networks, if the connections are adequate, compatible with the telecommunications infrastructure.

In this field, the forecast is for a gradual and systematic replacement of obsolete exchanges in all countries of the world and it is estimated that, for public service exchanges, it is correct to forecast that only electronic exchanges will be installed in the future. This fact creates a perspective of a strong and sustained demand for microelectronics products for telephone switching.

- Subscriber terminal equipment for the telecommunications network.

  . The telephone terminal, a typical example of discrete electromechanical equipment, already includes microcircuitry for multi-frequency signal code and in the future will include digital displays.

  . The data terminal consists, in practice, of microelectronic components.

  . The teleprinter, a traditional example of precision mechanical engineering, is approaching closer and closer to total integration of solid state components in its manufacture.

. The telecopier is an item of solid state equipment with simple mechanical devices for feeding the paper.

. The data modem, is an interface between the computer and the telecommunications network and is an item of equipment consisting of integrated circuits and, in some cases, microprocessors.

Given the nature of this work, we shall not provide an analysis at this point but the enormous field of use for microelectronics in subscriber terminals can be deduced.

- Links and transmission lines

. Carrier wave equipment.

Modern carrier wave equipment, whatever the nature of the wave propagation guide (overhead cable, pairs of cables, coax cable), are constructed entirely in solid state, with micro-circuits predominating.

. Radio links

Radio links for propagating electromagnetic waves are currently entirely solid state, whatever the transmission band or channel capacity. The reduction in the size of the equipment as well as the substantial reduction in the energy consumed, allows them to be located even in inhospitable places, protected by special packagings and powered for example, simply by means of solar batteries.

. Fibre optics

This technique exists as a consequence of the perfecting of the manufacture of diodes and photoemitter transistors and associated equipment, all belonging to the microelectronics family.

. Telecommunication satellites and microelectronic equipment in space and terrestrial artifacts.

The saving in space, energy and weight which is necessary in this type of equipment has made the use of microcircuits essential in such artifacts and the robustness necessary to withstand the vibrational and inertial forces which occur during launching are also obtainable as a consequence of the advances made in the specifications for microelectronic components.

- Entertainment telecommunications equipment

. Sound and short wave radio broadcast receivers.

. Television receivers. In this case, it is possibl[illegible] that the colour TV is possible only as a conseque[illegible] the advent of microelectronics, for dimensional reasons.

. Amateur radio transmitters, walkie talkies, and other supplementary equipment (radio telephones, etc.). All of this equipment is currently made with a continuous increase in integration and miniaturisation. It is now possible to state that almost all of a radio broadcast receiver is integrated into a single circuit.

2 - ECONOMIC FACTORS:

Participation of the telecommunications sector of the eccnomy in the overall economy.

As a world average, the apparent share of the gross product of the telecommunications sector in the gross national product is approximately 1%.

The term "apparent" has been used to indicate that the percentage given relates only to the classical conditions for national accounting and does not indicate the real impact which telecommunications have had on the overall economy of a country. In effect, it is already impossible to imagine an economic activity, including manufacturing processes, in which telecommunications are not an essential component. This is because the fundamental product which processes telecommunications, that is to say, the traffic, is substantially intelligent and of very high speed (approximately the speed of light). These characteristics mean that its participation in the national economy cannot be evaluated merely by using orthodox parameters. It is as if the importance of the brain and of the nervous system of a mammal were to be deduced from the fact that they weigh approximately 2% of the whole body.

In order to assist in understanding the complex relationships between telecommunications and the national economy, some comparisons have been carried out for this article which may be useful.

In effect, data has been taken from 7 highly developed countries relating to the period 1968-1978. As can be seen in Table 1, the first column indicates the percentage increase in the range of the telephone service (indicated by the change in the number of telephones installed in this period), the second shows the growth in trade, long term, of the same countries over the same period. The third column indicates increase in productivity in the period 1960-1975 (it assumes that the structure is valid for 1978) and the fourth column indicates the percentage of column 3 related to Japan = 100. Column 5 shows the values of column 2 as a percentage of those in column 4. This final value we shall call productive trade, since it is directly related to the overall productivity of the economy of each country.

It is clear both from Table 1 and from Graphs 1 and 2 that there is a very probable relationship between the growth in the supply of telephones and the increase in the overall productivity of the economy. It is also possible to observe with the same criteria the relationship between the increase in the GNP and the increase in "productive trade".

These relationships indicate that the impact of telecommunications (more precisely, this should be called telematics) on the overall economy goes further than its participation in the gross sectorial product. The nature of this article does not permit the analysis to be pursued more deeply, but leaves open the question: what is the true share of telematics in the overall economy ?

From the point of view of business figures, it is very interesting to refer to the work of R. Chapuis, an Engineer of the International Telecommunications Union, entitled "The Telephone, a Heavy Industry"(1), in which he shows that, in the telephone businesses alone, about 75,000 million US dollars were generated in 1975 at a world level. The real investment carried out in the same year reached 25,000 million in the same monetary units, 10,000 of which corresponded to investments in switching equipment. If, to these figures are added the advance made since this date in computing equipment and/or equivalents in telecommunications, it is not hazardous to assume that, at the present time, telematics represents one of the foremost of the world's businesses.

(1) Boletin de Telecommunicaciones - Vol. 42, p. 608. Geneva - 1975.

These substantial figures are, to a large extent, earmarked for the acquisition of equipment in which microelectronics play a decisive role. At the same time, it is to be expected that there will be a massive and sustained demand for microelectronics originating from the increasing development of telematics. Studies carried out in GAS-5, a specialist group of the International Telegraph and Telephone Consultative Committee (ITTCC) indicate that, even with a world recession, there has been a national input in terms of telephones per 100 inhabitants of 1.7, indicating the marked expansion which can be expected in demand for telematic equipment with the development of the world economy.

