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The Impacts of Computers
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1.0 INTRODUCTION

This paper presents an analysis of the impacts of computers on Latin American society. The introduction of computer technology obviously has many impacts [Kling 1980]; we will look here at many of those impacts and attempt to determine what adjustments may be necessary for a beneficial transfer of this technology to a developing country. We will consider the following major topics:

1. How are computers impacting employment in Latin America? We look closely at the high cost of computer technology for an underdeveloped country including the social cost of reduced employment.
2. The sociological implications of computer technology transfer for Latin American societies. Has the introduction of the computer really been a benefit, given the present cultural and educational levels of Latin America?
3. The present-day criteria for computer systems acquisition in Mexico and Brazil.

Lastly, we summarize our observations and consider who should accept responsibility for the social side effects caused by computer technology transfer.

We want the naive reader to have a feel for the difference between a "developing" country and a "developed" country. For this reason, we first describe the historical cause of the economic state of the so-called "underdeveloped" countries. We will not analyze the political or cultural facets of those countries, but rather examine the situation from an economic viewpoint. But the reader should be aware that historically Latin American countries have had a highly centralized power structure which carried an extensive bureaucratic frame. Lack of an appropriate infrastructure at all levels was also typical.

2.0 THE ECONOMIC STRUCTURE OF LATIN AMERICAN COUNTRIES

2.1 Raw Material Producers Vs. Manufacturers

During the last century, all countries tended to specialize in either the production of raw materials or in manufacturing. Trading patterns developed in accordance with the theory of comparative costs; products that were cost-effective for one country to produce were exchanged for products produced more economically elsewhere. These trading patterns worked well for the "central" countries which specialized in industrial production as well as for the "peripheral" countries which specialized in raw material production. These patterns continued through the last half of the 19th century.

During the first half of the 20th century, the role of the industrialized capitalist countries in Europe and North America changed. Such countries increased their production and exportation of agricultural products. This change was due mainly to technological developments. An unequal differential demand for industrial products and raw materials contributed to the change (for example, synthetic fiber became increasingly more popular than cotton). This change stimulated the concentration of international trade between the industrialized countries. It began during World War I, accelerated during the 1930's, and culminated when World War II started [Foxley 1974].

This increase in trade among the industrialized countries and the rapid obsolescence of the most dynamic economic sectors of the Latin American countries caused them to become isolated from the flow of world trade. As a result, the Latin American countries were forced to redefine their role in the world economy, which changed the nature of their international economic relationships. Latin American economies were adjusted by stimulating industrialization through "import substitution" (e.g., auto assembly plants). Also, programs were started to increase the size of their internal markets. These adjustments were positive but failed to provide for a transition to a more autonomous development. Raw material production was left as the main source of economic support for these countries [Thompson 1979]. By the 1960's, it had become clear that the model

for internal growth based on industrialization via import substitution was not working.

During the late 1960's, there was a brief period of growth in most of the Latin American countries. The general intensification of international trade was the major contributing factor. But the general economic crisis of 1974-1975 forced the redefinition of the model of accumulation for the world economy. This redefinition required important changes in the international division of labor.

2.2 The Effect Of Capital Internationalism

This redefinition consisted of "expanding the use of 'cheap' labor in dependent and underdeveloped areas to produce a greater range of goods for the international market." [Vuskovic 1980] This expansion was based on the growing internationalization of capital and production, and caused a general shift of the geographic locations of industrial plants that produced for the world market. Since "cheap" labor was the essence of this phenomenon, the underdeveloped economies became the manufacturing sites for industrialized countries. But this occurred only because there were very specific conditions which implied strict dependence on the existence of an abundant and low paid labor force.

This internationalization of capital was not a new phenomenon. It has been shown that the 100 principle economic units of the world are composed of 50 national states and 50 multinational firms [Vuskovic 1980]. What was new was the internationalization of the "production process". This internationalization allowed some branches of the industrialized producers to move to less developed areas; these areas became established as producers of certain manufactured goods exported exclusively to the world market. These areas have been relatively hidden and diffused throughout Latin America, except in Brazil and in the free trade zones (as at the U.S.-Mexico border). This world market oriented production was not limited simply to assembly tasks nor to a few particular branches of industry. It actually encompassed almost all of the 29 branches of the uniform international industrial classification. (The exceptions were beverages and tobacco.)

