Demand for and applications of extra large EDP systems in the EEC Countries and the United Kingdom in the seventies

Vol. 1 - General Report

soris - torino

The survey was conducted for the **"Commission des Communautés Européennes (Direction Générale des Affaires Industrielles)"**.

The survey was conducted by a research group from **SORIS**, consisting of: Andrea Barabino, Serena Girardi, Donata Leonesi, Guido Musso, Iacopo Muzio, Piero Taverna.

Collaborated have:

Enrico Albani, Giustino Gasbarri, Alfredo Mantica, Massimo Merlino, from **Praxis Calcolo**

Antonio di Leva, Graziella Pent, Maria Teresa Reinieri, from the University of Torino

Rinaldo Sanna from the University of Genova

The interviews with users and experts have been conducted by:

SORIS	in Italy and the United Kingdom
SOBEMAP of Brussels	in Belgium
SEMA of Paris	in France
Deutsche Revisions-und Treuhand A. G. Treuarbeit of Frankfurt	in Germany
Rijkskantoormachine-centrale of 'S Gravenhage	in Holland

June 1970 / n. 6835

SORIS s.p.a.
Economic Studies and Market Research
11, via Santa Teresa Turin tel. 539865/66

Demand for and applications of extra large EDP systems in the EEC Countries and the United Kingdom in the seventies

Vol. 1 - General Report

CONTENTS

page

INTRODUCTION

1. Preface 1
2. Research Design 2
3. The Research Field 3
4. Limitations 5

METHODOLOGY

1. General remarks 7
2. Direct Survey 9
3. Desk research 12
4. Methods of analysis 16
5. Forecasting Methods 23
   5.1. General remarks 23
   5.2. Forecast for the Industries 25
   5.3. Forecast of the total computer installations' development 32
6. Panel Discussion 33

SUMMARY

Introduction 35
2. Supply of hardware and software 36
3. Development of computer installations ... 43
4. New applications per industry 49
5. Final remarks 59

2. Contents) page

BIBLIOGRAPHY

1. Books & Reports 63
2. Reviews 69

Introduction

1. Preface

The Industrial Affairs Commission of the ECC has charged SORIS with the task of conducting "a technical economic survey" about the application of EDP systems based on analysis of the present computer market, technical development trends of production and theoretical development trends of the applications". During the course of this survey SORIS has asked the help of the following companies:

- SEMA
- SOBEMAP
- Deutsche Revision und-Treuhand A.G. Treuarbeit
- Rijkskantoormachinecentrale.

The foreign companies have been charged with the direct survey, whereas SORIS has organized the entire research, has coordinated the activities of the various companies and has done the writing.

The various companies have collaborated in the research to different extents. SORIS wants to thank especially those companies which have, in addition to the direct survey, furnished exhaustive information and documentation which were very essential to this survey.

SORIS expresses its gratitude also to all those who have contributed in the difficult task of finding analytic documentation, and to those who, with their advice, have made it possible to correct inevitable imprecisions.

2. Research Design

The survey consists of 5 volumes:

1. General report
   - Introduction
   - Methodology
   - Summary
   - Bibliography

2. Supply of Electronic Data Processing Systems
   1. Hardware and software supply
   2. Hardware
   3. Software

3. Development trends of the computer installations in the EEC countries and the United Kingdom
   4. Trend of installations in the EEC Countries and the United Kingdom (1962-1969)
   5. Forecasts for the seventies.

4. Current and future applications of extra-large EDP systems by industries
   6. Manufacturing
   7. Retail stores
   8. Banks and insurance companies
   9. Public utilities
   10. Universities and service bureaus

5. Future demand for extra-large EDP systems in Public Administration

6. Annexes
   - Experts interviewed
   - Users interviewed

3. The Research Field

a) High performance EDP systems

According to the definition established in the contract, the term "electronic processing system with high processing and storing capacity" has to be understood as a system which has at least one computer of the capacity of an IBM 360/65.

This definition has been narrowed down further in the course of the survey by adding to the high capacity processing system a large core storage with a capacity above 512 K words and a minimum purchase price of $ 5 million.

b) Forecast period

The forecast period has been extended until 1980 and requires therefore an approximation degree of the survey's results which grows with the extension of the period considered. Consequently, the quantitative forecasts on demand during the period 1970-1975 are more exact than those for the subsequent five years.

c) Geographical extent of the survey

The survey included the following countries:

- Belgium
- France
- Germany
- Holland
- Italy
- United Kingdom

The United States have been used, wherever it was possible, as a comparison.

d) Sectors of utilization

The possible high performance EDP system applications are numerous and heterogeneous. Hence there arises the need for a detailed examination per sector of utilization, because within each sector it is possible to recognize a certain uniformity of the applications.
The sectors considered are:

1. Manufacturing
2. Retail stores
3. Banks and insurance companies
4. Public utilities
5. Universities and service bureaus
6. Public Administration

This list of sectors is not as complete as that used in current statistical surveys. It does, however, include all those sectors which, because of the sizes of the actual installations and the presence of the largest users, are the most interesting ones from the viewpoint of diffusion of systems with a high capacity of data processing and storing.

4. Limitations

Formulation of long-range forecasts in a field such as EDP, which is undergoing rapid technological changes from the standpoint of hardware, software and applications encounters many methodological difficulties.

In fact, these long-range forecasts have to be based on a number of hypotheses (which we have tried to explain as much as possible) about those political and institutional conditions from which substantial stability can be assumed. Of course, these assumptions are less valid the longer the forecasting period becomes, even if they correspond to information which has emerged from studies on the future conducted in the principal European countries.

In addition, the forecasts are based on "rational expectations" about the development of automatic information processing by current big users of systems in the various industries and by experts currently studying or experimenting with applications.

The "rational expectations" of the users and experts interviewed do not take into account the activity of influencing demands which is a task performed by the manufacturers and which has, until now, always been decisive in the application field.

The lack of collaboration in the survey by the principal manufacturers has not permitted a verification of the influence of this variable. Also the formulation of hypotheses about technological developments of hardware and software have been made more difficult because of this.

Considerable difficulties have also been encountered during the gathering of statistical documentation, due to the

discrepancies in the data reported by the various sources and their lack of uniformity in methods and times of survey (and analysis of data). However, it must not be presumed that there exists no adequate bibliography in this sector; it does exist and is sufficiently complete, even if technical-applicational aspects prevail over statistical ones.

Through direct survey and collaboration by other companies it has been possible to make up only in part for the lack of existing documentation.
In fact, the available funds have allowed us to conduct only a limited number of interviews which, as a consequence, will give only a limited panorama of the present situation and the trends of the developments of EDP in the various sectors and countries examined.
Finally, there were operational difficulties regarding coordination of relationships between the buyers and the companies which have collaborated in the research.
For all these reasons, the forecasts have to be interpreted very cautiously, being first indications which require further testing.

Methodology

1. General remarks

The time limit proposed for the forecasts and the extension of the analysis into vast fields of application, have counseled a methodological approach in two distinct phases:

- direct survey with users and experts
- desk research.

The interviews conducted with the users have confirmed that it is impossible to pronounce quantitative forecasts for the period beyond 1973-1975 only on the base of opinions by users. They generally do not have:

- neither information nor hypotheses about applications which will be developed in the next few years;
- neither information nor hypotheses about hardware which will be available in those years and whic will differ greatly from the present one, especially regarding the ratio performance/price;
- forecasts for business development for a period so far ahead.

It was therefore necessary to complete the survey with the users with a sounding out of the opinions of various experts (university professors, business consultants, sofware specialists) in order to verify the opinions expressed by the users and to have available qualitative indications about long term trends.

The most important completion, however, of the information retrieved from the direct survey has come through desk research, due to the existence of a vast amount of general and specialized literature about EDP systems in the countries involved in this survey.

The analysis was essentially concerned with demand for and applications of high performance processing systems per sector of utilization. It had to be completed, however, by a survey of each country, in order to furnish indications about the trend of the overall demand for processing systems and, hence, about the importance of high performance ones. Furthermore, this survey has permitted an assessment of the importance of the sectors examined in the survey as compared to all the sectors of each country.
Also the forecasts made for high performance systems, within each sector of utilization, have been verified through the macro-economic compatibility of demand forecasts for each country.

2. Direct survey

Direct surveys have been conducted by SORIS in Italy and the United Kingdom, by SEMA in France, by SOBEMAP in Belgium, by the Deutsche Revisions und-Treuhand A.G. in Germany and by the Rijkskantoormachinecentrale in Holland, in order to get a clear picture of current and future applications of high performance processing systems and the requirements by the users for hardware and software. In each country there have been conducted:

- interviews with the major users of processing systems in each sector;
- colloquiums conducted with experts and opinion leaders in the EDP field for the purpose of completing the information about hypotheses of development of applications and materials furnished previously by the users.

It was helpful to include in the sample the large users who, because of the advanced techniques and the complexity of the problems which they will have to cope with, are the only ones who are able to give information about future EDP requirements.
The number of planned interviews was, however, insufficient for insuring proper representation of the large users in each sector of the countries considered.
In addition, the complexity and the characteristics of the enquiries required considerable collaboration by the interviewed firms which was essential for the accomplishment of this research.