3 - SOCIAL FACTORS:

Telecommunications represent public services which have penetrated deeply into the social fabric, both qualitatively and quantitatively. The high efficiency which has been achieved in land based, maritime and satellite networks, have enabled any event of interest which occurs on the earth or in space to be known in "real time" by any inhabitant who has a suitable receiver available. The technical means dedicated to radio broadcasting, both sound and television, have reached such degrees of perfection that it has now become a matter of routine to listen to a concert in high fidelity stereo or to follow all the chromatic richness

TABLE No. 1

1968 - 1978

VARIATION COUNTRY	% OF TELEPHONE SUPPLY	% OF GROWTH OF TRADE	% OF GROWTH OF GLOBAL PRODUCTIVITY	COLUMN 3 IN %	COLUMN 2 x COLUMN 4 / 100 % OF "PRODUCTIVE" TRADE
No.	1	2	3	4	5
UNITED STATES	56.2	23.5	2.0	20	4.7
UNITED KINGDOM	91.6	20.9	3.8	38	7.9
FRANCE	150.3	14.1	5.7	57	8.0
FEDERAL GERMANY	122.2	16.2	5.8	58	9.4
ITALY	128.4	17.8	6.2	62	11.0
HOLLAND	115.3	15.0	6.9	69	10.0
JAPAN	177.9	27.8	10.0	100	27.8

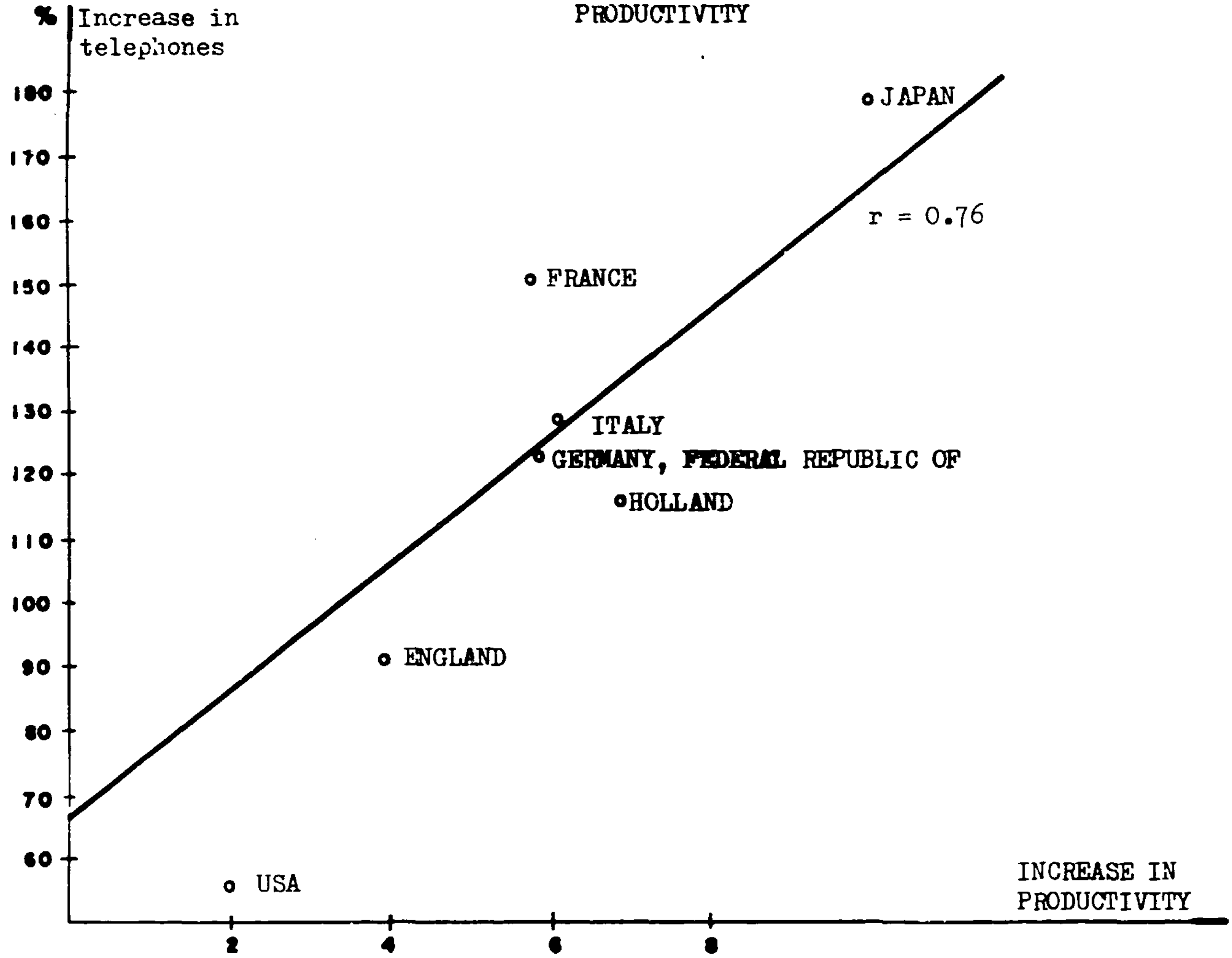
SOURCES: Column 1 - Telephones in the world, annual publication of the "American Telephone and Telegraph Corp. N.Y.

Column 2 - Comunicaciones Electricas - Volume 55 No. 2 - 1980, p. 130

Column 3 - Review of the Center of the International Cooperative for Computerization, Tokyo, 1978.