The main factor responsible for stimulating this internationalization phenomenon was technological development in the following three areas:

- A) ability to "break up" the production process into relatively independent modules,
- B) availability of efficient transportation systems, and
- C) advances in communications, automatic data processing, and control techniques that allowed

for centralized coordination of industrial complexes despite differing plant locations.

The computer has been very much embedded in all three of these areas.

The Latin American countries still find themselves very far from the traditional goal of export diversification. This goal is considered an important path to autonomous development and national economic independence. For better or worse, this process of internationalization has been dramatically increasing the economic subordination of the less developed countries.

We should note at this point that the difference between wage levels in advanced industrial countries and in underdeveloped countries was considerable, as Table I shows [Vuskovic 1980].

Table I

Country	Fraction of Corresponding U.S. Rate
Japan	2.8
Mexico	4.4
Hong Kong	11.8
Taiwan	18.2

Each number is the fraction of the hourly wage paid in the U.S. to the typical worker engaged in the assembly of electronic consumer goods. [Vuskovic 1980]

3.0 THE IMPACT OF COMPUTERS ON EMPLOYMENT

Latin America is a typical developing region; there is a varied panorama of nations at differing levels of economic development. In most of them unemployment and poverty are widespread.

Latin American countries have become interested in buying computer based information systems. They are attracted by the steadily reducing hardware costs, but these countries often forget that the establishment and efficient operation of a computer service entails many other costs relating to equipment and skilled manpower such as maintenance, user training, software testing, and systems upgrading to name a few [Kling & Scacchi 1979]. When the system is purchased by a developing country, this cost prediction is even more difficult because of a significant lack of an infrastructure for systems support, including clean and continuous electricity, acceptably educated managers, operators and users, service availability, and cultural acceptance of information systems technology. The existence of such system "supports" is taken for granted in the exporting country.

The second-hand computer market is also attractive to a buyer in a Latin American country. It has grown because of the continuous obsolescence of large computer mainframes and it has been stimulated even further by IBM's policy of selling only used systems to third world countries. (Not

all countries like IBM's policy: India has decided to discontinue dealing with IBM because of this policy.) The hardware and software for these systems was developed for use in industrialized countries: countries with high consumer incomes, a relative shortage of labor, and a large service sector. None of these factors are as prevalent in Latin America, and therefore the economics of scale in information processing which make computer systems cost-effective have not been exploited to the same extent.

We must recall that most of the industrialized countries are highly rationalized societies with well defined policies and rules that govern, direct, or limit the course of many organizational and individual activities. In the U.S., the internal operations of mature organizations are very carefully considered, partially due to government requirements, but also because of the competitive environment and the high rate of employee turnover. Under such conditions, the development of data processing systems is not only convenient, it is necessary.

Latin American countries in contrast are not as rationalized in their organization due mainly to historical and cultural reasons. For example, in Mexico, the greatest percentage of the population is of Indian heritage, which has caused a diffusion of the objectives of science and technology, whereas in the U.S. the main percentage of the population is of a European heritage that stressed a work

ethnic. Note also that the political forces in Mexico, though apparently stabilizing, have been very turbulent, thus decreasing the institutional structure of society.

The need for data processing in Latin America is not as prevalent as in the U.S. Development in the areas of natural resources, educational standards, health standards, and food production is more important than the development of data processing technology.

3.1 The Cost Of The Computer Vs. The Cost Of Cheap Labor

The foreign exchange used to obtain computer hardware could be spent on capital goods with which industry could create new jobs and increase output. Automatic data processing installations employ a few highly skilled workers. Any one computer system is short lived and utilizes expensive high technology equipment. The average life of a computer system is 6-10 years in the United States (assuming it is not continuously updated). Older systems are harder to maintain because parts and skilled labor became scarce as the manufacturer's resources are redirected toward support for newer computer systems. This means that if an installation is to maintain its effectiveness, a new computer system should be purchased every 6 years. With each purchase, although the price of the hardware may drop, as the software becomes more sophisticated, training costs are likely to increase.

