PERSONAL COMPUTERS AND MANAGEMENT TECHNOLOGY TRANSFER: THE PORTUGUESE EXPERIENCE

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ABSTRACT

Clearly, an important step for developing countries is an upgrading of their management skills. But how can these skills be imported and further disseminated in the local economy? The potential for microcomputers as one vehicle is discussed in the context of a pilot Masters of Business Administration program in Portugal.

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A. SITUATION

In 1981, a pilot Masters of Business Administration (MBA) program was begun in the New University of Lisbon with financial assistance from the US Agency of International Development and with the guidance and coordination of the Wharton School of the University of Pennsylvania. In the initial years, the program includes a mixture of Portuguese and foreign (mainly American) faculty. During the first two years of this project, the author has participated was a visiting faculty member teaching an introductory course on "management and decision making," but with the additional responsibilities of directing the development of a computer laboratory for the school. This article summarizes some of the key observations from this experience and attempts some generalizations towards the problem of technology transfer to technologically less developed countries.

B. CULTURAL CONTEXT

In 1974, a military reaction to the long drawn out colonial wars picked up immediate popular support and in a matter of days, with almost no bloodshed, a forty year fascist regime was ended. However, as the original intent was merely to end the colonial wars, the further political direction of the country was not planned. Thus, while there is considerable enthusiasm, the country's direction is also characterized by uncertainty and vacillation, having had fourteen different governments in the last nine years.

On the other hand, while suffering political instability and enormous economic shocks from the loss of its colonies, the cultural character of the country is one of refinement and dignity. A classical education is highly regarded, especially in the areas of history, languages, music and poetry. Thus throughout the restrictive fascist years, the universities developed a strong traditional orientation. For instance, at the University of Coimbra, (one of the oldest in Europe), students were required to wear long black capes to classes. Chaired professors in each department more or less decided what would be the admissible ideas in each subject area.

While this orientation is perhaps useful in the arts in maintaining the Portuguese cultural traditions, it is especially harmful in such areas as economics and technology where the country must remain in step with the rest of the world.

Rather than attempt to revise the existing university structures, the strategy taken was to begin new university, the so-called "New University of Lisbon," with a more contemporary orientation.* The MBA program, with which this case is concerned, was begun as a new department of management within the faculty of economics of this new university.

A precipatating factor for the initialization of this program was Portugal's announcement of its intent to join the Common Market. It was felt that, after nearly half a century of protective isolationism, the general level of Portuguese management skills would need considerable upgrading to cope with these new circumstances.

The principal point of these background observations is to indicate the general climate in which this program was begun: one of relative newness, inexperience, enthusiasm and great expectations.

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* A word of qualification: there were also certain political factors involved with these developments, and not everyone would agree with this characterization.

C. TECHNOLOGY TRANSFER OBJECTIVES

Thus the role of the American faculty in this project was not only to substitute where Portugal itself lacked appropriately trained faculty, but also a more general one of importing new management technologies and techniques. This latter aspect focuses not only on the MBA school itself, but how these concepts are in turn to be transferred into Portuguese industry. There are several vehicles available for this transfer:

1. education of MBA students — who presumably would join Portuguese companies and convey what they learned.
2. executive courses — a series of executive seminars was begun to give higher level managers some direct contact with these concepts. A secondary objective here was to cultivate awareness of the training received by the MBA students and thus prepare a receptive market for them on graduation.
3. textual materials — in developing the school's library, consisting of books and reprint materials (albeit somewhat slowly due to the high cost and time delays of importing these materials). This library is intended to serve as a resource not only for the students of the school, but for the business community at large.

These might be considered the traditional vehicles of technology transfer in a project of this type. One other is slightly less traditional:

4. computer programs — computer programs embody the technical, mathematical aspects of the techniques taught in the classroom.

The MBA's training focuses not in the techniques themselves, but in their application and use. However, if the supporting computer facilities are available only in the MBA school, the techniques learned will have little impact on the business community. The perspective in the development of our computer laboratory was therefore not simply as a classroom tool, but as an additional vehicle for technology transfer into Portuguese industry.

D. FRAMEWORK FOR INFORMATION TECHNOLOGY AND MANAGEMENT

The role of the computer in the MBA program has importance as a vehicle for representing quantitative techniques, but also as a subject in itself. The organizing perspective taken for the roles of information technology in management was based on the familiar classification by Anthony (1965) of management activity (see Figure 1).