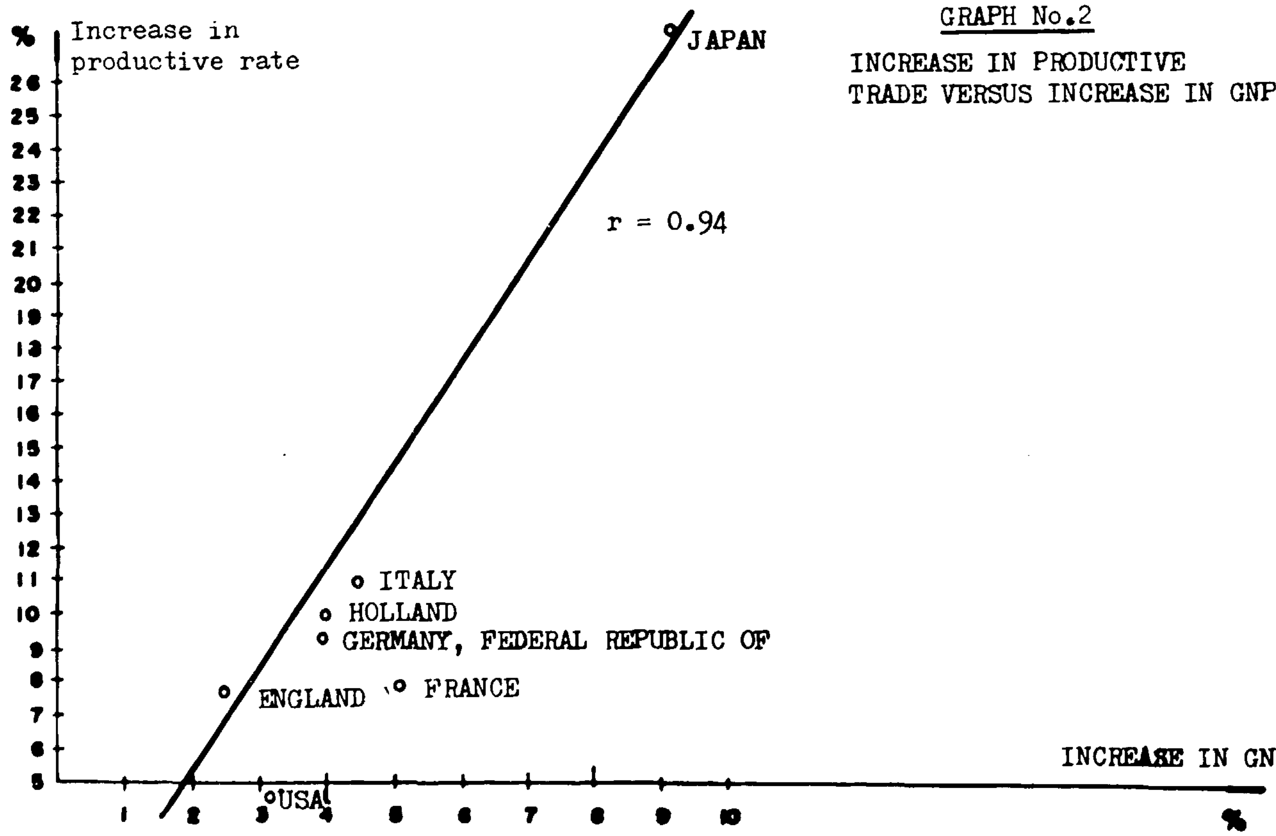
GRAPH No. 1

INCREASE IN TELEPHONES VERSUS INCREASE IN PRODUCTIVITY



GRAPH No.2

INCREASE IN PRODUCTIVE TRADE VERSUS INCREASE IN GNP



of a colour television picture. These facts combine to contribute to the formation of a "spectator civilisation", in which the effects of the means of transmission and the message itself are so intense that they have succeeded in altering the behaviour of the whole of society. In addition, this emphasises the political importance which these services have for propaganda and the spread of idealogical models and propositions. In terms of impact on the employment factor, its implications are deep and sustained. Even in the decades of the 20's and 30's, the replacement of the telephone operator by automatic exchange systems resulted in a large number of women who worked as telephonists being left unemployed. At the present time, corresponding telematic networks are rapidly replacing employees in the third sector (secretaries, administrative personnel, financial personnel, etc.) and in the near future, telerobotics will replace workers even in manufacturing areas and probably in rural and mining jobs.

As will be clear from the points made above, which do not claim to be exhaustive, telecommunications and its basic equipment component, microelectronics, will play a fundamental role in the most intimate processes of the economy and society.

For this reason, this combination of services and goods will achieve a value which transcends the mere technical productive or economic effects. We are dealing therefore with a reality which must be adopted as a strategy for the growth of the people and as one of the factors related to their sovereignty and independence.

Telematics, for example, a combination of telecommunications networks and computers, handles an increasing amount of traffic, that is to say, is increasingly circulating a greater quantity of intelligence through its interwoven networks, but this is only possible thanks to microelectronics (whose products are fundamentally intensive intelligence) advancing in giant steps. That is to say that for a country, the flow of information is a property, a fact which is intimately connected with its existence. Microelectronics, which allows it to be channelled, is not a mere technocratic matter. It is transformed into a matter connected with sovereignty. Decisions related to micro-electronics, telematics and robotics cannot be merely scientific and technical means but must be essentially political actions, intimately related to each people: the sovereignty of its intelligence.

B - LATIN AMERICAN SITUATION

Latin America has developed its telecommunications at a faster rate than the rest of the world. Taking the number of telephones as a valid indicator for the sector, the Latin American countries had approximately 11 million telephones in 1974, that is to say

3.3% of the world total and equivalent to 3 telephones for every 100 inhabitants.

In 1980, the quantity of telephones was some 18 million, which represented 4% of the total of telephones installed in the world and approximately 5 telephones for every 100 inhabitants[2]. The average annual increase was 9.1% per annum in the telephone field.

The American intraregional and external telephone traffic grew at an overall rate of approximately 35% per annum[3]. The annual average rate of growth of the GNP for the period 1976-1980 was 5.6%[4]. As can be seen, the relative growths of the variables of demand (traffic) and supply (number of telephones) in the Communications Sector, particularly demand, are growing at rates very much greater than unity. Comparing the indicator T/100 inhabitants, which is 5 for Latin America as against 12 which is the world estimate at the present time, it can be seen that all the parameters show an optimistic situation for the growth of telecommunications, since the region is far from the world average

(2) - Development plan for telecommunications in Latin America (ITTCC-RICC) International Telecommunications Union, Buenos Aires, 22-29th October 1981, PLAN Document AL-Temp. No. 5-5, pp. 2 and 3.

(3) - Ibid, pp. 2 and 4.

(4) - Comercio Exterior, January 1982, p. 7.

in respect of telephones per 100 inhabitants and also supply and demand are growing rapidly with the growth of the global economy.

In addition to the growth of approximately 1.6 million telephones per annum, this service alone shows values of the order of 960 million US dollars per annum for investment[5]. If it is considered that approximately 32%[6] of this value relates to urban and inter-urban exchange equipment, the great majority of which currently consists of microelectronics components and parts, the annual demand for microelectronics products, in the telephone sector alone, will rise to approximately 307 million US dollars per annum. In an initial appreciation, it is possible to estimate for Latin America[7] approximately 3 times the demand in terms of mass consumption telecommunications products (radio, T.V., recorders, audio, etc.), with which we arrive at a total

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(5) - This value is obtained by considering the unit value of investment in the telephone service (installation of a number of telephones) together with all the installations on the network. This value has been assumed to be 600 US dollars.

(6) - Economic studies in the national plan, on telecommunications (ITTCC) International Telecommunications Union, Geneva, 1972, Chapter VI, p. 4.

(7) - See: INDUSTRIES AND TECHNIQUES REVIEW, No. 472, 20.12.1981, p. 26.

value of approximately 1,500 million dollars for the demand for microelectronics products per annum. If, to this analysis, we add the more global concept of telematics, in which is included the demand for computers, terminals, etc., the preceding figure is greatly increased. This is to say, that in Latin America, the demand for microelectronics related to telematics is very large and, more significantly, has a considerable and sustained annual growth.

It is evident that the values indicated mean important business both for multi-national companies or countries outside the region or for the countries of Latin America itself, if they develop a suitable strategy, correctly planned for the medium and long term (up to the year 2000).

As has already been said, the figures indicated are only the visible part of the "iceberg" of the factors grouped around telematics and microelectronics.

It is here that the great challenge arises dramatically for the whole of a continent such as Latin America and for the countries which comprise it: whether to start a sustained action to participate in a suitable form in the decisions related to microelectronics in the area, by collaborating in deciding a joint and global policy on the subject; or to see the technology gap grow to insuperable dimensions, with the dangers of dependence to which such an attitude would lead, as compared with a complex but vital union of national and regional interests.