Compare a computer installation to a pulp mill. The number of workers in a pulp mill is higher than in a computer installation and each worker needs much less technical skill. The life expectancy (before obsolescence) of the mill is much longer than that of the computer installation, and its output (paper) is a more tangible product than the computer's output (information). The pulp mill exploits natural resources directly and creates many new jobs; it also increases production in a form much more substantial than the processing of information of dubious value.

A computer installation may significantly reduce the capacity of society to absorb labor as it develops. That is, computers, once installed and working, may displace unskilled workers and create an immediate demand directly and indirectly for more skilled labor.

The increasing use of computers in many sectors of the economy in the U.S. has contributed to the displacement of less skilled workers, but the continuous expansion of the U.S. economy and the effectiveness of its educational system have provided the opportunity for relatively effective job mobility, even for unskilled workers. Often the government or industry will absorb the expense of retraining a worker.

In Latin America where unemployment is very high and job mobility for the unskilled doesn't exist, any displacement caused by the installation of a computer system is likely to be more detrimental to the social and political stability. A person displaced by the installation of a computer system in Latin America very often cannot find another job (because the job simply isn't available). It is our conclusion that although a computer might be used to successfully solve a localized problem, long-term negative social impacts are likely.

3.2 Implications From The Use Of Computers In Business

In this section, we will look at four categories of applications where computers help businesses in industrialized countries, and see how useful each is to a business in a developing country.

3.2.1 Recording And Reporting Tasks -

The recording and reporting tasks consist of simple data-processing and data-generating tasks in which the computer takes over some of the duties of a clerk. If we consider efficiency as being the motive behind such an application, we can analyze (in a manner similar to [Baron 1976]) the following reasoning patterns:

3.2.1.1 The computer generates a faster and more accurate output than the manual process with implied cost savings. Use of a computer frees some personnel to improve other parts of the enterprise. -- This justification often does not work out as expected. It is not known if high level managers in developing countries actually put the time saved by the installation of a computer system to profitable use.

3.2.1.2 Service to the customer is improved. For example, a bank may distribute statements of accounts more promptly or the electric company may send invoices earlier by using a computer. -- If such an improvement does not generate a real benefit to the enterprise or to its customers, the use of the computer may be regarded as "merely a matter of prestige" [Baron 1976]. In Latin America, firms in dominating market positions and monopolistic public utilities may be able to afford such low benefits. But most service industries can not afford to purchase a computer just so invoices can be sent earlier. Compare, for example, a machine-building capital goods industry that is efficient, and the computerized billing system of a government-owned electric company. The former accelerates general economic development by producing capital goods. The latter benefits consumers only marginally (bills may be processed faster), but service will remain poor (noisy lines, frequent blackouts, and poor customer attention are unaffected by the computer). The billing system does not aid society as an

economic agent. This particular use of the computer should be regarded as luxurious in a developing country.

3.2.1.3 Data generation by computer will help management to make decisions. -- The value to management of more comprehensive data is difficult to quantify. If managers have no idea how to use the data, the value of such data is zero. When managerial skills are scarce, as they are in Latin America, investment in such a computer system is risky because the benefit is uncertain, and the cost of learning how to use the system is high.

3.2.2 Management Decision Systems -

Data subsystems in an enterprise may be steadily integrated to create a management information system. Such a system can support a great variety of short-term decision making techniques. Mathematical techniques in this area have been used for optimizing the use of scarce resources. In the Latin American countries, where there is an acute scarcity of capital resources, the optimization of internal asset distribution is the most justifiable application for a computer.

The use of a computer in an enterprise could possibly reduce the clerical labor requirement in certain parts of the firm, and may seem to have positive long-term employment

implications. But local increases in output, sales, employment and profits may be offset by a reduction in global employment potential because the increased efficiency of one firm may gradually give it a dominating market position, perhaps putting others out of business and reducing the over all employment potential. In some product markets, an efficient modern sector with computer-assisted management might take over the position of the less sophisticated industries in provincial towns and rural areas.

3.2.3 Small Businesses And Shops -

Small businesses and shops are the largest economic contributors in all Latin American countries. These businesses are especially important to provincial towns and rural areas.