At the top level is 'strategic planning.' This is the activity of the highest level of management, concerned with long term planning. It tends to be external in orientation, concerned with the position of the firm in the marketplace, the activities of competitors, government regulation, overall economic factors, etc.

Following this are two types of control activities. The level of 'operational' control is concerned with the day to day operations: production, sales, operating collections and payments, etc. The concerns here tend to be largely short-term and task oriented. By contrast, the middle level

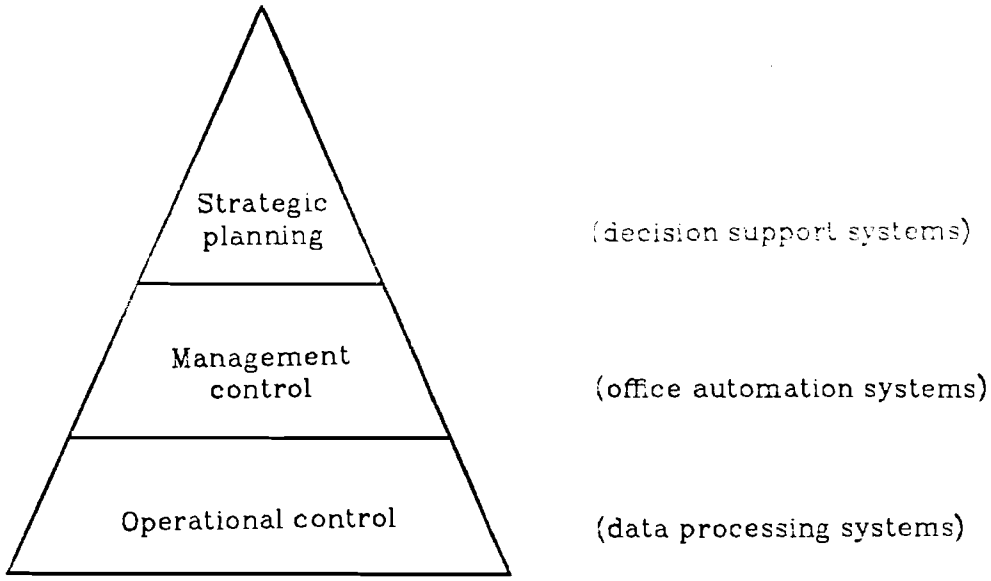

Figure 1. Anthony classification of management activities and associated information technologies.

of 'management control' is people oriented, concerned mainly with coordination: implementing strategic plans and handling the exceptions arising at the operational level.

The perspective of information technology introduced in the MBA program corresponds roughly to these three levels:

1. data processing systems (DPS) — correspond mainly to the use of information technology at the operational level. The processing involves high volumes of routine transaction data used for relative well-structured management activities; e.g., production scheduling, inventory control, detail level sales analysis monitor receivables, etc. The functions of these systems are well-specified, and the system development problems are largely engineering oriented, concerned with cost, speed, reliability, etc.
2. decision support systems (DSS) — are more oriented to the ill-structured types of problems involved with strategic planning. These involve novel, ad-hoc types of solutions, for situations that are constantly changing. Unlike data processing systems which record facts, decision support systems are used to explore the future. They are used to ask "what if" questions using various models under varying assumptions. Flexibility and adaptability are key aspects. On the other hand, the data involved is

generally in a condensed, summary form, so that many of the technical problems associated with high volumes of transactions are avoided. The problems of system development here are thus less technical and more in the definition of the system's purpose, which evolves and changes with each decision.

3. Office Automation — this level may roughly associated with the management control activities of the firm, focusing on effective *communications support*. The objectives of the technology are to help the manager maintain close communications with relevant parties within and outside the organization, but yet to allow him to concentrate attention on matters of priority without distracting interruptions on less important subjects. The computer related topics here are word and text processing, to facilitate the preparation of written correspondence and reports, and electronic communications, such as electronic mail and teleconferencing, eventually converging with new developments in the communications technologies.