With regard to the reality, the current situation in Latin America in relation to the problem is as follows, as a quick summary:

. Sustained growth of the regional economy, which will increase incorporation of new fringes of population in mass consumption and the possibility of maintaining the rate of investment in telecommunications.

. A public and private market size which will give realism to the pretension of mass production at competitive costs.

. An important funding of first level universities and R and D institutes.

. An installed capacity for the production of telecommunications and electronics goods, from which a capacity for the production of microelectronics could be recruited.

. A dynamic and mobile labour force, eager for education and progress.

These selected items indicate a promising future for the production of microelectronics in Latin America, provided that a realistic and reasonable program is followed to achieve it. However, the opportunity is imminent and the time for taking decisions is short. We must therefore excite the interest of the Governments of the Latin American countries and persuade them to action on a subject which will be vital and essential in the near future to identify a sovereign nation.

CHAPTER II - SHORT HISTORY OF TELECOMMUNICATIONS IN LATIN AMERICA

1 - A VIEW OF THE TECHNOLOGICAL DEVELOPMENT OF THE LATIN AMERICAN COUNTRIES IN RESPECT OF TELECOMMUNICATIONS.

The development of telecommunications in Latin America is generally connected with the expansion of the rail transport infrastructure, which started its growth from the middle of the last century. The telegraph, which has recently been employed, was the essential communications link to ensure the speed and safety which the transport services required. It is for this reason that, in the 80's, a large rail network is being served by telegraph and various national, state or provincial administrations already have their corresponding telegraph networks. In recent years a start has been made on installing the telephone service, which, in some cases, has made experimental use of the existing telegraph lines. The telegraph extended to the national boundary and the national telephone of small exchanges were in full use in the most important cities of the South American countries from the start of 1900. From this time until the start of the 20's, the manual exchange telephone made considerable progress, counting its subscribers installed in the more developed countries in the area in the order of 10's of thousands. The decade from 1920 was one of the most fruitful in terms of technological exchange techniques, since it saw an expansion in the use of radio broadcasting, radio communications on an international level and automatic telephone switching. The decade from the 30's witnessed the consolidation of the public telephone service, where automation advanced deeply into the cities with larger numbers of subscribers, the telegraph, radio telegraph and radio broadcasting were perfected and international telecommunications improved in safety and efficiency. This decade was of particular importance in respect of own technology for the countries of Latin America. It saw the start of an import substitution stage (with different nuances, of course, for each country) which created the conditions for the commencement or consolidation of manufacture of certain goods and components, particularly in the radio broadcasting area. During the first part of the 40's, because of the negative influence of the Second World War on supplies, national production increased fundamentally in qualitative techniques, since production was diversified in an attempt to meet the requirements imposed by restrictions on external trade. These years saw the first setting up in the region of plant and component producing companies, branches or subsidiaries of large foreign companies. The impact which the injection of technology involved produced on the national telecommunications technology market was very great, producing among other phenomena a discouragement of small industries which had developed their own technology, since they could not compete with the large companies which were receiving a continuous stream of innovations from their central research and development institutes. For this reason we could draw the following conclusion: the large majority of the technologies used in the Region are not the product of national research and development.

In terms of users of technology, the countries of the Region have made considerable progress, since their telecommunications infrastructures can count on advanced automatic exchanges, high capacity long distance microwave systems, coax cables, submarine cables, satellite stations, fibre optics, etc.

In terms of the offering of public services, all those considered as fundamental are available: telegraph, urban and interurban automatic telephone, telex, data transmission (teleinformatics), rural telephone, international services of all types, etc.

That is to say that Latin America can be considered as reasonably well situated, in comparison with other regions of the world, both in respect of the use of technology as well as in the provision of telecommunications services. It is, in our view, retarded in the generation and diffusion of its own technology and innovations so that it must face the following challenge:

- To satisfy the growing national needs for services
- To increase and satisfy with suitable technology[(8)] and, where possible, of regional origin, the requirements in materials, components and telecommunications infrastructure systems.

2 - INVESTIGATION AND DEVELOPMENT OF SOLID STATE COMPONENTS IN LATIN AMERICA

Presented below is the information which it has been possible to collect in this connection.

CHILE

In this country there is a Microelectronics Laboratory subordinated to the Department of Electricity of the Faculty of Sciences, Physics and Mathematics of Chile University.

It has a laboratory of approximately 200 m^2 with equipment divided into four areas: Diffusion and Oxidation area (with furnaces and laminar flow chambers), Lithography area (with mask alignment, jig, spinner, drying ovens), Metallisation and Encapsulation area (with evaporator/diffuser, chip bonder, ultra-sonic wire bonder) and Test area (with microtester, metallographic microscope).

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(8) - Edgardo A. GALLI, Technology and Planning in Developing Countries. Article No. 2-10. Primeras Jornadas Latinoamericanas y Quintas Argentinas, de Ingenieria Electrica. Mar del Plata, Argentina, October 1972.

The objectives being pursued are Silicon Slice Technology and the Physics of the Solid State.

Main activities: research projects.

- Bipolar devices

  I) Transistor optimisation: geometry - power - frequency response configuration

  II) Development of integrated circuits

  - Test Circuit
  - Feedback amplifier
  - Functional blocks

- MOS

  I) Process development and evaluation

  II) Manufacture of MOS transistors

  III) Manufacture of a MOS integrated circuit

- Complementary projects

  - Development of new technological processes

  I) Diffusion with non-traditional sources.

- Manufacture of special instruments and equipment

  I) Electronic power tube for metallizing

  II) Automatic digital monitor for resistivity and type of semiconductor.

In addition, the personnel are in charge of educational courses for Engineer and Master. There are a total of 6 courses per annum.

MEXICO

Has a research centre for advanced studies at the National

Polytechnic Institute. With a development similar to that of the Argentine, this Research Laboratory has the capacity for making masks to order.

In addition, the Mexican Telephone Research and Development Centre, is planning in its 1981-1985 program to have available a design laboratory dedicated to the following tasks:

- Design of microprocessors
- Design of high density memories
- Design of other integrated circuits.

ARGENTINA

In 1976, this country decided to unite the forces available in its various research institutes (INTA, CITEFA, CNEA) with projects in the area of solid state components into a unit which they called CENICE. In 1980, it was decided to include this in the COMMUNICATIONS SECRETARIAT with the object of obtaining a new source of finance for the CENTRE and to integrate demand with the main state consumer of this type of component.

With a total of 47 development personnel, this Centre has carried out:

1) Hybrid circuit technology, that is to say, that in which resistances, conductors and (small) capacitors are deposited on a base (ceramic) and connected with semiconductor (transistor, microcircuit) "chips" of large capacitors provided with a complex electronic circuit.