The recent availability of small, business oriented microcomputer systems would seem to help the small business owner cope with the competition of the larger enterprises. Theoretically, with the help of a microcomputer, he could perform several tasks faster and cheaper, thus reducing costs. This possibility, although attractive, is far from the reach of these entrepreneurs. A certain level of education and skill in systems programming, systems analysis and design, software reliability, and so on are absent in Latin America. This large, interconnected array of skills

is required to understand and use these systems.

Manufacturers of microcomputer based systems for small business applications are already taking advantage of this large potential market, particularly in Mexico and Brazil. Several small companies in these countries have emerged that offer integrated systems. This integration is accomplished by putting together imported software and hardware packages into one unit with little or no in-house development or adaptation (such as changing the English input and output into Spanish). Their naive customers usually believe the cost of the hardware is the total cost of the system and later find out that usually the hardware is only the down payment on the desired system. The impact of these systems on the small business owner is similar to that experienced by a U.S. business owner, but magnified many fold due to the inability of these economies to absorb mistakes.

The availability of canned software (Payroll, Accounts Receivable, Accounts Payable, Inventory, etc.) could reduce the cost, but, again, Latin American business practices would have to be modified to fit the North American model if such a system were to be used. Such a modification can cause serious dislocations in a local society.

For a Latin American small business owner, it is cheaper to buy a software package from the U.S. and adapt the procedures of his firm to the procedures required by the software package than to pay a local consultant to customize

such a package. This is because the demand for DP professionals, at least in Mexico, far exceeds the scarce supply [French 1979a].

3.2.4 Large Scale Operations -

Some computer applications are justified on the grounds that clerical operations would be impossibly large. Banks and government bureaus are typical users of such large-scale applications.

In such cases it is possible to argue that even with the low wage paid for clerical work in developing countries, computerized methods may be cheaper. But this justification is undermined by practical experience. In developing countries, computers are rarely operated efficiently. The learning period is longer and more costly than in the industrialized countries.

There have been cases where a whole team of clerical workers were dedicated to verify the computer output and to be ready to replace the computer system when it failed. The cost of keeping the computer running (electrical generator, air conditioning, operations staff, analysts, service contracts, etc.) is usually more than the cost of the human backup of the system.

To summarize, the impact of new computer technology on employment is much more critical in the Latin American countries than in the U.S. The application and use of expensive computers must be carefully studied and closely watched in order to be sure such use is beneficial. Irrelevant or luxurious applications should be avoided while meaningful and essential applications should be promoted.

4.0 SOCIO-ECONOMIC CHARACTERISTICS IMPACTING THE USE OF COMPUTERS

There are many social, economic and political factors impacting the use of computers in Latin America. Two adverse factors are predominant.

4.1 Low Educational Level

A large fraction of the population in all of Latin America (more than 40 percent in Mexico [Olizar 1976-77]) still lives in rural areas. This is one of the main reasons for the generally low level of education in Latin America. The quality of formal education in rural areas, if even available, is low. The average educational level at the universities also is low. In Mexico, for example, for every 5 million children who entered the first grade, only 2 million were still in school by the end of grade nine. Of that number, only one million graduated from the Mexican equivalent of the U.S. twelfth grade, and only about

250,000 entered college. In college only a few went into the Computer Science (Informatics) discipline and only a handful made it through graduation [French 1979a]. By 1979, there were only about 200 individuals in Mexico with degrees in Informatics from Mexican institutions. There are only a handful of schools in Mexico that provide any formal training in Informatics:

- Universidad Autonoma de Mexico (UNAM)
- Universidad Anahuac (UA)
- Tecnologico de Monterrey (ITESM)
- Universidad la Salle (ULS)
- Instituto Politecnico Nacional (IPN)

Most other Latin American countries do not offer any formal training in Informatics.

The chronic problem of a low educational level is a significant barrier to the expected expansion of data processing installations in Latin America. On the one hand there is not enough skilled data processing manpower to run an installation, and on the other hand there is an insufficient (public) critical mass capable of really benefiting from a computer installation's services.