Regarding the exposure of the MBA students to each of these subject areas it was felt:

a) data processing systems — an MBA should know how to specify the functions to be performed by such a system, but that the design and programming involved are more the domain of a specially trained analyst.

b) decision support systems — here is where an MBA might play a critical role since the important aspects involve careful understanding of the managerial decision problem, whereas sophisticated computer training is typically less important.

c) office automation systems — students should become acquainted with the possibilities of these evolving technologies, though certain aspects of the development of such systems may be outside their competence.

In summary, our pedagogic objective were to give these students a rather passive exposure to data processing systems; an active, development-oriented familiarity with decision support systems, and exposure, as far as possible to office automation related areas.

E. COMPUTING ALTERNATIVES IN PORTUGAL

With these teaching objectives in mind, the computing alternatives available to the MBA school were considered.

The financial resources included a modest sized grant from a Portuguese bank plus additional funds from the university. In total these amounted to about $40,000.

Certain additional constraints were also involved.

First, the design of the MBA program was condensed into a single calendar year of three semesters. This did not allow for a separate introductory course in computing. Thus, exposure to computing had to come as part of other courses, viz. mathematics, statistics, management, finance. This implied that the computer laboratory had to be, as far as possible, easy to learn and use and, indeed, self-teaching.

Secondly, the school's budget did not allow for a permanent staff to maintain the computer laboratory. In any case, there was a shortage of skilled people available for this purpose. This implied, correspondingly, that the computer laboratory had to be effectively self-maintaining.

Thirdly, as a pilot project, the MBA school was in a position of high visibility in Portugal. Consequently the expectations for the computer laboratory were for quick and apparent results. Since I was the principal motivator for the computer development, and my participation was only during the winter semesters in each of two years, this reduced the effective development time available to about six months.

At the outset of the project, several Portuguese organizations offered us help with computing resources.

IBM-Portugal made an offer of free computing time on their large in-house machine, but as they had no time sharing access, the students would have had to travel to the IBM building to run programs. This was therefore rejected.

The economics department was currently installing a remote batch station to a government owned Univac installation. However, the is was encountering certain technical difficulties, and the orientation of the development was mainly to large scale econometric analyses, two factors which made us hesitate on this alternative.

Some limited timesharing resources were also available, but these were in the main already heavily loaded and difficult to access. For instance, the National Laboratory of Civil Engineering had a DEC-10, but external access was only permitted at night, after 7:00 p.m.

Hence our "choice" of microcomputer technology as the basis for our laboratory was hardly a choice at all. It was the only reasonable alternative.

On the other hand, I had considerable experience using microcomputers in the United States as components in text processing applications (see Lee 1980), and was favorable favorably disposed towards them. Likewise, the head of the MBA school, Mr. Carlos Barral, had formerly been vice president of Shell Oil Portugal where they had been developing decision support types of applications using microcomputers with considerable success.

Thus, we likewise were not driven to this alternative but rather were quite receptive to it.

This initiated a survey of the available supply market in Portugal.

The microcomputer industry is mainly US based, and much of its initial growth in the U.S. was due to purchases for home entertainment and hobbyists. In Europe, where disposable income is lower, this hobbyist market has not developed and consequently, along with distribution lags

from the US, the distribution and marketing of micros is perhaps three to five years behind that of the US.

Portugal, as one of the poorest countries in Europe, might be expected to be considerably behind the average in this regard, but it is actually probably about in line with the average. The reason behind this is one of the themes of this study: in a poor, developing country, where industry is small scale and institutional budgets are tight, small scale computers are in many cases the only alternative. For instance in the computing departments of both the New and the Classical Universities of Lisbon, microcomputers constitute a major computing resource.

The range of machines available was, nonetheless, nowhere near the scope available in the US.

Aside from price, our other choice criteria were the general reputation of the machine, the availability of software, the reliability of the vendor and the availability of service and spare parts.

My preference would have been a machine supporting the CP/M ("control program/micro") operating system, an emerging standard for this industry. At the time (1981) the only machine of this type represented in Portugal was Heathkit, and they did not have sufficient stock on hand for our needs. Since vendors have to observe complicated import regulations and quotas, shipments can take from two to four months, with up to half of the is time spent in customs.

As this was outside our available time frame, our decision considering the other factors led us to buy Apple II machines.

F. COMPUTER LABORATORY DESIGN AND DEVELOPMENT

Recall that my involvement in this program was for the winter semesters of 1981 and 1982.