With this technology, this Centre has produced various pilot series for industry manufacturing telecommunications equipment. In addition they have brought about transfer of knowhow for the production of these hybrid circuits to an internally financed private company.

2) Transistor manufacturing technology, including this year encapsulation in plastic (metal encapsulation has already been effected for high reliability transistors).

3) Design of simple circuits to be manufactured as integrated circuits, for example an integrated circuit with 8 active components.

4) Acquisition of high frequency transistor manufacturing technology.

5) Encapsulation of 14, 28 and 40 pin "chips".

6) Development of an epitaxial reactor system.

7) Design of a differential amplifier for integrated circuits.

In the present year:

1) Start with the CMOS pilot plant.

2) Develop processes for bipolar integrated circuits.

3) Multi-layer hybrid circuits.

4) Design of various hybrid and integrated circuits.

BRAZIL

The following are the laboratories and national university groups which are working on research and development in the electronic components sector:

- The Microelectronics Laboratory of the USP (LME) Polytechnic School (EPUSP).

  Objectives: Development of techniques for growing silicon and for the manufacture of silicon slices: design and processes for manufacturing silicon semiconductor devices, computer aided design; development of specific production equipment; and thin film technology.

  Number of investigators: 50

  Finance provided by: Finep and Telebras.

- Unicamp Electronics and Devices Laboratory (LED-FEC)

  Objectives: design and manufacturing processes for silicon semiconductor devices, the development of specific production equipment; the manufacture of electronic materials and computer aided designs.

  Number of investigators: 30

  Finance provided by: Telebras

- Unicamp Device Physics Laboratory(LFD-IF)

  Objectives: gallium arsenide technology, processors for the manufacture of optoelectronic components and solar cells.

  Number of investigators: 38

  Finance provded by: Telebras

- Groups of Electronic Grade Materials (MGE-FEC-UNICAMP)

  Objective: process for obtaining, purifying and forming electronic grade materials; specific production equipment.

  Number of investigators: 15

  Finance provided by: Telebras

- Unicamp Fibre Optics Laboratory (CFO-IF)

  Objective: development of fibre optics for telecommunications

  Number of investigators: 8

  Finance provided by: Telebras

- Crystals Group (IF-UNICAMP)

  Objective: development of infra red detectors.

  Number of investigators: 6

  Finance provided by: CTA

- Military Engineering Institute (IME-Rio)

  Objective: thin and thick film technology, plan for developing components in these technologies and electronic grade silicon.

  Number of investigators: 8

  Finance provided by: Ministry of the Army and Finep

- Telecommunications Studies Centre (CETUC-PUC-Rio)

  Objective: development of thick film technology, planning and development of components in this technology.

  Number of investigators: 4

  Finance provided by: Finep-Telebras

- COPPE-UFRJ

  Objective: development of thin film technology, some activities in computer aided integrated circuit design (CAD)

  Number of investigators: 5

  Finance provided by: Finep

- Integratable Subsystems Groups - GSSI - EPUSP

  Objective: development of microprocessor architecture and of integratable peripheral subsystems. Integrated circuits project.

  Number of investigators: 10

  Finance provided by: Finep - Fapesp

- UFMG

  Objective: computer aided design

- Addressable Memories Group - MEFE - EPUSP

  Objective: development of semiconductor mass memory and development of an electron beam photolithographic system;

  No: 1

  Finance provided by: Fapesp

CHAPTER III - INFORMATICS AND THE TELECOMMUNICATIONS NETWORKS IN LATIN AMERICA (DATA NETWORKS)

The informatics explosion in the countries of Latin America is being brought about as a consequence which started with the redimensioning of the telecommunications networks, leading to the formation of data networks which, using the existing transmission systems, allowed this growing traffic to be handled.

Until now, all of these countries have solved the matter by means of the public telephone network or by leasing "point to point" circuits. This led as a consequence to this service becoming expensive and limiting for the economic development of the countries; by not allowing the small users to have access to this technology, it became impossible to standardise and as a consequence it is difficult to exchange information between users since the use of databases which may hold information of general and specific interest is not allowed.

The development of computer technology, motivated by the increase and expansion of economic and social activities, means that the demand for services for data communication will increase rapidly, along with the requirements for quality, capacity and confidentiality of the telecommunications networks. According to various experts, the data networks will mark the "third era of communication". This will be possible thanks to the investments being made in R & D, reduction in the costs of the hardware and the software, change in the social regulations which justify the introduction of the mini and micro computer, revolutionary innovations in administration and operation of organisations and interconnection of different data systems.

Some of the efforts which have been made in this connection in Latin America are summarised below:

ARGENTINA: (9)

In the Republic of Argentina, a public data carrying service by means of point-to-point connections has been available for some time. At the same time, there is a large number of private data transmission networks and public telex services and electronic mail are offered.

This country has decided to standardise this expanding market by means of a Public Packet Switching Data Transmission Network for some 3,000 subscribers in a first stage forecast for the current year.

This network will adopt the X.25 protocol and will have the following facilities:

- A permanent virtual circuit.
- Closed group of users with or without output access.
- Packed/unpacked.
- Call with abbreviated address.
- Virtual call.
- "Obtegrama"*.

The political objectives which are being pursued may be summarised as:

- An obligation of the nation and its dependent companies in the form of users of data nets, to connect to the national public network.
- To induce those with networks already installed to connect into the public network by means of the nature of tariffs.

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* Word not understood

- Restriction on individual users who wish to set up private networks (except for very justified reasons and always provided that the public network is not in a position to satisfy the user's requirements).

For the purpose of handling the country's telegram requirements, the Argentine National Post and Telegraph Company is completing the installation of an Automatic Message Retransmitting Centre (CRAM), which is computer programmed for automatically switching of messages between terminals, using a technology suitable for a Message Switching Network.

Among the main characteristics of these systems are the following:

- Intercommunication between terminals with different codes and speeds.
- Multiple addressing.
- Alternative destination.
- May exchange messages with the telex network.
- Closed user group.

Finally, it is possible to say that Argentina has, at the present time, taken decisions indicating that it is introducing the new teleintermatic techniques with the networks mentioned above and with its decision to incorporate the new standardised services totally or partially through the ITTCC, as are Videotex, Facsimile and Teletex.

MEXICO: (9)

From the end of the 60's, the Communications Secretariat in this country has been meeting the demand for data services by allocating private telephone lines. These are in general small and almost always special purpose, with medium speeds (1,200 - 2,400 bps).

With regard to public teleinformatics systems, only a few exist and these are considered as general purpose (time sharing), providing a service to a small number of users (approximately 500).