For this reason, interviews were sometimes conducted with more "available" users, even if they were not the ones with whom interviews had been planned.

The principal issues discussed with the users were:

- history of data processing in the organization or firm : EDP cost, personnel, organization, hardware, software;
- past, present and future applications per type;
- EDP development forecasts: organization, personnel, hardware, software;
- expectations about large computers, hardware and software.

A breakdown of interviews conducted per country and sector is listed in the enclosed table.
In the report the interviewees have not been listed by name, because some of them requested explicitly to remain anonymous; they are, however, recognizable through the code assigned them in the annexes. Each code is composed of letters and numbers: the letter indicates the initial of the sector to which the interviewee belongs and the number the progressive sequence with which the interviews have been conducted.

NUMBER OF INTERVIEWS CONDUCTED (WITH USERS AND EXPERTS) PER COUNTRY AND SECTOR

	BELGIUM	FRANCE	GERMANY	ITALY	NETHERLANDS	UK	TOTAL
BANKS	2	1	3	1	1	1	9
INSURANCE COMPANIES	-	1	-	1	-	1	3
RETAIL STORES	1	1	2	-	1	1	6
MANUFACTURING INDUSTRIES	1	3	3	7	5	2	21
SERVICES	2	2	4	3	1	4	16
GOVERNMENT	4	2	3	8	4	1	22
UNIVERSITIES - SERVICE BUREAUS	2	4	-	-	2	1	9
TOTAL	12	14	15	20	14	11	86
INTERVIEWED EXPERTS			10			4	14

3. Desk research

In order to analyze the trend and current structure of the computer installations, a great deal of information coming from various sources has been examined. Analyses of the available data have shown that it is difficult to compare information coming from these sources and that the reliability of some of the data supplied by specialized agencies is doubtful.

Despite the ever increasing amount of literature dealing with computers, there exists still today a noticeable lack of official statistics in the various countries which is compensated only in part by information coming from private organizations.

Unfortunately, the computer manufacturing companies are not generally among them, since they would be the only ones able to give reliable information about the number of the installations.

Also the differences between the many available sources are numerous.

Primarily there are differences in the contents of guidelines used by the various sources, then, the information referring to the same year refers often to different dates. The greatest disparity, however, comes, from the different meanings attributed to the term "installed computers" (1).

During our research we have mainly used the Diebold Statistics, primarily because they used rather uniform

---

(1) See annotation on following page.

(1) Concerning the definition computer:

a) some sources survey only those digital computers above a certain size (e.g. International Data Corp.: EDP Industry Report);

b) others survey all digital computers, including microcomputers (i.e. the Diebold Group);

c) still others survey all digital computers (in the sense of a) and b)) and the analogic computers (e.g. Official Bulletin of the French Republic).

According to the sources "installed" means:

a) computers installed and actually operating with specific categories of users;

b) all computers installed and actually operating;

c) computers installed and operating (in the sense of a) and b)) and those delivered, but not yet in operation;

d) computers installed (operating or not) and those returned by the users for substitution by new models.

surveying methods in all countries, secondly because they conduct periodically a census of all installed computers, broken down by models and finally, because they are the most easily available ones.

Detailed analysis of these data shows however that they are not very accurate, especially when listing the model of the installed computers and when making distinctions between installations and orders.
The data furnished by the abovementioned source have therefore been completed or even substituted by other, more reliable ones, wherever that was possible: thus, for example, it was preferred to use the statistics from Computer Survey for the United Kingdom.

The main correction which had to be made in the Diebold statistics, was the total elimination of those machines which, because of their technical features, classify more as accounting machines or card calculators than as computers.

The limits of reliability of the information available about the trends and current composition of the EEC countries' computer installations are, however, not such as to compromise the validity of the general indications about future trends which can be derived from them.
If the absolute data have to be interpreted very cautiously, the relative variations which can be deduced from them are obviously more reliable and assume the constancy of the survey methodologies over time and in the countries

considered.

Statistics about computer distribution per sector of utilization are scarce. It was possible to know only for the United Kingdom over a number of years and for Germany for one year, the installations per sector broken down into models - valuable information for this survey.

Such detailed information is, however, not available for the other countries examined. Comparison between the various countries has been made more difficult, in addition to the abovementioned reasons, by the lack of uniformity when defining the sectors.

Among the vast field of technical literature about computer applications, we have selected only that documentation which was useful in completing the indications emerging from the direct survey, especially those concerning future development.

4. Methods of analysis

a) Evaluation of Hardware

Due to the considerable differences existing between computers because of their different capacities, any estimate of the trends of any one country's or any one industry's installations is not significant if reference is made only to the number of computers installed.
Such an assessment is more meaningful, if the installations are known by model and if they can be subdivided by classes.
There arises, however, the problem of determining the sizes. They can be determined either physically, that is according to a computer's storing capacity or processing speed, or by value, which means the purchase price or the monthly rent paid for a computer. The physical sizes, if looked at alone, are no good indicator of a computer's size, because high storing capacity can be accompanied by low processing speed and vice-versa.
For this reason several methods have been established which combine in one measure means with different weights, etc.
But also these weighted means are not immune to strong criticism, because, depending on the type of weights used, computers can be classified in different manners.
Hence, classification according to value seems to be better (expressed in yearly rent or purchase price).

Attributing a value to the computer installations is difficult, since most of the amailable information refers only to manufacturer and model the machine.

The yearly rent of the installations, stringly depends upon the actual configuration (number and type of tape drives, disc storage units, IO units etc.).

Moreover, the ratio, purchase price = 4 times price of annual rent, is not always valid, although it has, been noticed (1) that, with the exception of some desk computers, ratio it is fairly constant.

In order to be able to make comparison between the size of the installations and other economically important quantities which are also expressed in terms of value, we have adopted as main criterion of classification that of the purchase cost of a typical configuration, jointly with that of capacity of main storage.

---

(1) Calculating the ratio maximum price/maximum rent and minimum price/minimum rent (based on data furnished by Digital Computers in "Computer and Automation 1969, Directory"),the result is around 4, with the exception of desk computers.

The criteria of classification used are summarized in the table on the following page; and on this basis the structure of the computer installations in all the countries which were subject of this study has been analyzed.
The evaluation of the installations is without doubt underestimated, because the prices used which were taken from "Computer and Automation", June 15, 1969, (World Computer Census) refer only to central units and "average" configurations on a worldwide basis.
It does, however, furnish the possibility for a comparison between the installations in the various countries and a first indication of all theresources destined for EDP hardware.
The computers' value is expressed in US Dollars (1969). Also all the other values mentioned in this study are in US dollars based on the IMF exchange parity and do not necessarily reflect the purchasing power of the various currencies (1).

b) Classification of information systems.

In order to assess the smaller or greater need for an extra-large computer in the sectors considered, we have classified the information systems according to:

- structure of the firm or organization
- requirements for EDP at the periphery
- decisional requirements at the periphery

---

(1) The exchange parities used are: 1$ = DM 4; 4,9 Ffr.; 625 Lit.; 3,6 Fl.; 50 Fb.; 0,36 (until 1968) 0,42 £.

GUIDE FOR CLASSIFICATION OF COMPUTER SYSTEMS (1)

CLASS	MONTHLY RENTAL (dollars)	CAPACITY IN THOUSAND WORDS	PURCHASE PRICES (dollars)
DESK	up to 2,000	under 4	up to 60,000
SMALL	2,000-12,000	4-32	60,000-600,000
MEDIUM	12,000-25,000	32-256	600.000-1.2 million
LARGE	25,000-70,000	256-512	1.2 -.3.6 million
EXTRA LARGE	over 70,000	over 512	over 3.6 million

(1) SIZE CLASSIFICATION IS BASED ON THE PRICE OF A TYPICAL CONFIGURATION FOR EACH MODEL-MONTHLY RENTALS AND PURCHASE PRICES ARE QUOTED BY:

- KEYDATA CO., COMPUTER CHARACTERISTICS, REVIEW, APRIL 1969
- COMPUTER AND AUTOMATION, WORLD COMPUTER CENSUS, JUNE 1969
- EDP EUROPA REPORT, COMPUTERS BUILT BY EUROPEAN COMPANIES, JULY 1969

The structure of the information system depends essentially on the physical structure of the firm or organization; if a firm carries out all its activities in one place, also its processing requirements have to be concentrated. By the same token, if the firm or organization is decentralized, the structure of its information system will depend on the processing and decisional requirements of the periphery.

The indicated combinations are illustrated by the following scheme to which correspond different needs for extra-large computers.