In 1981 we purchased three Apple II machines, an inexpensive matrix printer and a letter quality Qume printer.* In 1982, two additional Apple II machines were purchased and, at the end of that period, a color television for graphics displays.

Having committed to a certain type of hardware, the following issue is one of software acquisition and development.

One of the criteria favoring the purchase of the Apple II's was the overall popularity of the machine and the range of software available for it.

Exploring more closely, however, I found that much less of this software was usable for our purposes than I had thought.

A key disappointment was the famous program "VISICALC," which is easy to learn and extremely useful for MBA students in producing proforma financial statements and other types of "spread sheet" analyses. However, as has become frequent practice in this industry, the program

* In addition, a Heathkit machine and an Ohio Scientific were purchased for secretarial word processing and administrative applications of the school, respectively. These uses are however rather outside the focus of this case.

diskettes are "copy protected." This is a particular coding scheme which prevents the duplication of these diskettes. The purpose, of course, is to protect the software producer from black market duplication of the product. In the event the diskette becomes damaged, the producer normally offers to supply a replacement diskette for a minor fee in exchange for the damaged diskette. In Portugal, however, sending away to California for a new diskette takes a *minimum* of six weeks and often longer. Thus, reliance on copy protected software for student assignments becomes risky since one person's accidental mis-handling of a diskette halts everyone's work.

As a general policy, therefore, we avoided the use of copy protected software.

The range of other software available, while voluminous, was also rather disappointing. As mentioned, a large part of the early development of this industry was oriented towards hobbyists and home entertainment. Computer games continue to dominate the software catalogs. So-called "business software" is oriented oriented towards small scale versions of accounting packages, inventory management, sales order processing, etc. These tend to be over-simplified from what is needed in actual business operation, and further, because of the volume of data involved, tend to quickly exceed the capacity of the diskette technology of these systems. More importantly for us, however, are that these are applications of the data processing type, i.e., on management practice; hence of only indirect interest to management education.

As indicated above, our primary interest was in software for managerial decision support, which would reinforce the analytical techniques taught in the classroom, and prove useful to Portuguese industry itself.

Of the commercially available products, we were able to make use of:

- Applewriter — an elementary, but adequate word processing package
- Appleplot — a plotting package with attractive graphics, but rather limited range
- various utility programs for copying diskettes, etc.

In the second year, we obtained an outdated release of the VISICALC program that, while it had fewer features, was not copy protected, and so could be used in our program library.

Also, we purchased a statistical package, written in BASIC, that initially seemed to have an adequate range of programs. However, it used a rather clumsy system of data entry and was found to be rather over simplified in a number of the analyses (especially linear regression, multiple regression, ANOVA), but nonetheless served useful as a starting point.

In addition, we managed to obtain BASIC source listings from the program library of the Portuguese governments department of statistics. Some of these proved useful as starting points for modifications, but most were inappropriate to our needs, either having insufficient analytical detail or flexibility, or otherwise tailored to specialized problems of the government's statistical gathering that did not apply to us.

Thus it became evident that the main part of our program library development would have to be done through in-house program development. A list of locally developed software at the time of this writing is shown in Exhibit F.

This of course is not a new story, nor is it limited to applications with microcomputers. It is a central aspect of what is sometimes called the "software crisis" that each company or institution has certain special requirements that inhibit the use of commercial packaged software. The problem however appears to be more acute at the microcomputer level since the industry is still very young, and the range of commercial software is correspondingly more limited and less mature.

While in-house program development was certainly much more costly in terms of development time than acquiring commercial packages, there were certain advantages.

Since we were more or less forced to start from scratch, the development could be guided along certain standards. In particular, a standard data file format was developed. Programs were written to create, edit, sort, print, etc. data files that followed this format. All analysis programs that use more than a very small amount of data were required to include the option of data entry via a data file of this format.

This greatly simplified the students learning to use the program library since most programs used this common form of data entry. Also, data files could be developed for use in a variety of analyses.

Another interesting aspect was the language used in the program interactions: English vs Portuguese. The MBA students are required to speak English to enter the program. While I speak adequate Portuguese, the programs I wrote all interacted with the user in English. I did this since it was easier for me and also made these programs accessible to the other visiting faculty who mainly only spoke English. I also considered that other countries (e.g., Greece, Bulgaria) may have a situation similar to the one in Portugal and some software exchange arrangements might be started, which would typically require English as a standard language.