There is in this country, at the present time, a Public Data Transmission Network which employs the packet switching technique. On the carrier network the rate is 64 Kbips and in the access is 50-48,000 bps in asynchronous and synchronous mode, as relevant. The electrical interfaces which are considered are: V 24 (X21 bis), V 28 and 35 and, in the future, X 21.

The services which are offered are:

- Switched virtual circuits (SVC)
- Permanent virtual circuits (PVC)
- Closed subscriber group
- Retrieval communications
- Protocols for conversion to X 25 (19)
- Asynchronous user connections (X.3, X.28 and X.29) (19)
- Input access through the switched telephone network
- Access through the telex network.

In future, the services which will be offered are:

- High speed transmissions at 2,048 Mbps on the carrier network.
- Transmission via satellite at high speed (above 19.2 Kbps).
- Messenger services (for example: electronic mail)
- Facsimile
- Radio packets
- Integrated packet switching and circuit service
- Virtual terminals
- Multi line procedures and improvements which are to be incorporated in the standardised protocols, as well as in any new ones which may arise.

This network will have 24 access points, 4 packet switchers, 950 terminals and computers. By the end of the current year, 20 more cities will have access to the network and will be able to meet a demand for up to 2000 terminals and computers.

BRAZIL: (9)

At the present time, the only public network in this country is Transdata, which provides data links without switching, either point to point of multi point. The previous prohibition on employing the switched telephone network for the transmission of data is being reconsidered.

The international service is known as Interduta, which consists of the leasing of international channels for use in data transmission. It is planned to channel all the international data transmission through the future International Data Node.

Consideration is being given to starting a pilot videotex system in San Pablo and there are existing telex and telegram services through the SICRAM network. For the present year, Brazil is considering establishing a Public Data Network (REXPAC) for packet switching with an X 25 access interface. In the first step, there will be nodes in Rio de Janeiro, San Pablo and Brazilia. The forecast is for subsequent stages to be carried out with local development of technology and with the pressure of local development and production of: minicomputers and small computers, peripherals, modems, data communication supervisory systems and packet switching devices.

The Brazilian policies are:

- In the communication of data, the establishment of an international data node, through which all data connection with abroad must be effected whether this corresponds to the telephone network, the telex network, the public data network or the private networks and lines. In a second stage, the adoption of the ITTCC protocols for data communication within the country.
- To discourage teleprocessing on foreign computers.
- Computer programs (software) shall be considered as

merchandise and treated as such. The only products allowed to be imported will be those which do not compete with similar national products or which, because of their complexity and the small size of the market in Brazil, cannot conveniently be developed there.

- Databases: the procurement of information from foreign databases will only be permitted where the information is not available in local databases; the establishment of databases in Brazil will be encouraged. In those cases in which it is convenient to employ foreign databases, a local duplicate will be purchased.

- "Software" is considered in Brazil as non-patentable technology. Its commercialisation must be determined in a registry of products in the SEI.

- Brazil proposes that the information shall be included as merchandise by means of a series of special features in the regulations of the Law on International Trade.

- Privacy is considered as an irrelevancy at the international level, and preference is given to the protection of the state against the misuse of information belonging to it.

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(9) Reports of the IV Latin American Seminar on Data Communication - Rio de Janeiro - October 1980. The public data transmission network for Mexico by Roberto E.K. Cueva; The Argentine National Network for Automatic Message Transmission (SITRAM) by Armando Francisco Garcia; Data Communication Networks in Brazil by Kival Chaves Weber; The "RENPAC" project by Antonio Salles Campos Filho; The Argentine Packet Switching Data Transmission Network by Juan Carlos Rivera.

CHAPTER IV - PROPOSAL FOR A LATIN AMERICAN STRATEGY

1 - General Overview

In the preceding chapters, we wanted to indicate the various factors involved in the subject of microelectronics and telematics.

The direct and indirect implications of these activities on the Latin American task requires a general overview since it is an involved, changeable subject which does not allow of a partial solution, as would be the case in simply evaluating the lines of industrial action required to meet the needs of this branch of production in Latin America. This position has been adopted, for example, by the French Government[10], which promoted deep studies at all levels of society in order to understand and predetermine the impact of these applications. The proposed strategy which will be put forward for Latin America will be based on a basic policy premise: to consolidate in this field the independence and sovereignty of the Latin American countries[11].

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(10) - See: L'Informatisation de la Societe, Simon Nora and Alain Minc, La documentation francaise, 1978.

Les enjeux culturels de l'informatisation, F. Gallovedec-Genyus and P. Lemoine. La documentation francaise, Paris, 1980.

L'Impact de la micro-electronique 1981-1985 P. Bonelli and A. Fillion, La documentation francaise, Paris, 1980.

(11) - It is felt to be well worth consulting: Raul Prebisch "Biosfera y Desarrollo", Revista de la CEPAL, No. 12, December 1980.

2 - Areas involved in the strategy

2.1 - National planning

In all the countries of the Region, there are planning units which consider the classical problems of the use of available resources to meet the requirements of the population in the most convenient way.

We believe that this is a key area to sensitise. In addition to encouraging them to include a new industrial area: microelectronics, for their specific analysis in the industry sector and a new area, telematics, in the Services Sector, it is proposed that the planning bodies should be the forum for collecting all the information which can be gathered relating to the various ways in which microelectronics and telematics will impact on the economy and the society.

In this way it will be possible to have available objective elements of judgement in order to take decisions of a national nature[12]. The evaluation will have to be carried out for at least the following areas:

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(12) - In this respect, we consider that it is not sufficient to prepare a plan. It must be executed and this will require a positive vocation on the part of the political power.

See: WIONCZEK, M.S. and D. Thomas: Science and Technology Planning. Problems in a large Circum-Caribbean Country (Mexico), 1979.

AMADEO, E.: National Science and Technology Councils in Latin America: Achievement and failures of the first ten years. Pergamon. New York 1979.

- Industry Sector: evaluation of the impact of adopting microelectronics equipment in the industrial system. Internal capacity to produce or collaborate in the production of microelectronics goods(13).

- Employment: evaluation of the impact on employment of the use of microelectronics in the national economy (robotics, telematics, computation).

- Foreign Sector: analysis of the imports of microelectronics and telematics components, parts and equipment (telecommunications and informatics).

- Trade balance and payment balance with exporter countries for these products or sellers of technology.

- Technological Sector: capacity of the national institutes to participate in generating or adapting suitable technology. Policy on technology. Sophisticated technology or suitable technology. National seal of quality. Technological and production auditors.

- Education Sector: Use, as a tool, of these technologies to improve education and training.

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(13) - An ill-considered import replacement policy could be of little benefit: says Celso Furtado "..... to the extent that it promotes the replacement of imports of more complex products, the dependence on goods coming from the parent companies will tend to increase". See: Celso FURTADO: Un projeto para o Brasil Edit. Saga, Rio de Janeiro, 1968.