Processing requirements

Physical structure of the firm	At the periphery	Regarding central information
1 centralized		
		1 low decisional requirement
	1 low processing requirement	
		2 high decisional requirement
2 decentralized		
		1 low decisional requirement
	2 high processing requirement	
		2 high decisional requirement

1.0.0. Extra-large computer only for very large centralized processing requirements or service centres;

2.1.1. Extra-large computer only, if the decisions at the centre require real-time consulation of the few peripheral data;

2.1.2. Extra-large computer for great data transmission and multi-processing requirements;

2.2.1. Extra-large computer for the need to know, at the centre, elements of large peripheral processings;

2.2.2. Extra-large computer for the decisional needs on the periphery to interrogate the centre.

The periphery's processing requirements can be defined:

- as an atomic information system, characterized by great amounts of information from the periphery sent to the centre for processing.
- as a solar information system, characterized by processing and systems performed in the periphery, before the information is sent to the centre.

Taking into account also the decisional requirements by the periphery, the atomic system corresponds to combinations 2.1.1. and 2.1.2. of the scheme, the solar system to combinations 2.2.1. and 2.2.2.
The processing requirements can also grow in function of the faster and slower transmission speed of the information in both directions.
Thus, two systems can be obtained:

- off-line	batch remote job entry
- on line	batch real time

Information requirements are also determined by the need of taking decisions: the information from the centre to the periphery are useful for operational decisions, while the information from the periphery to the centre are useful for management decisions, which can be integrated into one system: the Management Information System (M.I.S.).

5. Forecasting Methods

5.1. General remarks

In order to overcome the difficulties arising from forecasting for a time so far ahead and a technologically new product, it was necessaryto establish a rather complex forecasting methodology.

Forecasting development trends of the applications requires an approachper sectors of utilization, because the computer applications are not uniform with all the users, but show some uniformity only within each sector. The data available per sector does not, however, permit an assessment of the installations' trend per size, which is the only one to permit an estimate of future developments of demand and especially, of demand for high performance systems. In order to overcome this obstacle we have determined a forecasting methodology which is based on the assumption that high performance processing systems are used primarily by firms or organizations which, because of their size and the problems they have to cope with, will require higher processing and storing capacities.

Identification of potential users of high performance processing systems in the sectors examined does, however, not allow forecasts of the number of extra-large computers which will be used in the decade 1970-1980, nor does it permit determination of their value.

In fact, the potential users can acquire one or more large computers and their total expenditure for hardware must not only comprise the large computer.

In addition, the government sector which is a great potential user of large computers, has not been in a position to express quantitative forecasts, because government's behaviour in the EDP field is influenced by the political choices during the time period considered. The sectors of utilization considered, being today the ones who are most interested in high performance systems, do not, however, exhaust all the possible fields of application. For these reasons it was necessary to verify the macro-economic consistency of the forecasts formulated for the sectors through an overall forecast of the demand for high performance processing systems in the countries examined. It was further necessary to formulate forecasting hypotheses about hardware and software development, in order to verify the compatibility of the technical requirements connected to the application development with the characteristics of the materials, processing means and software which will presumably be available during the decade.

The technological forecasts have been formulated by using the opinions expressed by the interviewed experts and the most significant indications emerging form the technical-scientific literature which was consulted for this survey.

5.2. Forecast for the Industries

Formulation of forecasts for the industries means:

a. identification of the principal firms or organizations which operate in each industry, of their current hardware expense and of their size.

b. forecast of the development of the various industries and the principal firms during the decade 1970-1980.

c. examination of the trends for development of the computer applications

d. forecast of the hardware expense of the principal users as related to the applications' development and identification of potential users of extra-large computers.

a. We have identified the principal users through lists provided by the organizations of each category, specialized economic journals, etc. These lists were based on dimensional indicators varying from industry to industry, such as, for example amount of deposits for the banks, premium paid for the insurance companies, turnover for the other firms etc.
Information about the principal users' computer equipment has been obtained from special sources in some countries: in the United Kingdom from a census of the users conducted by Computer Survey and in France from an O.I. Scope inquiry which comprised however only slightly more than 2/3 of the users. In the other countries we have resorted to direct surveys, conducted in Belgium by SOBEMAP, in Holland by the Rijkskantoormachinecentrale and in Germany and Italy by SORIS.

Information about principal users and their current computer equipment is naturally difficult to obtain: an analytic method, such as the one which had to be used, brings with it considerable gaps and possibilities of mistakes.
The principal users' current computer installations have been evaluated on the basis of the purchase price for the figuring out of indexes, such as the value of the installation per employee and turnover. These indexes permit evaluation of the relative position of the various users as compared to the size of the computer installations and are the first element of the forecast.

b. For the development forecasts for the various industries during the decade 1970-1980 we have used, where available, the guidelines mentioned in national or international plans (especially EEC plans), limiting ourselves to estimates of trends in the other cases.
The trends toward industry restructuring through concentration have been taken into account, at least on a qualitative level, especially in those industries, where these trends are more pronounced and where they could thus change considerably the number of large users during the next few years.

c. The development trends of the applications typical of large computers have been derived primarily from interviews conducted in the industries, verified later by information from available technical literature, dealing especially with the presently more advanced applications in the US.

d. When forecasting the hardware expenditure of the principal users, account was taken not only of the qualitative influence of the applications' development, but also of the influence of each user's behaviour on the behaviour of other users. Important is the criterion of imitating the industry's leaders, i.e. those firms which, while performing the same type of economic activity and having the same turnover, have in the same country, or other European countries or the US, a higher ratio hardware expenditure/turnover.

Thus, as results from the enclosed forecast procedure, the first step toward determining the future behaviour of the large users in the industry is their present position concerning hardware investments as compared to other firms of the same industry and country.
If already in 1969 there existed other firms of equal size active in the same industry, we can conclude that, as an effect of the imitative model, the interviewee will tend toward achieving their present level of the hardware/turnover ratio. Smaller will be the effect of the imitative model, if the leader belongs to another country. If the leader is national, it can be safely assumed that the other firms equal in size will try to achieve his level of hardware expenditure per turnover. If the leader is from another European country or the US, he will challenge the other firms to increase their EDP expenditure/turnover ratio.

The enclosed diagram shows the general forecast procedures of hard ware expenditures at the level of each individual firm. This procedure has been formulated according to steps of calculus and periodic checkups of the qualitative evaluations made by the research group. The various logic knots are:

1. User's present sales and value of computers installed

In this preliminary phase the data available on sales and value of computers installed (the value of computers installed being expressed in the purchase price): in this way it is possible to localize in a diagram, which has as ordinate the value of computers installed and as abscissa the sales, a representative point of the considered firm and to determine the straight line passing through that point (defining this line as a locus of points which represents a constant ratio between the value of computers installed and sales).

2. Test A - Has the firm been interviewed ?

If the firm has been interviewed evaluations of the hardware development are considered; the latter being corrected by the researcher on the basis of the advancement of the specific applications of each industry.

3. Tests B/C/D/ - Is there a national leader? A European or an American one ?

Moving from the firm's representative point upwards, maintaining the same class of sales, one can single out the leaders of the particular subsectors, i.e. the firms of the same type and size as the one being examined which have already

reached higher values of computers installed. National, European or even American leaders can be found. The guiding effect of these leaders depends on the leader's country of origin. In case there are no leaders, we have chosen to stay on the original ratio.

4. Evaluation of the application explosion

It is necessary at this point to make an evaluation of possible new applications for the subsector which imply further increases in the size of hardware expenses. This evaluation is therefore valid for the interviewed and not-interviewed firms, whether these are leaders or not, because an upgrading in applications of this kind can naturally also be applied to the top firms in this group.

5. Test E - Trends toward concentration?

If higher concentration in the user's branch can be foreseen, it is necessary to find a new ratio of the total value of computers installed and their total sales.

6. Test F - The new ratio is critical?

In some subsectors we can find a critical ratio, beyond which it is necessary to make a negative correction, due to the specific decreasing course of the ratio: value of computers installed / sales. If the critical level has been reached, a negative correction will be applied.

7. Determination of user's sales and value of computers installed in 1975 and 1980

Based on available data specific rates of sales increase for 1975 and 1980 have been applied and one enters into the abscissa of the above-mentioned diagram putting in ordinate the forecast of a firm's value of computers installed in 1975 and 1980.

8. Users with > US$ 5 million value of computers installed in 1975 and 1980

Comparing the future value of computers installed (step 7) with the threshold of the purchase price of the extra-large computers (US$ 5 million), the potential users in 1975 and 1980 can be determined.

9. Test G - Atomic System?

It is necessary to make a critical evaluation for the future, referring to the present hardware equipment of the firm and to its EDP philosophy.
Defining the "atomic system" as a system with very large central computer and many peripheral terminals without intermediate computers, one reaches a confirmation of the forecasts concerning value in the case of a positive answer of the test.
In the opposite case, when the forecast philosophy is oriented towards the "solar system" (defining "solar system" as a system with a large central computer, some intermediate computers and many peripheral terminals), one has to reconsider the judgement along more conservative lines. This criterion

can be decisive in those cases in which the threshold of the value in only barely reached, especially in the near future (1975).

10. Forecast of potential users of extra-large computers in 1975 and 1980

Of course, the value of computers installed as determined in the above-mentioned manner, can have much higher results than the minimim limit of 5 million dollars, thus giving way to the possibility of using more than one extra-large computer.

5.3. Forecast of the total computer installations' development

The long range development of computer installations (expressed in value) may be represented by a temporal function of a logistic type (1).