On the other hand, the others writing programs, being Portuguese, found it easier to write programs that interacted in Portuguese.

While from a programming standpoint this merely involves the substitution of one set of character strings for another, from the user standpoint, the difference is substantial. Even for our students, who spoke excellent English, there was a certain emotional impact of programs that communicated in their mother tongue.

While our programs presently are written using one language or the other, it now seems clear to me that for international applications such as these, a programming standard should be imposed so that as an option the programs can interact in a standard language (English) and the local language (in this case Portuguese). This could be a key point for international cooperative efforts at software development. Programs could be written so that adaptation to a different local language (e.g., Spanish, Hungarian) would simply involve the replacement of the local language character strings. This of course ignores the problem of special characters, e.g., umlaut, cedilla, tilda, accents, and special scripts such as

Greek and Cyrillic. More will be said on this subsequently.

Another advantage of local, in-house development in this case is that the persons developing the program become intimately acquainted with its structure, and consequently are more likely to attempt modifications and improvements.

More importantly, perhaps, is the personal attachment that develops for the work, and the desire to see it used effectively. This occurred for instance with the statistics professor, Dr. Neves Adelino. A Portuguese, trained in the US, he joined the school in its second year (1982). He first made certain improvements and modifications to the linear regression program I wrote and then continued to write a very comprehensive multiple regression program (with interactions in Portuguese). These programs then became central teaching devices in his statistics courses, used on a number of different student assignments.

There is one final advantage of this local software development. As mentioned earlier, one of the objectives here was not only the development of computer resources for the school, but also to have these programs serve as a vehicle for communicating the technology and techniques into Portuguese industry. Since these are proprietary to the school, copies can be given to local industry without violation of copyrights. Furthermore it becomes clear that this is a specific contribution of the school to Portuguese industry, that would not otherwise be available.

None of the program diskettes in the school are copy protected. We make no effort to prevent students from making their own private copies; indeed we encourage it.

For the Portuguese situation this presents another important advantage of microcomputers. For students to fully benefit from their MBA training, it is important that they have access to computer resources in their subsequent jobs. Few Portuguese companies can afford a large computer, though a microcomputer would often be within their budget. An MBA who was convincing in this request could show immediate results by transferring copies of programs from the school's library; programs which he has already been trained to use and apply.

Exhibit F: Locally Developed Programs

A. Data Analysis Utilities
   - Create and Edit Data File
   - Sort Data File

B. Financial/Mathematical Programs
   - Investment Analysis
   - Function Plot
   - Matrix Operations
   - Gauss Jordan
   - Linear Programming
   - Queuing Simulation
   - Pert Analysis

C. Statistical Programs
   - Generate Random Variates
   - Lead and Lag Variables
   - Transform Variables
   - Descriptive Statistics
   - Histogram
   - Crosstabs
   - Linear Regression
   - Multiple Regression

G. COMPUTER LABORATORY USAGE

As mentioned earlier, we ended up buying the Apple II machine with a certain reluctance. Had the opportunity been available, a machine using the CP/M operating system would have been preferred since software is compatible across a wider number of microcomputer brands.

On the other hand, the Apple II, had one advantage we did not recognize at first which proved appropriate for these circumstances. Along with the TRS-80, the Commodore PET and the Exidy Sorceror, this machine was designed originally for a home hobbyist market. The design of the machine and its operation reflect this. First it is reasonably durable. These machines have had heavy usage and have been moved around frequently for demonstrations, etc. but have had comparatively little repair difficulties. The overall down time has been substantially lower than various university time sharing systems with which the author has had experience.

A more important factor, however, is that the marketing approach of these machines had to orient itself to an inexperienced user. While the machine is less flexible than those using CP/M, it is also considerably easier to learn to use. It is likewise much easier to learn than the average time sharing system.

For us, this turned out to be an important factor. By the second year we had developed a sizable user's manual of our program library (Lee 1982a), and students are now able to explore most facets of the available programs on their own, with very little instruction or assistance.