Training of staff at secondary, tertiary and post-graduate levels to meet the design requirements.

- Financial Sector: To determine the financial requirements for the production of microelectronics. Analysis of the possible sources of finance. Capacity for generating financial resources. Development credits, financial auditing.

- Sociological level: analysis of the current and future impact of the use of microelectronics and telematics goods. Determination of the impact of robotics in societies in the course of development.

  Analysis of the cultural impacts. Formalising a policy related to the national objectives.

- Urbanisation level: impact on the macropolis in the medium and long term. Decentralisation of work. Effects of telerobotics and of telematics[14].

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(14) - See: Arthur C. CLARKE: Anticipation et prospective de l'Information a l'ere Spatiale. UNESCO 1968. On page 42, with the subtitle "The end of the era of the city", he says: "In this connection, telecommunications satellites will be fundamental. In addition what could be considerably more important is the reversal of an historical tendency which has exhibited itself almost without interruption for the last 5,000 years: the traditional role of the city as an attracting magnet will come to an end. The tempting modern city will shortly undergo the fate of the dinosaurs, except for those in remote areas ...."
"..... this will be possible when almost all of the effects of the areas of competence and technical means which we use in every day life can be transmitted by telecommunications, and this will occur very shortly".

- Legislative field: deciding on coherent legal standards relevant to the general objective.

  Determining the impacts on transference of technology and on the patent and trademark laws. Proposal for flexible regulations, capable of responding efficiently to the requirements for action in relation to these technologies.

- Institutional field: Promoting the use of domestic microelectronics equipment where its functions are equivalent to imported equipment, in national institutions.

  Knowledge and comparative analysis of the domestic and imported equipment on offer.

- Public field: the spread and analysis of the problems and solutions introduced by microelectronics and telematics.

2.2 - National and Regional Market

2.2.1 - Telecommunications supply

The large majority of the telecommunications networks in Latin America belong to the Public Sector or to companies in which the state has a large share. In addition, as can be seen from Table 2, almost all countries in the Region have a telephone availability in terms of telephones per 100 inhabitants which is found to be much lower than the average figure for the whole world which is of the order of 12 T/100 inhabitants. These two circumstances allow a considerable expansion in the telecommunications services supply over a long period(15). In this way, the public sector of the Latin American countries will be the entities who will have the heavy responsibility of having to increase the supply of services to the community and, in addition, of having to produce, on a realistic basis, since the demand is very much unsatisfied, sustained purchase programs which are transformed into a strategic demand for microelectronics goods. Here emerges the task of one of the great protagonists of a possible long term strategy in the production of microelectronics: the public sector related to telecommunications can contribute with great efficiency to the creation, maintenance and progress of Latin American microelectronics(16). This important possibility may be conducted at a regional level since the Latin American States have a large and productive experience in sharing in regional telecommunications organisations:

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(15) - Considerable expansions are possible even for those countries which comfortably exceed the world average. Japan, with 44.2 T/100 inhabitants in 1978, was assigning 4.5% of its public investment to telecommunications for the period 1978-1985. See: Comercio Exterior, Vol. 30, No. 11 "Economic Planning in Japan" by the Japanese Deputy Minister for Economic Planning, Mr. Isamu Miyazaki, p. 1195, Table 6.

(16) - See: Revista Nacional de Telecomunicacoes, January 1980. Statements by the Brazilian Minister of Telecommunications, pp. 8 to 12.

Development plan for telecommunications in Latin America (UIT), Inter-American Telecommunications Conference (CITEL), Association of State Telecommunications Companies of the Andean Sub-Regional Agreement (ASETA), the Inter-American Telecommunications Network (RITAL), etc.

This appeal may be the lever which moves the will of the States in drawing up a common area strategy for a subject as transcendent as microelectronics. From this it is possible to draw the following conclusion:

The demand of the public sector connected with telecommunications for microelectronics goods is a basic and realistic pillar of the economic establishment in this branch of industry in Latin America.

2.2.2 - The supply to the Consumer Sector of durable goods related to telecommunications

The tendency for the consumption of durable goods such as television, fixed or portable radio, car radios and video cassette systems to grow will surely continue given the highly resilient inroads which they have shown in all countries and economies. The possibility of a massive supply of microelectronics components in such products opens a strategic opportunity for industry which will already allow a "sustained volumetric demand" to be ensured and will ensure economic profits to this field. For this, it is essential that the Governments should have a concerted policy which homogenizes the position of Latin America as an importer and producer of microelectronics. This policy must appear in the ALADI and also in international relationships.

The States must clearly establish the tariff policy, the resources, controls and other instruments of a global economic policy to ensure that the demand will be met primarily from national production.

2.2.3 - Supply of measuring instruments for the telecommunications industry and of consumer durable goods

This sector of production has greatly benefited from the advantages of microelectronics and it is possible to forecast that, with the development of a consistent policy for the production of telecommunications equipment and related consumer durables, the sector will require not inconsiderable quantities of components. It is clear that although the scope of this work is not the whole of the electronics industry, in this field it is possible to affirm that the production of measuring instruments and equipment will, as a whole, benefit from adopting microelectronics.

The manufacture of these products does not demand major availability of capital and is "on a par" with the possible development of the microelectronics industry in Latin America[17].

2.2.4 - International position

The position of Latin America in relation to telephone progress indicates that it has approximately 4% of the world supply. If it is assumed simply for a preliminary analysis, that this percentage will have to be that which Latin America will produce in relation to microelectronics, the hard struggle which the Region would have is immediately apparent, since the actual approximate distribution of world production in 1980 is as follows:[18]

United States	2/3
Japan	1/4
Europe	1/10

In the regional field, there are various subsidiaries of multi-national companies belonging in some way to one of the countries indicated or to Europe. This situation

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(17) - See: Christopher Freeman: "La teoria economica de la innovacion industrial." Edit. Alianza, Madrid, 1975, p. 159.

(18) - Industries and Techniques Review already cited, p. 194.

makes it possible to forecast important actions to be carried out by the Latin American countries to allow them to make the necessary decision for setting up and developing microelectronics.

To increase its position as a negotiator, Latin America will have to implement a positive plan for exchanging scientific and technological information with other countries in a similar state of development and, in addition, request the cooperation of the large agencies of the United Nations in the preparation and startup of the companies and projects required.

2.3 - Technological proposal

Microelectronics and telecommunications and, more recently, telematics, are included in the technologies which have had the most spectacular development over the last three decades.

For Latin America, a region which is in the process of development, this circumstance must be analysed calmly to decide on a reasonably autonomous strategy and, at the same time, to resist the impulse to launch on an unbridled race, however brilliant intellectually, to obtain semiconductor slices of the thickness of a few hundred atoms, or infinitesimally fast switching speeds or power consumptions of only 1 W. This race is a game which can be played only by the most developed countries, with massive budgets, who are competing in a veritable maelstrom, which probably only they can understand.