4.2 Lack Of Job Mobility

The unemployment index in the Latin American countries ranges from about 10% in Venezuela to above 50% in Haiti. The level of subemployment (temporary and seasonal) is even higher. In Mexico, for example, the estimated subemployment level is above 40 percent [Olizar 1976-77].

The deficient and impractical educational system of Latin America contributes to the absence of intermediate, technically oriented schools. Only a few countries, like Brazil, Mexico, Argentina and Venezuela have promoted the creation of technical institutions. Such programs are fairly new and are not yet able to cope with the demand.

Technically oriented institutions are necessary if the less skilled worker is to be given the opportunity to improve his skills. In the U.S., these types of institutions are well established and widespread. An "educated worker" naturally has more job mobility. A worker in the U.S. displaced by the installation of a computer has a relatively better chance to move to another job or upgrade his skills to cope with the change. This ability to move is not available in Latin America. The typical clerical or factory worker in any Latin American country is likely to retain his original job for his entire life. The professional or the highly skilled technician does not have a job mobility problem in the Latin American countries, of course, because the professional enjoys the benefits of a high demand job market.

5.0 THE PRESENT CRITERIA FOR COMPUTER TECHNOLOGY ACQUISITION IN LATIN AMERICA

"... the big danger is that [the Latin American countries] may view progress only in terms of their catching up with what the corresponding U.S. [computer] system looks like at the moment." [Boehm 1970] This quote sums up the current trend in Latin America towards the acquisition of newer, faster, and more powerful computer systems. The decision makers in these countries seem to be more concerned with keeping up with the latest developments in computer technology than with using the technology they already have effectively. This situation, where decisions are made solely on the basis of technical possibilities, is similar to the problem of the "skill bureaucracy" [Danziger 1978].

5.1 Government Agencies

Mexico and Brazil have recently (1975) created government agencies to regulate the importation of computer systems; in Brazil this agency is named the Commission for Coordination of Electronic Data Processing (CAPRE) and in Mexico it is Direccion General de Politica Informatica (DGPI). The main objective of CAPRE is to protect Brazil's five government-owned minicomputer companies [French 1978a], and DGPI is responsible for controlling the imports of computer systems.

In a trend towards the complete nationalization of the minicomputer industry, CAPRE launched a policy that called for a ceiling on imports of computers and peripheral gear. CAPRE required that all applications (government and private) for purchase of a computer system describe the user's master plan for present and future computer use. The plan also had to have defined the need for the equipment being sought in the context of that overall plan. This procedure created much red tape, and resulted in many complaints and frustrations from users [French 1978b].

This nationalization policy is similar to the one established by the Japanese government in the 1950's to protect that country's domestically made computer products. The Brazilian policy is not always clear, but seems to be fairly effective. CAPRE analysts look at each application in terms of the overall policy, and in doing so, find that policy in constant need of clarification. The different ways of clarifying the policy have created seemingly arbitrary changes.

The objective of DGPI in Mexico, in contrast, was more geared to controlling and rationalizing the imports of computer systems. There is no domestic computer industry in Mexico. In previous years computer technology became predominant in the list of imported goods. This trend prompted the creation of DGPI. DGPI application requirements are very similar to those of CAPRE, but involve

less red tape.

DGPI is mainly concerned with large, expensive systems. The agency is very careful in looking for potential under-utilization of the new systems. The emphasis of the analysis is on the quantitative data provided by the applicant relative to the use of the system. There is no analysis done about, or policy with regard to, the potential impacts of these computer systems on employment or on society in general.

An application for a large fully configured minicomputer system will be approved more readily than for a basic (minimum) large mainframe configuration. It is also easier to get approval of an initial minimum mainframe system and then request for its expansion than to receive approval for a full configuration. There is certain amount of arbitrariness in DGPI as in CAPRE. Requests submitted by government agencies get priority over requests submitted by private enterprises (mainly for political reasons).

The analysts of CAPRE as well as those of DGPI are data processing professionals with MS or PhD degrees from foreign universities (mainly in the U.S.), so the evaluations done are mainly focused on the effective utilization of the system. The analysts only certify that the amount of hardware and software requested will not be inappropriate for the proposed application. Analysts from other disciplines (like sociologists, environmentalists,

economists) aren't hired by these agencies, thus inhibiting the establishment of comprehensive criteria.