The ratio hardware expenditure/GNP has been taken as a dependent variable in order to have comparable values from each country.

The use of a logistic function to interpret the trend of said ratio implies that the hardware expenditure, after an initial period of steady absolute growth, slackens its development rate, pointing to a relative saturation level. When it nears to it, the annual variation rate draws near the GNP.

---

(1) That is a function of the type : $y_t = \frac{1}{a + bc^t}$ where

y_t = a dependent variable
t = number of years
a = reciprocal of the ceiling parameters
$b;c$ = function parameters.

6. Panel Discussion

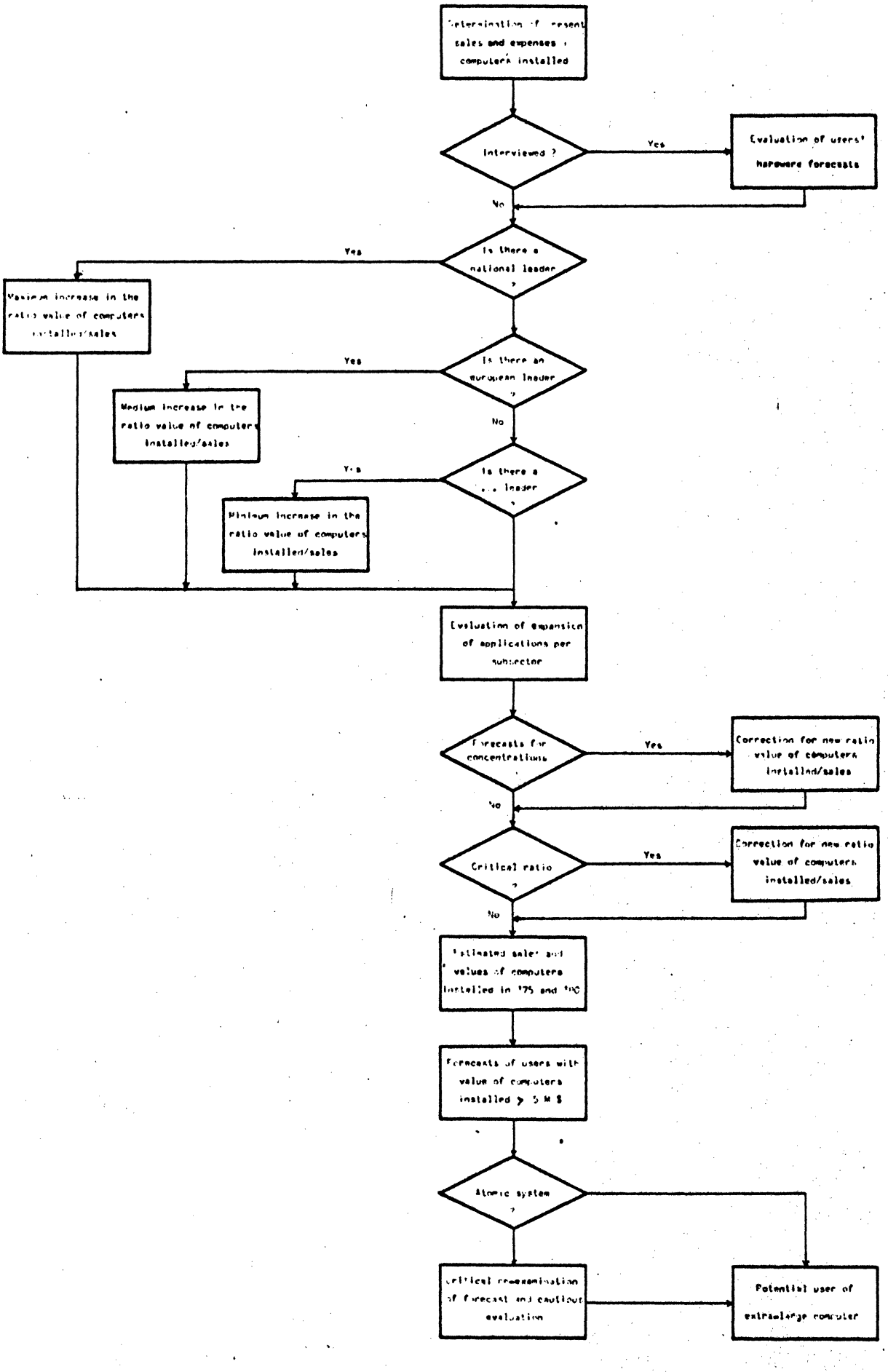
The aim of panel discussion was to verify the trends of applications and to forecast potential users in each industry.
The experts were:

* M.C. Friz * M. Jansen	C.E.E. - Commission des Communautés Européennes Direction Général des Affaires Industrielles BRUXELLES
* Mr. A.A.M. Veenhuis	IFIP - Administrative Data Processing Group I.A.G. AMSTERDAM W.1. (Holland)
* Prof. Szyperski	Universitaet KOELN (Germany-Federal Republic)
* Dr. Zajonc	Gesellschaft für Kernforschung KARLSHRUE (Germany - Federal Republic)
* M. De Jaeger	CEGOS - NEUILLY-Sur-SEINE (France)
* Dott. Pietro Gambino	FIAT - Direzione dei Sistemi e della Organizzazione delle Informazioni - TURIN (Italy)
* Prof. Lionello Cantoni	Ing. C. OLIVETTI & C. S.p.A. Direzione dei Sistemi e delle Informazioni - IVREA (Italy)
* Dott. Ing. Maurizio Bufalini	STET - ROME (Italy)

* Dott. Sandro Ragazzoni	ITALSIDER - GENOA (Italy)
* Dott. Ing. Carlo Tedeschini Lalli	ITALSIEL - ROME (Italy)
* Dott. Ing. Guido Frigessi	IRI - ROME (Italy)

The results emerging from the panel discussion about the hypotheses for development of the demand have been incorporated into this survey.

GENERALIZED SCHEME OF FORECAST



Summary

Introduction

The technical-economic survey about development of applications of extra-large EDP systems in the EEC countries and the United Kingdom during the decade 1970-1980 includes three fields of research:

1. Hardware and software supply
2. Development trends of computer installations per country
3. Demand and applications per sector of utilization.

The survey's results about the current situation and the trends for development in each field of the research are listed in the following paragraphs, taking into account also the observations which emerged from the panel discussion.

2. Supply of hardware and software

A. General

In the EEC countries and the United Kingdom, American as well as European firms are present on the computer market. The principal US manufacturers have in all EEC countries shares above 60%, with a maximum of 98% in Italy. Only in the United Kingdom, due to ICL's presence, they have a smaller share of the market.

The American superiority is particularly evident in that segment of the market which is of interest to this survey, namely that of the large and extra-large computers. The US manufacturers control completely this segment of the market in Belgium, Holland, France and Italy.

In Germany and the United Kingdom also ICL and Siemens are active in this segment, however with very modest shares.

The national companies of the European countries offer thus little competition in the large and extra-large computer market. Expansion of these companies is hindered by the limited size of the market on which they have operated until now, by the limited funds they use for EDP and by the high number of manufacturers present on the European market.

Given the quasi-monopolistic structure of the computer market and the consequent controlled development of technological progress, the supply has considerably influenced during the last decade the applications developed with the users. This influence is evident in the generalization of those applications derived more directly from the substitution of pre-existing keypunch machines by

computers and in the imposition of a hardware line which is not very sophisticated for the more advanced applicational requirements.
This to us seems to be the most important reason for the delay in the utilization of computers by the government, where standardization of applications is not so easy as in business.

B. Expected characteristics, hardware

Going through the interviews, it appears that present day computers are regarded as having large and fast enough brains to solve the most vast and intricate puzzles set or anticipated by any of the users in the sectors covered (1).
The most ambitious requirements anticipated for central processor units are:
- 1024 kilowords of 32-bit words main memory;
- memory access time 300 to 100 nanosecs;
- transfer rate 300 K bauds.

These targets are met or surpassed by today's largest computers, such as e.g. IBM's 360/195.Apart from the c.p.u. proper, however, substantial improvements including both software problems and technicalities of peripherals and input/output units are expected along the following outline.

---

(1) Which, it may be worth to recall, do not include military and special purpose scientific applications, such as space-craft guidance and control.

Large computing power is required in the near future (1975) by applications implying real-time processing of data collected by widely scattered terminals. This requirement may be shared in a not too immediate future (1980) by more applications, such as information retrieval in its broader sense and computer assisted instruction.
These developments are largely dependent upon the reliability and (to a lesser degree) the speed which will be attained by teledata nets. Existing teledata facilities are considered unapt to allow error-free use of terminals and too expensive. Direct connection by high-speed (> 2048 bauds) lines is an anticipated requirement for reliable, efficient operation of integrated systems. A European teledata net should begin operating before 1980 to back the efforts to integrate in a wasteless scheme today's independently growing applications in many sectors, such as public administration, transportation, research, education, hospitals.
Intermediate (mass) memory, today consisting of "extended core" memories backed by drum/disc stores in large computers and of drum/disc units only in medium/small machines, must substantially increase in capacity towards 3×10^9 bytes. Present implementation by disc/drums is considered not likely to become as economical as it should be to meet these requirements. Present access time of drum/discs is stated as satisfactory. Static mass memories would be favourably accepted should their cost become bearable: a target which is considered not in sight.
There is general agreement among users about the requirement for improved, reliable, flexible, economical input-output devices.