On the other hand, we also reject categorically developments in Latin America with an obsolete or absolutely basic technology, as we would be a sink for techniques discarded or abandoned by the central countries.

In order to make rational use of the physical and intellectual resources of the Region, using scientific and technological capacity, research and development organisations, universities and private and public manufacturing companies to the full, it is proposed to adopt convenient or appropriate technology for the objective requirements of the countries of Latin America. This is a brilliant and unique opportunity for the Region, since finding an almost virgin state in this industry, it is possible to start a well thought out joint project, dimensioned to meet current needs, using own resources and collaboration with the large international institutions. However, there is no acceptable reply to the question: are sophisticated or ultra-sophisticated technologies useful in developing countries ?

However, the concept of suitable or adequate technology must not be deprecated. It is not a trivial or simple matter to select it. For this complex mechanisms may be required for analysing the real situation and the available or necessary means, which in this case extend from precision engineering to pure mathematics, and splitting up this analysis into social, economic and financial problems.

However, the decisions which it is proposed to apply in this type of problem will be, in general, as follows:

1 - A definition of adequate technologies for each one of the specialities required in a Latin American microelectronics program (PLAMIC).

2 - Assignment of the R & D projects per country or group of countries.

3 - To create a number of centres of excellence (2 or 3) which would push forward in the research and development to combine in the medium term in a balanced fashion with the industrial sector, to determine the innovation suited to Latin American requirements in the long term.

4 - To ensure that a substantial part of the purchases by the public sector are from the industry to be established.

2.4 - Telecommunications technologies

With the caution which is proper to any prediction in an area where technological exchange is very pronounced we could imagine the following technological uses related to telecommunications and telematics over the next 20 years (2000):

1 - Digitalisation of the telecommunications networks, enabling more widespread use of the services which are currently expanding rapidly: videotel, teletex, telefax, telemail and telenews. That is to say, to obtain an integrated services network.

2 - The systematic replacement of the copper cable networks by fibre optic cables, capable of carrying filiments of telephone channels or equivalents.

3 - The gradual digitalisation of radio broadcasting (T.V. and radio), including digital transport of programmes.

4 - The use of satellites, including digital satellites, capable of carrying a high volume of traffic (bursts of data) between computers or data banks.

5 - The spread of the intelligent data terminal into the room, office, etc. which will allow decentralisation of work and direct access to databases throughout the world.

6 - Telecommunications with automatic translation.

7 - Access to individual telematics by means of digital, portable radio communication equipment, with access to the national or international networks.

8 - The possibility of applying remote control and tele-robotics to conduct entire production processes from a distance (industrial, administrative and domestic).

This description, which makes no claim to be exhaustive, has a principal protagonist: microelectronics, as provider of the components which make it possible to produce equipment which is desirable, either from the point of view of the infrastructure or in the view of the consumer (T.V. sets, radio, radio/cassette recorders, car radios, portable personal equipment, etc.).

If the proposal at section 2.3 is put into practice, it is very possible that in the next 20 years the microelectronics industry in Latin America could have a reasonable share of this enormous internal market; here is where it will be necessary to produce a combination between the available supply of components, a product of the technological strategy adopted and the imagination and intelligence of the equipment or systems planners in using the resources available as rationally as possible.

CHAPTER V - CONCLUSIONS AND RECOMMENDATIONS

Throughout this article it has been shown that telecommunications and microelectronics represent a phenomenon of such magnitude that it cannot be treated merely from its technocratic aspect. Its implications on the economy, society and culture require a global overview which will nurture the concrete policies which each Latin American nation must dictate. We believe, that, because of the tradition which the Region has for undertaking projects in common, it is possible to coordinate these policies to contribute to the objective of supplying an important part of the

Latin American microelectronics requirements within the next 20 years from the area's own industry. This proposal appears realistic since the market which the requirements of the telecommunications, data and consumer infrastructure creates is large and will be capable of maintaining itself for a sufficiently long period. This fact enables an adequate or suitable technological strategy to be proposed for the proposed objectives in such a way that it does not result in an uncontrolled scramble for technological goals, more appropriate to the highly developed countries.

It is concluded that if the Latin American countries act rapidly and cautiously, it is possible to develop in the Region a microelectronics industry of a size suitable to the actual requirements of the respective nations.

To achieve this objective, the following recommendations are proposed:

1 - It is necessary to have available an area of coordination. With the object of promoting and animating a Latin American microelectronics program, a sphere for the coordination of the actions must be available. It would seem logical to suggest that this could be found in any Latin American or international organisation which shows an aptitude to carry forward an undertaking of this nature.

2 - To pursue the idea in various Ministries, Councils and or

Planning Commissions in the various countries of the region.

3 - Forming a working group at the level of the coordinating body with the following program of tasks:

3.1 - Raising the Science and Technology Councils and other equivalent bodies to a higher level of decision in each country.

3.2 - Evaluation of the University or R & D Centres capable of being centres of excellence for the program.

3.3 - Studying the feasibility of creating a computer assisted design centre for components in each country.

3.4 - Evaluation of the potential or installed industrial capacity. Analysis of the industrial censuses in each country. Analysis of the different industrial specialities required by the microelectronics industry.

3.5 - Determination of the economic and financial requirements for industrial projects.

3.6 - Proposal of a common policy with regard to the foreign sector.

3.7 - Evaluation of the sources of finance and the possible requirements for international bodies.

3.8 - Suggestions for the use of the bilateral science and technology meetings between the Latin American countries.

3.9 - Determination of the international cooperation necessary (South-South cooperation; UN Organisations; other bodies).

3.10 - Analysis of the personnel requirements. Suggesting the personnel requirements by speciality.

Seeking and promoting training grants in the higher centres in more developed countries.

3.11 - Analysis of patents and trademarks and transference of technology.

Examine the position of the Latin American countries in this matter. Proposals for meetings, transfers, uses, etc. which will promote the objective of producing microelectronics goods.

3.12 - Legislation to be proposed for progressing the program.

3.13 - Initiating in-depth studies of the impact of microelectronics:

- on labour
- on the role of the universities or R & D institutes
- on the family's tendency to consume and the actual investment (public and private)
- on the intensive use of the intelligence available in Latin America and its protection as a sovereign property.

- on the Latin American society and culture.

4 - To organise, by the middle or end of 1983, a Latin American Microelectronics Meeting, with the official presence of the Ministry of Planning or equivalent functionaries, to analyse the proposal of the Working Group and to adopt the official form of the agreed program.

This Meeting will give rise to the general and specialist coordinating bodies to carry forward the program.