The standard programming language on nearly all microcomputers is BASIC, a language which was designed to be simple to learn and use. We find this appropriate for an MBA environment. These people are not expected to become professional programmers. Their purpose in learning a computer language is mainly to be able to code "quick and dirty" solutions to ad hoc problems.

Instruction in BASIC was not part of the required program, but was offered as a series of optional tutorial sessions. About half of the forty students attended. The fundamental concepts of program logic, including access to (sequential) data files was covered in five lectures. It should be mentioned however that these students were already familiar with using various library programs so that these tutorials did not need to include initial orientation to the machines.

A typical problem for educational computer facilities is the management of disk space. Students (and faculty) have a tendency to leave outdated files on the disk and space inevitably becomes scarce. Microcomputers using diskettes provide an automatic solution to this problem. While diskettes containing library programs are supplied by the school, students were required to buy their own diskettes for data storage and their private program development. Since the disk space is their own, they manage it efficiently or inefficiently according to their pocket book. In any case it becomes their individual concern and not the school's.

On the other side, the school's program library is also stored on diskettes which are kept in boxes in the computer room. As the program library has grown, and the number of machines increases, this has led to a proliferation of system diskettes that is becoming difficult to manage. A next step, currently underway, is to invest in a Winchester-type hard disk to which all the machines would be linked which provides a centralized access to the system programs.

H. FUTURE DIRECTIONS

The message of decision support systems, and the potential for microcomputers for these types of applications is, we feel, being communicated effectively to these students.*

However, referring back to the taxonomy of computer applications in organizations introduced earlier, the other two areas of data processing and office automation still need to be further developed.

As mentioned, we do not feel that MBA students should need to get involved with the engineering aspects typically involved in building data processing systems. On the other hand, they should have exposure to such systems and to the types of reports one can expect from them. There are several routes to conveying this. One, currently being done in a limited fashion, is to give some brief classroom exposure to the techniques of system flowcharting and perhaps data structure diagrams. This however seems quite abstract and remote to students who have not had exposure to these systems. (This by the way is one area where cultural context impacts on the classroom. Americans have much more contact with data processing in the form of paychecks, personal forms, bank statements, etc.)

To present a concrete example of data processing, as well as for its own economic reasons, the school would like to automate its student records and accounting systems. However, because such systems make heavy disk demands, its doubtful whether even a small scale application would be practical using microcomputers.

The more serious difficulty is that data processing applications tend to be more complex from the software engineering standpoint than the analytical applications so far developed, and the school lacks the resident talent.

One other possibility is to introduce a model data processing system in the form of a business game. Such games are used quite effectively in a number of MBA programs, including Wharton's. In Portugal, this has begun in the form of a privately sponsored participation in a French based game called Management '82 in which some of our students participated. Teams in Portugal, Spain, France and even in South America compete with each other through international data networks. The results of each round are conveyed through stereotypical data processing reports.

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* The concept of DSS was likewise conveyed to the business community through a series of executive courses and publications, Lee (1982b and 1982c).

The mention of data networks leads to what I think is the most crucial area of future development for management education in Portugal about information technology: office automation, and managerial communications support.

As regards word processing, Portugal shares a problem with most other non-English speaking countries: their their language contains special character markings not contained in English: tilda, cedilla, circumflex, forward accent and backward accent. So far, most word processing manufacturers, mainly American, have not given serious attention to this problem. Larger countries, like Germany and France, have developed their own word processing equipment for German and French. However, the smaller countries do not have their own domestic industry and depend on foreign products.

The problem has two parts: the text image on the CRT screen, and the form of the text on paper. The latter is the more important since that is the final copy. In response to this, Qume and Diablo printers have inter-changeable Daisy-wheels specialized with these markings.

However the problem is still not solved, for the text formatting software itself is not general enough. One of the most attractive aspects of text done on word processing machines is that it not only has straight left margins, but straight right margins as well. This is done in software by counting how many characters to the line being printed and interspacing extra blanks within the line. However the special characters in Portuguese are over-print characters. That is, the printer must backspace before it prints them. This has not been allowed for in most word processing formatters, at least not those available on micros. Hence, even if the backspacing can be done, the formatter gets the character counts confused and leaves a ragged right margin. Similar problems occur for centering lines, footnotes, and other contexts.

Analogous problems are to be found in Spanish, Czeck, Hungarian, Rumanian, etc. In each case the country is too small to have its own microcomputer industry which adapts the technology to its special needs.