Outstanding requirements are: silent, fast substitutes of present teletypes. These are claimed to be also subject to too frequent failures. The sought-for substitutes would be: a) Electro-optical devices, keyboard operated as input, delivering hard copies as output; b) Visual display devices, code or band compression operated in order to not overburden output channels; c) Optical multi-font character readers; d) Graphic input-output devices.
Substantial improvements along these lines are required and expected in the near future (1975). These improvements are expected in a far-off future in fully automated man-to-machine interfaces effecting direct reading/writing of scripts, documents, drawings, as well as verbal man-to-machine communication. While in other respects hardware requirements are clearly lagging behind technical feasibility, the contrary is true in this field.
Required are improved terminal units taking over some of the most trivial computer jobs.
Conversational mode (implying time-sharing operation of central or satellite processors) is sought mainly for special purposes, such as automated design and computer-assisted instruction.

C. Expected characteristics, software

The interviewees agree on the fact that the ever increasing cost of software is today the bottleneck of EDP. Forecasts are for an even greater increase. This trend depends essential-

ly from:

a) the ever growing number of applications

b) hardware's technical development. This brings with it the necessity to develop always new operating systems and new programming languages apt to use fully the ever more advanced performance of the computers.

To stop this trend it is necessary, above all, to achieve that the various EDP systems have greater mutual compatibility, vertically, i.e. between members of the same family as well as horizontally, i.e. between systems produced by different manufacturers.
In this way one obtains also a common man/machine interface, that is, the staff can use without difference one or another EDP system without requiring special training.
In order to achieve this, it is necessary to standardize the programming languages as well as the principal characteristics of the computer's management operating systems (such as utility and diagnostic programs, control cards, input/output management).
Concerning the programming languages, a certain result has already been obtained in the US because of the intervention of the US government and syndicates of users (languages COBOL, FORTRAN). In Europe, because of the action of scientific committees (ALGOL), the users (universal languages such as PL/1) and recently government agencies (National Computing Centre in the United Kingdom). However, these results are stillunsatisfactory and do, e.g. not allow utilization of common files, which is requested from data banks, nor do they permit direct interconnection of the various computers. A standard inter-

face on the level of "extended machine" (hardware plus operating system) would permit solution of the problem and satisfaction of the users' expectancies.
The interviewed users request also a more secure and flexible software for the management of both terminal networks and data tele-transmission.

D. Technical development against EDP expectations

Technical development trends appear partly to match those of users' requirements or expectancies, and partly to diverge greatly from them. Agreement is good concerning: a) central processor speed and capacity, b) transfer to hardware of some of the present software functions by means of read-only memories, c) extensive use of multi-programming and time sharing procedures to allow real-time operation from many "active" terminals, d) increased medium speed mass ("external") memory.
There is disagreement mainly concerning peripheral and terminal hardware and software. Industry could easily level out the first of these mismatchings by making available better, simpler to use, more reliable devices in the man-to-machine interface.
Standardization, vertical and horizontal inter-family and inter-make compatibility of hardware, is the most commonly shared expectancy by users, second only in importance to that of greatly improved software. Here again, what users are principally expecting from new computers is that they may be loaded with old programs.

That of standardization is not a new problem, of course. Every industry has met it at a certain development stage, and each of them has solved it by originating or accepting some organization to take care of it. An agreement among producers under the sponsorship of some or more state agencies, such as the National Computing Centre in the United Kingdom, could have great beneficial influence on this point.

3. Development of computer installations

The topic of computer expansion in the EEC countries and the United Kingdom has been discussed often in the last few years during debates about the technological gap with the US. Sources of information in this respect are quite numerous, but often the data available are so different as to lead to contradictory conclusions, especially concerning the extent and the trend of this gap. During this survey we have tried to gather with uniform criteria statistical data about the computer installations in the EEC countries and the United Kingdom between 1962 and 1969 (1). The results are summarized in the following table:

COMPUTERS INSTALLED IN EEC COUNTRIES, UNITED KINGDOM AND UNITED STATES IN JUNE 1969

	NUMBER	VALUE (million $)	ANNUAL RATE OF GROWTH 1962-1969	
			NUMBER	VALUE
BENELUX	1,964	128	45.5	41.9
FRANCE	4,663	348	46.5	40.9
GERMANY	5,600	380	35.9	33.5
ITALY (2)	1,644	142	29.0	28.7
EEC COUNTRIES	13,871	998	39.0	35.8
UNITED KINGDOM	3,575	320	33.7	37.2
UNITED STATES	59,779	5,667	30.2	29.4

(1) Using Diebold statistics completed with the results of our direct survey.

(2) The Italian figures are underestimated because of difficulties in the survey of desk computers.

The rates of increase of the European installations are higher than the US ones. In that country, expansion of computers began earlier and installations existing in 1962 were therefore already numerous, whereas in the European countries which started at a very low level, the relative increase in the installations was typical of any initial development phase.

The degree of the computers expansion in each country can be assessed through indexes which take into account the different economic features of the various countries compared.

In 1968, EEC countries spent 2.3 Dollars for hardware per each 1,000 Dollars GNP as against the 5.8 Dollars of the US who spent the abovementioned EEC amount as far back as 1964 (1). Hence the European delay behind the US in 1968 was about four years, and has shown during the period 1962-1969 a slight increase.

Given the considerable differences between computer capacity, we have found it necessary to examine the structure of the installations on the basis of their sizes.

---

(1) In 1968 the hardware expenditure, expressed in the annual rent paid, per 1,000 Dollars GNP was 2.4 in the Benelux countries, 2.3 in France, 2.6 in Germany, 1.7 in Italy and 3.0 in the United Kingdom.

PERCENTAGE DISTRIBUTION OF COMPUTERS INSTALLED IN 1969, BY SIZE

COUNTRY	NUMBER						VALUE					
	DESK	SMALL	MEDIUM	LARGE	EXTRA-LARGE	TOTAL	DESK	SMALL	MEDIUM	LARGE	EXTRA-LARGE	TOTAL
BENELUX	25.2	63.6	8.9	1.5	0.3	100.0(1)	6.9	52.5	27.5	9.5	3.6	100.0
FRANCE	29.4	59.1	8.3	1.7	1.1	100.0(1)	7.7	50.8	16.1	11.0	14.4	100.0
GERMANY	18.5	73.5	6.3	1.4	0.3	100.0	4.6	62.4	20.0	9.3	3.7	100.0
ITALY	2.1	84.9	9.1	2.4	1.3	100.0(1)	0.5	54.4	21.4	11.0	12.7	100.0
EEC	21.1	69.3	7.0	1.7	0.7	100.0(1)	5.4	55.9	19.8	10.2	8.7	100.0
UNITED KINGDOM	19.3	64.3	12.0	2.8	1.2	100.0(1)	3.1	46.2	25.9	12.7	12.1	100.0
UNITED STATES	23.4	60.3	10.5	4.1	1.7	100.0	3.2	39.5	23.4	18.2	15.7	100.0

(1) In the total non-classified computers are included.

During 1962-1969 the composition of the computer installations by size in the EEC countries and the United Kingdom has changed in such a way as to approach that of the US. The weight of the extra-large computers on the total is, however, smaller in Europe than in the US.

This is due not only to the more advanced state of the EDP applications development in the US, but above all, to the fact that in that country there are more large government and private organizations which employ high performance computers.

In June 1969 there are 138 extra-large computers installed in the EEC countries and the United Kingdom (1); among those about 40% is installed in France and 30% in the United Kingdom.

Desk computers account, in number, for a rather important share of the total market (about 20%). Surveying them is however difficult, and only in the last few years has it been possible to get somewhat accurate information about them. For this reason, we have considered it more correct to look at the changes in the computer installations, excluding desk.

Forecasts for installations in the decade 1970-1980 have been formulated on the basis of an estimate of historical trends.

---

(1) At a monthly rental above 70,000 dollars.

The forecast model used is a logistic function, explaining the trend of the ratio hardware expenditure/GNP (1) in the EEC countries and the UK as compared to the analogous trend in the US.

Using this forecast procedure we have obtained the following results:

Hardware Expenditure per 1,000 Dollars GNP	1968 (2)	1975	1980
EEC	2.1	6.9	9.6
United Kingdom	2.5	8.1	10.3
EEC + UK	2.2	7.2	9.7
Hardware Expenditure (Millions of dollars)			
EEC	829	3,722	6,583
United Kingdom	303	1,213	1,860
EEC + UK	1,132	4,935	8,443

Through some hypotheses on the development of the installations structure and on the average price of computers one can arrive at an estimate of the number of computers in the EEC countries and the United Kingdom during the coming decade.

All computers installed, including desk, will be 59,900 in 1975 and 96,600 in 1980.

---

(1) Annual rental value of c.p.u.