5.2 Exogenous Planners

Planners, decision makers, and politicians have different dimensions of vision and some of these dimensions are very exclusive or monocular. In cases where these perceptions are at different levels, an additional need for integration is required to grasp the whole view. This integration was (in theory) the function that DGPI and CAPRE were created to perform. Both are a step in the right direction but leave much to be desired.

Planning in Informatics in Latin American countries lacks polyocular or multi-dimensional perception combined with comprehensive integration. Often, because of monocular perception, the criteria used to identify an appropriate computer system (assuming one is required) do not exist. Thus an integrated polyocular criteria for appropriate systems evaluation has yet to develop.

One reason it hasn't developed is because of the influence of a large number of "exogenous planners"s who take on the work as experts from outside. They have their positions solely by virtue of their academic training or professional experience. Agencies run by these outside

experts are watchdogs who determine only if a requested computer system is appropriate, feasible and cost effective for the intended use specified by the applicant. They assume that a computer is required and only check if the requested system is not overspecified for the application. The research that leads to the decision to buy is done by the user; the decision of which system to buy is made by the exogenous planner.

Many decisions in Mexico are made based on exogenous planners' criteria. Frequently, these planners unwittingly do more harm than good. They are hindered by a decision making process with great centralization of power and by inaccurate data. Large quantities of macrodata are available with very little disaggregation, since large infrastructural facilities for collecting the socio-economic data are not well organized. Even the collected and extracted data is exogenously derived and lacks detail.

6.0 CONCLUSIONS

It is no major discovery to say that the Latin American economies differ from the U.S. economy. When a U.S. company buys the wrong computer, there is negligible long-term impact on the whole economy. However, in a developing country, the purchase of an inappropriate computer can tie up a lot of capital and time that would have been used in other capital investments. In an

environment where unemployment is rampant, and job mobility barely exists, the opportunities for an unskilled worker to remove himself from the negative effects of such a major executive decision are few.

While the creation of agencies to guide the use and acquisition of computer systems is a good idea, particularly in a society that doesn't have the "critical mass" of knowledgeable people needed to generate an informed environment, these agencies must be very careful about the plans and policies they create. Careful attention should be paid to the difference between the cultural characteristics that these experts were trained in (usually a United States' university) and the culture of the particular country they hope to be helping. It is important to look at the problems facing a developing country in terms of the conditions of that country, and not in terms of conditions in the United States.

The differing emphasis in the economy on manual labor means that some jobs should not be done with machines yet, even though those jobs can and are being done by machines in the United States. In Latin America, cost of manual labor is often cheaper than the cost of a computer system, and also more reliable. Using human systems to backup computer systems also suggests that the computer is not necessary since it may be replaced by a human system at some cost savings. The familiarity that the Latin American manager

would have with the human system along with the fact that the human system was a local invention, and not something brought in from the outside, would also seem to recommend the human system. Here in the U.S.A, it is not always clear that anything that can be computerized should be computerized; this is doubly so in the Latin American countries.

We have shown that extreme care must be used by all the parties involved in a computer sale that involves the transfer of technology in addition to the simple transfer of equipment. Imported technology that is not understood by the buyer could give rise to major dislocations for the importer. The exporter also has more to gain in the long run by a successful infusion of the technology into the new environment. "Dumping" inappropriate technology on his neighbors by the exporter lessens his chances in the future for sales and growth, and increases the chance that foreign governments will find it necessary to interfere with his business. The fact that India no longer does business with IBM illustrates this finding.

It is often said, "Let the buyer beware", and this no doubt applies to the purchaser of a computer system, but it is hard to justify exploitation, and the marketing of improper systems to ignorant buyers is exploitation. So, while it is clear that the purchasers of computer systems in developing countries should be careful when buying a

computer system, we feel that much of the responsibility for insuring that the appropriate system is purchased lies with the company supplying the product. A large company in the U.S.A. has far more knowledge and experience with its own equipment than a developing country's Data Processing personnel (who may or may not be "expert") are likely to have in the foreseeable future.

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