In addition to these typographic difficulties, Portugal has one other oddity which has hindered the entrance of word processing. As many know, the typewriter keyboard common in Europe is not exactly like that in the US. These keyboards are typically identified by the upper left six characters. In the US these are QWERTY while in Europe, they are AZERTY. The difference is only minor: two pairs of characters are interchanged.

For some bizarre, nationalistic reason, Salazar in 1937 introduced a completely different keyboard in Portugal. Its upper left characters are: HCESAR. In comparison to the American QWERTY keyboard only two keys are in the same position. This has not only been a barrier for the entrance or word processing Portugal, but also for foreign made electric typewriters, book keeping machines, etc.

Thus, since the 1974 revolution, there has been a concerted effort to convert the secretarial population to the better known standards. Probably almost half of all Portuguese typists are now competent on either the QWERTY or AZERTY systems. Ironically, this conversion is taking

place just at the time when computer-based office equipment is reaching the stage where keyboard organizations can be put under software control, and changed to the convenience of the user.

The impact of word processing in Portugal, as elsewhere, would be mainly in improved office efficiency. Related technologies with more potential impact at managerial levels are electronic mail and other forms of computer aided communication. It is a common observation that transportation and communication can trade off economically; e.g., the concept of telework where (information related) work is communicated to the home rather than the person commuting to the work place. For a capital poor country like Portugal, this could become very important: transportation systems are expensive and costs are rising; on the other hand, communication systems are less expensive and getting cheaper.

Portugal is said to have the worst road system in Europe. They have less than 60 Km of freeway, total. There is no railway line connecting north and south. (This is a country about the size of New York State).

The telecommunications system is likewise poorly developed, though it has recently come under aggressive leadership. Nonetheless, for lack of cables, it still takes over year, sometimes two, to get a new telephone. Also, the phone exchanges are often overloaded and unreliable. Perhaps because of this, the telex system is widely used for business communication so that these people are already pre-conditioned for something like store-and-forward electronic mail.

Beyond the economies of transportation vs communication, this technology was the potential to relieve one of Portugal's most crippling diseases: an exceedingly baroque bureaucracy. Many government offices have not even recognized the utility of pre-printed forms. Passports, licenses, government registrations of various kinds all require the applicant to submit a piece of "papel selado." This is a blue sheet of paper with a government stamp that sells for about 50 cents per sheet. On this, the applicant must write, long hand, a formal letter of petition (following one of several dozen model texts posted on the wall) in ornate Portuguese prose requesting the item in question.

Along with this, the country is very "macro cephalic" —i.e., nearly all of its government authority and most of its corporate authority is located in Lisbon, the capital. In addition, nationalizations after the revolution have left some 40% of domestic industry under government control, though in most cases these continue to be run as independent companies. Nonetheless, the present structure of the country requires fast and efficient communication channels to run effectively, and this is something it does not have.

On the other hand, there is a brighter side to all this —the possibility of what is sometimes called 'technological leap.' The general idea is that one country does not have to follow all the evolutionary phases in a technology's development but can sometimes enter at a later stage and thereby avoid the costs of earlier phases. Ernst (1981) suggests something to this effect for microelectronics in developing countries. Alvin Toffler's (1980) new book *The Third Wave* has a chapter entitled "Ghandi with Satellites" that suggests the is situation with respect to communications in developing countries. For instance, rather than the very

expensive and time consuming task of laying cable networks, such countries might 'leap' directly into satellite communications. Other technological opportunities are suggested by Sebstyen (1981), Sugiyama (1982), Maurer and Sebestyen (1982).

However, the limiting factor in these predictions seems to be the adaptability of the countries educational base. Interestingly, foreign aid offices maintain what they call an 'absorption index': countries vary on the rate which they can effectively employ outside aid money. The problem returns to the educational system and, in this case, the education of managers is likely to be an important factor.

I. CONCLUDING REMARKS

A fundamental problem in developing contries is the local development of technical knowledge. Microcomputers, by their low-cost and easy learnability, are provide a convenient means for these countries to learn the basics of computer technology (sometimes called "computer literacy").

The point here was that more than an object of technology transfer, microcomputers also provide a *medium*, in the form of programs, for the transfer of analytic techniques and methods.

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