(2) Real value.

The number of extra-large computers, that is those with a monthly rent of more than 70,000 Dollars, could vary between 590 and 705 in 1975 and between 1,050 and 1,450 in 1980. Computers with a monthly rent above 100,000 dollars (1) could vary between 90 and 105 in 1975 and between ~~105~~ 425 and 310 in 1980.

(1) With purchase price above 5 million Dollars (1,25 million Dollars yearly rent) with central units with more than 512 K.

4. New applications per industry

The theoretical development prospects for the applications and the demand for high performance systems connected with it have been assessed per industries.
The industries considered are:

* Manufacturing industries
* Retail stores
* Banks and insurance companies
* Public utilities
* Universities and service bureaus
* Public Admistration

Assuming that the high performance systems will be used by organizations who, because of their size and because of the complexity of the problems which they have to cope with will have great processing and storing requirements, direct surveys have been conducted with these users.
The number of high performance processing systems which will be installed in the coming decade has not been estimated, but the number of potential users of these systems and their capability to invest in computers.

The computer equipment of 1037 large users has been analyzed, only 118 of which have extra-large computers at present (1).

---

(1) In June 1969 there were 138 extra-large computers. This difference is attributable to the incomplete listing of industries considered.

A. Manufacturing industries

Having a faster development trend in computer investments than the other industries, the manufacturing industry has developed until now a mix of operating applications (administrative, technical and commercial), laying thus the foundation of the Management Information System.
Given the heterogeneity of the industry, the current and future applications divided by the various branches have been analyzed.
In 1969, 291 large firms (1) having a total equipment of 20 extra-large computers have been examined. The potential users of high performance systems have been estimated at 31 in 1975 and at 75 in 1980 with an investment capacity in computers of 553 and 1,230 million Dollars.
As a rule these users will be very large firms. Among process industry and those conducting a great amount of R & D, extra-large computers will be requested also by not so large firms.
The quantitative development of current operating applications, the gradual introduction of new management applications (Information Retrieval, intersectorial data banks etc.) and the integration of traditional applications into the Management Information System will require extra-large computers.
In addition to this development hypothesis, further expansion related to the first applicational experiments in the field

(1) Whose sales exceeded 100 million Dollars in 1968.

of strategic planning is probable. This will require a multi-sectorial informational approach and management of large data banks connected with terminal systems and a greater processing speed.
Also in the future the manufacturing industries will be among the principal users of the largest and most powerful systems available.

B. Retail stores

In this industry there prevail at present not very sophisticated administrative-commercial type applications, even if they handle a great volume of data. The jobs performed by the computer are primarily invoicing, general accounting, suppliers invoicing, stock control and personnel management. These applications are not very integrated.
Batch processing is prevalent.
Computer users in this industry are rather large firms, but none of them disposes at present of an extra-large computer.
The profound restructuring the industry is undergoing at the moment and the increase in the market's size cause almost all interviewees to forecast for the future a considerable development of on line processing, sometimes with real time processing.
Also integration among the various applications is foreseen, especially in the invoicing and stock control subsystems.

It is predicted that the entire flow of information, which passes from the sales outlets to the intermediate warehouses and to headquarters, will be handled by a network of terminals.
As a consequence, employment of extra-large computers can be forecast, even if there will not be a high number of potential users.
As a matter of fact, only 4 have been estimated for 1975 and 11 for 1980, with an investment capacity in computers of 32 and 131 million Dollars respectively.

C. Banks and insurance companies

Banks and insurance companies were among the first European users of computers. The banking industry, which is rather concentrated in almost all European countries considered, has currently 12 extra-large computers. On the other hand, in the insurance companies, being less concentrated, there is at present no such computer installed.
Until now the computer has carried out the principal operations of the banks and insurance companies, such as management of checking accounts, deposits, preparation of insurance policies, control of payment of premiums and all the administrative and personnel management procedures of these firms.
Batch processing is prevalent, even if processing through terminal networks linking the peripheral agencies to headquarters is already under way in the more advanced firms.

For the future continuous expansion toward on-line and real-time data transmission is predicted, given the requirement for short answering times in all current applications.

Moreover, development of the substitution of money circulation by information circulation is forecast. This type of application, already being studied and being used partially by large banks, could be extended into an inter-bank information system linked with the principal original points of the information flow.

Concerning the development of internal and external interconnections of the industry, greater employment of extra-large computers can be predicted.

Potential users of high performance processing systems will be 19 in the banking industry in 1975 and 5 in insurances; in 1980 there will be 35 in the banks and 15 in the insurances.

D. Public utilities

The greater part of the firms operating in this sector depends or is controlled by the central or local government. These firms furnish four kinds of service: transportation, telecommunications, radio-television, electricity, gas, water. There are already 21 extra-large computers installed with 9 users, five of which belong to the transportation sector and four are electricity and gas companies.

The various subsectors have common applications: cost control, management of suppliers,payroll,general accounting and stock control. The most advanced sector is long distance transportation: typical applications are at present automatic seat reservation, and to a lesser extent, automatic management of the rolling stock.

Service planning is one of the most important applications in both the electricity, gas, water and the telecommunications companies.

The applications' future development is connected to the service's quantitative development and to the need for improvement of quality through diversification.

In the transportation subsector forecasts are for interconnections of the automatic seat reservation systems with equal or different services furnished by different organizations through terminal networks operating in real time. In the telecommunications subsector controlled expansion of the Pert technique for the control of new installations is predicted.

In the energy companies new methods of investment planning with simulation of the service offered will be used.

Data banks and investment planning seem to be the hypotheses for the applications' qualitative development in the radio-television subsector. The hypotheses for the applications' qualitative development indicated above, which will not all be accomplished during the coming decade, will be accompanied in all subsectors by a quantitative development of the current applications.

Hence, a strong increase in the number of users of high performance systems can be foreseen.

For 1975, 18 potential users can be predicted with a capacity for investment in computers of ~~135~~ 315 million Dollars and for 1980 28 users can be foreseen with an investment capacity in computers of 612 million Dollars.

E. Universities and service bureaus

The universities and service bureaus are considered together, because both perform processing services for others. In this sector there are at present many users of extra-large computers: the universities and the research centres, because of their needs for scientific calculations, and the service bureaus, especially those connected to the computer manufacturers. In fact, in 1969 already 25 users of extra-large computers were counted. The current applications at universities and research centres cover an extensive range: from research to basic documentation, from diffusion of software packages for technical and scientific calculation to applications for the administrative and financial departments.

Services provided at present by service bureaus involve mainly administrative and operating fields: production, distribution, technical calculation and engineering. Service bureaus also process management models of operational research.

The characteristics of the services provided, the service bureau's structure and their institutional purposes make them big users of on-line processing systems of remote job entry as well as of time-sharing.

In universities and research centres we do not foresee substantial changes in applications concerning general and specific research and scientific calculations and business-like applications. New applications are computer-based or assisted instruction and information retrieval.

In service bureaus the service supplied for each type of application will change from simple renting of machine hours to a progressive extension of assistance to processing and the preparation of programs.

Development of service bureaus can be more or less intense depending on the development of the EDP structures within the firms using their services. Some firms will be interested in using service bureaus as alternative to internal services.

Given the fact that short term forecasts (1975) depend largely from current equipment and applications for which little information is available, especially concerning universities, forecasts have been formulated only for 1980. On the basis of our hypotheses, there will be a total of 76 users of extra-large computers by 1980. Investment capacity of service bureaus in computers will be 2,480 million Dollars in 1980.

F. Public Administration

This sector is different from the other previously examined ones, because of its heterogeneity and variable extension of the functions and government's different structural features in the various countries.
This difference makes it difficult to identify the current EDP applications and pronounce forecasts for the next decade.
Public Administration, as a whole, is the most fertile ground for the use of extra-large computers in the future, because of the amount of data to be processed, also if the structure of the procedures which have to be transferred to the computer is rather simple qualitatively.
Until now the European countries have faced EDP in an uncoordinated manner and with considerable disaggregation of the applications. As a consequence underestimation of the size of the computers employed occurred, and often optimal distribution from an economic standpoint was not carried out.
Due to the lack of coordination it is difficult to make forecasts about the development of the state's various information systems, because such a forecast would have to be based on a gradual development of suitably integrated mass applications.
Among the possible EDP applications in Public Administration we have examined only those which are used in particularly explosive situations and which require employment of extra-large computers.
Central Administration's information systems which have been examined here are: state budgeting, taxation, population

register, labour force register, public health, social security, air traffic control, meteorology, law data banks and statistics. Moreover, some of the more important applications of local government's information system have been examined.

On the basis of information about present applications in these fields, general indications have been obtained about the time period in which each of the systems, if realized, will request installation of high performance equipment. The corresponding demand for extra-large computers can, however, be defined only on the basis of the evolution of the organizational structures of government in the various countries.

5. Final remarks

From the preceding summary several analogies existing between the various industries become evident, concerning both what is being done at present and forecasts for future developments.

* The present applications concern mainly fields in which simple and repetitious activities are being carried out. Computers are mainly in batch off-line, i.e. do not depend from terminal networks.
* Future expectancies are directed mainly toward;
  - quantitative expansion and qualitative improvement of the applications;
  - integration of subsystems into the Management Information System which will, by necessity, require use of extra-large computers;
  - intersectorial data archives, especially in Public Administration;
  - on-line processing of applications through use of large terminal networks gravitating around a central computer and structured according to the two principal philosophies which have been called "solar system" and "atomic system", the latter being necessarily based on employment of extra-large computers.

On the basis of hypotheses for the applications' development in the various subsectors, with the exception of Public Administration, 280 potential users of extra-large computers can be forecast (1). The number of potential

---

(1) By 1975 there will be 101 potential users in the industries examined, except universities.

users does, however, not correspond to the number of extra-large computers which will be installed in the industries considered by 1980.

As a matter of fact, the potential users will be those enterprises which in 1980 will be able to invest more than 5 million Dollars in computers. They can, however, install one or more extra-large computers, or, if they tend towards the solar and not the atomic system, they can distribute their investment among several smaller computers. This second hypothesis is, however, in our opinion improbable, because many of the applications discussed require installation of an extra-large computer.

If each of the potential users installed an extra-large computer, the forecasts formulated for the industries would be compatible with the overall forecasts which predict for 1980 installation of between 310 and 425 extra-large computers (1). During the next decade development of extra-large installations will depend to a large degree from EDP development in government. If government's engagement in this field will be small, the number of extra-large computer installations will probably be near the lower limit given above; on the other hand, greater engagement on the part of government can easily cause the number of installations to reach a number which could be even higher than the maximum limit indicated.

Development of investment in EDP has in the past been

---

(1) At a purchase price above 5 million Dollars, corresponding to an annual rent of 1.25 million Dollars.

influenced by at least two factors:
1) types of applications the computer performs and
2) number of firms using these computers.
The research group has tried to identify the greatest possible number of factors which influence this process by following the development of each factor and assess its influence on the EDP investments.
The forecast obtained this way is the result of the effect of all the factors considered on the process of investment in extra-large computers.
Separating the weight of each factor was necessary in order to:

- distribute the risks deriving from mistakes which could have been made during the individuation of these factors and their weighting;
- make possible eventual corrections of these factors;
- facilitate introduction of new factors which were not previously individuated.

Limitation of the results thus obtained are due to the fact that the procedures used project dynamic phenomena only on the basis of static analysis.
This forecast, however, referring to an industry which undergoes rapid technological changes, requires periodic verification in order to include all the variations which can influence the factors examined.
The forecasting procedure used permits to reassess quickly and in a standard way the contribution of each factor to the development of EDP investments.
Efficient feedback with the users is a perequisite for exploiting the advantages of the proposed forecasting mechanism, in order to take account of the effects on the industry examined which are strongly influenced by supply.

Information necessary for continued reassessment of the forecasts can be obtained also through careful desk research which has, however, to be completed with periodic interviews with the predicted "potential users' of extra-large computers.

Bibliography

1. Books & Reports

ACCADEMIA DEI LINCEI - L'automazione elettronica e sue implicazioni scientifiche, tecniche e sociali, Atti del Convegno, Roma, 1967

ARTHUR D. LITTLE INC. - The USA Computer Industry 1968-73, Cambridge, Mass., 1968

- The Computer Industry, 1969-74, Cambridge, Mass., 1969

- The Electronic Data Processing Industry in Europe, Cambridge, Mass., 1967

A.I.C.A. - Rapporto Preliminare del Comitato di Studio A.I.C.A. sul Problema della Preparazione del Personale per L'elaborazione elettronica in Italia dei Dati, Roma, 1968

BENN, A.W. - The Government's Policy of Technology, Ministry of Technology, London, 1967

BIPE (Bureau d'Information et de Prévision Economique) L'industrie Electronique des Pays de la Communauté et les principaux Pays Tiers, Paris, 1967

CENTRE EUROPEENNE DE L'ENTREPRISE PUBLIQUE - Les Entreprises Publiques dans la CEE, DUNOD, Paris, 1967

CNUCE (Centro Nazionale di Calcolo Elettronico) - Utilizzazione degli Elaboratori Elettronici nella Programmazione Economica Regionale, Convegno Nazionale organizzato in collaborazione con la IBM Italia, Pisa, 1967

COMMERZBANK BRANCHEAN BERICHT - Elektronische Datenverarbeitung, Juni 1968

COMMISSIE OPLEIDING VAN DESKUNDIGEN VOOR AUTOMATISCHE INFORMATIEVERWERKING' - Opleiding in Informatica, Studiecentrum voor Administratieve Automatisering, Amsterdam, 1969

COMMISSION DES COMMUNAUTES EUROPEENNES - Direction Générale des Affaires Economiques et Financières -
- Groupe d'Etude des Perspectives Economiques à moyen terme, Bruxelles, 1969

- Groupe Spécial Recherche Scientifique et Technique - Rapport du groupe spécialisé INFORMATIQUE, Bruxelles, 1968

- Groupe de la politique de la recherche scientifique et technique - Rapport du Groupe Spécialisé INFORMATIQUE , Bruxelles, 1969

- OFFICE STATISTIQUE DES COMMUNAUTES EUROPEENNES - Comptes Nationaux, 1959-1968, Bruxelles, 1970

- OFFICE STATISTIQUE DES COMMUNAUTES EUROPEENNES - Etudes et enquêtes statistiques, n. 3, 1968

COMPUTER BOARD for UNIVERSITIES and RESEARCH COUNCIL - First Report of the Computer Board, HMSO, London, 1969

COMPUTER CONSULTANTS LTD. (ed.) - European Computer Handbook 1968-69, London, 1969

DADDA, L. - Il Settore dei calcolatori, in Convegno FAST: "La ricerca industriale per l'Italia di domani", Milano, 1967.

DESMONDE, W.H. - Computers and Their Uses, Prentice-Hall,1964.

DEARDEN, J. - Computers in Business Management, Irwin, 1966

DE BRUIJN, W.K. - Computers in Europe 1966, Netherland Automatic Information Research Centre, Amsterdam,1966

- Service bureaus: De mogelijheden van het huren van computertijd in Europa en in het bijzonder in Nederland, Studiecentrum voor Administratieve Automatisering, Amsterdam, 1966

- Het gebruik van computers bij de lagere overheid in West-Europa en in Noord-Amerika, Stichting Studiecentrum voor Administratieve Automatisering, 's-Gravenhage, 1965.

DELANNOY, R. - L'emploi des Ordinateurs pour les Statistiques de production et le calcul du Prix de Revient, Radio Diffusion-Television Belge, Bruxelles, 1969

ELLIOTT, C.O. and R.S. WASLEY - Business Information Processing Systems, Irwin, 1965

ENTREPRISE (Les dossier de l'), november 1969

EUROPA PUBLICATION (ed.) - The Europa Year Book 1969, London, 1969

- The World of Learning 1969-1970, London, 1970

FITE, H.H. - The Computer Challenge to Urban Planners and State Administrators, Spartan Books, 1965

FRIELINK, A.B. (ed.) - Economics of Automatic Data Processing, North-Holland Publishing Company, Amsterdam, 1966

GENERAL ELECTRIC - L'Automazione negli Istituti Ospedalieri, Milano, 1970

HATTERY, L. and G. BUSH (Ed.) - Automation and Eletronics in Publishing, Thompson Book Co.

HATTERY, L. H. and E.M. McCORMICK (Ed.) - Information Retrieval Management, American Data Processing, 1963

HEARLE, E.F.R. and R.J. MASON - A Data Processing System for State and Local Governments, Prentice-Hall, 1963

HOSKYNS GROUP LIMITED - U.K. Computer Industry Trends 1970 to 1980, October 1969

HUGHES, J.L. (ed.) - Programmed Learning: a critical evaluation, London, 1969

ILIFFE, J.K. - Basic Machines Principles, McDonald Elvisier Computer Monographs, 1968

INSTITUT FÜR ANGEWANDTE REAKTORPHISIK - Untersunchung des Einsatzes von elektronischen Datenverarbeitungsanlangen in Deuschtland Stand und Entwicklungstendenzen, Gesellschaft für Kernforschung M.B.H., Karlsruhe, 1969

(The) INTERGOVERNMENTAL BUREAU FOR INFORMATION TECHNOLOGY - The International Directory of Computer and Information System Services 1969, London, 1969

INTERNATIONAL COMPUTATION CENTRE - Le contexte Mondial de L'informatique Française, Rome, 1968

ISTAT - Indagine sugli elaboratori elettronici in Italia al 31 marzo 1968, Roma, 1968

IVERSON, K.E. - A programming language, J. Wiley & Sons, 1962.

KRÖMER, H. - Der Drifttransistor, Naturwissebschaften,1953

LERMITTE, P. - Le Pari Informatique, Edition France-Empire, Paris, 1968

MINISTERO DEL BILANCIO E DELLA PROGRAMMAZIONE ECONOMICA - Progetto '80, Feltrinelli, Milano, 1969

NAA RESEARCH STUDY - Computer Based Information Systems for Management - A survey, March, 1969

NETHERLANDS AUTOMATIC INFORMATION PROCESSING RESEARCH CENTRE - Development of the Computer Market in Europe, Amsterdam, 1963

OCDE - Labour Force Statistics 1956-1967, Paris, 1969

- International Statistical Year on R&D, Paris, 1967
- National Accounts of OECD Countries, 1958-67, Paris, 1969
- Ecarts Technologiques entre Pays Membres: Calculateurs Electroniques, Paris, 1968

PARKILL, D.F. - The Challenge of the Computer Utility, Addison-Wesley, 1966

PUBLIC AUTOMATED SYSTEMS SERVICE - Governmental ADP: The Practitioners Speak, Public Administration Service, Chicago, 1968

RAI - Relazioni sull'impiego dei calcolatori per le statistiche di produzione e per il calcolo dei costi di produzione, Torino, 1969

ROSE, M. - Computers, Managers and Society, Pelican Library of Business and Management, London, 1969

ROSEN, S. - Electronic Computers : A Historical Survey, Computing Survey, 1969

ROSSI, S. - Il Calcolatore Elettronico, ETAT KOMPASS, 1967

SALMONA, G. and J. URVOY - L'Intégration des Ordinateurs dans les Structures de Décision, Institut Ekonomiki I Organizacji Przemyslu, Warsawa, 1966

SOLOMON, I. I. and L.O. WEINGART - Management Uses of the Computer, Harper & Row, 1966

SPER (Syndicat des Industries de Matériel Professionnel Electronique et Radioelectrique) - Résultat de l'Enquête relative au Matériel Electronique à Traiter l'Information, Paris, 1969

THOMAS, S. - Computers : Their History, Present Applications, and Future, Holt, Rinehart & Winston, 1965

(The) TIMES 500 - Leading Companies in Britain and Overseas 1969-70, Times Newpapers Ltd., London, 1969

UNESCO - L'Education dans le Monde, Paris, 1967

UNIONE REGIONALE DELLE PROVINCE TOSCANE - Progetto Etruria: L'elaborazione Elettronica al Servizio delle Automie locali, Firenze, 1969

U.K. CENTRAL STATISTICAL OFFICE - Monthly Digest of Statistics, HMSO, London, 1968 and 1969

U.K. MINISTRY of LABOUR - Computer in Office "Manpower" Studies n. 4, London, 1965

- Statistics on Incomes, Prices, Employment and Production, London, 1968

U.K. MINISTRY of TECHNOLOGY - Developments in Technology, London, 1967

U.S. COMMITTEE on GOVERNMENT OPERATIONS - Privacy and the National Data Bank Concept, U.S. Government Printing Office, Washington, D.C., 1968

U.S. DEPARTMENT of HOUSING and URBAN DEVELOPMENT - Urban Regional Information Systems: Support for Planning in Metropolitan Areas, Washington, D.C., 1968

U.S. GOVERNMENT PRINTING OFFICE (ed.) - Inventory of Automatic Data Processing Equipment in the Federal Government, 1965

U.S. GOVERNMENT PRINTING OFFICE (Ed.) - Use of Electronic Data Processing Equipment in the Federal Government, 1964

- The Management of Automatic Data Processing in the Federal Government, McClellan Committee Report, 1965

- Economic Report of the President, Washington, 1970

WHITLOCK, J.W. - Automatic Data Processing in Education, Collier-Macmillan, 1964

WILLIAMS, W.F. - Principles of Automated Information Retrieval, The Business Press, 1965

ZERO. UN. SCOPE 68 - Annuaire Général de l'Informatique, Tests, Paris, 1968

2. Reviews

A.D.P. NEWLETTER, The Diebold Group Inc., Management Sciences Publ., U.S., from 1959 to 1969

AMERICAN DOCUMENTATION, American Society for Information Science, U.S., from 1966 to 1969

ANALYSE ET PREVISION - "Le traitement de l'information en Europe et le retard technologic" by A. Charguéraud, Vol. V, mars 1968.

AUERBACH TIME-SHARING REPORT, 1970, Service Summary, Auerbach Info. Inc., US, 1970

AUERBACH - STANDARD EDP REPORTS, Auerbach Info. Inc., US, 1969

AUTOMATISME, Association Française de Regulation et Automatisme, France, from 1966 to 1969

(The) BELL SYSTEM TECHNICAL JOURNAL, American Telephone & Telegraph Co., New York

BULLETIN CEGOS INFORMATIQUE, CEGOS, France, from 1966 to 1969

BULLETIN DU CIMAB, Centre d'Information du matériel et des articles de bureau, Paris, 1969

BUSINESS AUTOMATION, OA Business Publications Inc., US, 1968 and 1969

CENTRI MECCANOGRAFICI ED ELETTRONICI I.S.E.O, Centro Studi Meccanografici ed Elettronici, Milano, from 1966 to 1970

COMMUNICATIONS OF THE ACM, Association for Computing Machinery, New York, from 1961 to 1969

COMPUTER BULLETIN, (The) British Computer Society, London, 1969

COMPUTER CHARACTERISTICS QUARTERLY, Adams Associates Inc., US, 1967 and 1968

COMPUTER CHARACTERISTICS REVIEW, Keydata Corporation, US, 1969

COMPUTER DESIGN, Computer Design Publishing Corp, US, 1968 and 1969

COMPUTER SURVEY, United Trade Press, London, from 1962 to 1969

COMPUTERS AND AUTOMATION, Berkeley Enterprises Inc., US, from 1964 to 1969

CONTROL ENGINEERING, Reuben H. Donnelley Corp., US, 1968

DATAMATION, F.D. Thompson Publications, Inc., US, from 1961 to 1969

DATA PROCESSING, Iliffe Technical Ltd., London, 1968 and 1969

ECONOMIE APPLIQUEE - "Evolution des ordinateurs pendant les vingt dernière années" by J. Peterson, N.4, 1969

- "Impact économique de l'informatique" by F.H. Raymond, n. 4, 1969

- "L'industrie de l'informatique française à la veille du VI Plan" by J.M. Treille, n. 4,1969

- "Le Plan Calcul dans une strategie d'ensamble de dévelopment de l'industrie électronique française" by P. Andorn, n. 4, 1969

(Les) ECHOS, "1970 Informatique et équipement de gestion", Supplement au n. 10416

EDP EUROPA REPORT, IDC Europa Ltd., London, 1969 and 1970

EDP INDUSTRY AND MARKET REPORT, International Data Publishing Co., US

ELECTRONICS, McGraw-Hill Inc., New York, from 1967 to 1969

(L') EXPANSION - Livre Blanc : Les Ordinateurs, Juillet/août '68

- Special : Ordinateur 1969, Juillet/août, '69

FORTUNE, "The computer industry's great expectations" by G. Burck, august 1968

HARVARD BUSINESS REVIEW, "Managing to manage the computer" by S. Taylor and N. Dean, september/october 1966

IBM RIVISTA, Milano, from 1966 to 1969

IBM SYSTEMS JOURNAL, International Business Machines Corp., US, 1968 and 1969

I.E.E.E., Proceedings of the Institute of Electrical and Electronics Engineers Inc., US, from 1963 to 1969

I.E.E.E. SPECTRUM, The Institute of Electrical and Eletronics Engineers Inc., US, 1968 and 1969

I.E.E.E. TRANSACTIONS ELETRONIC COMPUTERS, The Institute of Electrical and Eletronics Engineers Inc., US, from 1967 to 1969

INFORMATIQUE et GESTION, Paris, 1968 and 1969

IRE, Proceeding of the Institute of Radio Engineers Inc., US, from 1955 to 1962

JOURNAL of APPLIED PHYSICS, American Institute of Physic, New York, from 1966 to 1969

JOURNAL OFFICIEL DE LA REPUBLIQUE FRANCAISE, "Les perspective de dévelopment de l'automatisation industrielle en France", N. 2, 12 Février 1970

JOURNAL OF THE AMERICAN INSTITUTE OF PLANNER, "Planning agency experience with urban development models and data processing" by G.C. Hemmens, september 1968

MONDO ECONOMICO, "Elaboratori elettronici installati suddivisi per tipo di attività economica", n. 21, 23/5/1964

MOODY'S COMPUTER INDUSTRY, Moody's Investors Services Brandon Applied Systems Inc., US, 1968 and 1969

NEW LITERATURE ON AUTOMATION, IFIP A.D.P. GROUP, Netherland, from 1968 to 1970

PHILIPS RESEARCH REPORTS, Philips Research Laboratories, Netherland, from 1965 to 1968

RCA REVIEW, RCA Laboratories, US, from 1966 to 1968

RIVISTA DI ORGANIZZAZIONE AZIENDALE ETAS-KOMPASS/IBPA, Int. Business Press Associates, Italy , from 1960 to 1968

SMPTE, Journal of Society of Motion Picture and Television Engineers, Inc., US, from 1960 to 1969

TRAVAIL ET METHODES, Paris, from 1964 to 1969

ZERO UN INFORMATIQUE - ETUDES, Editions Tests, France, from 1966 to 1969