A History of Computing
In the U.S.S.R.
by Andrei P. Ershov

Though second generation machines still perform the bulk of the workload, a nationwide computer utility is planned for the 1980s.

There are three specific fundamental factors which have greatly affected the development of data processing in the U.S.S.R.:

- The Soviet Union has been forced to develop all aspects of the computer business relying exclusively on its own intellectual and technological resources.
- Computer development in the U.S.S.R. exists outside the scope of multinational computer companies.
- The U.S.S.R.'s social system directly and decisively influences the development and application of computers.

The first factor is not now as absolute as it was, say, 10 to 15 years ago. The normalization of international relations and growth of exchange in trade, science, and technology, led to a levelling of the scientific and technological base through a flow of technical information. The extension and reinforcement of this base have been greatly affected by processes of integration in the national economies of Socialist countries and, in particular, have been embodied in the development of ES EVM (the Unified Range of Electronic Computing Machines) known better under the acronym “Ryad.” It wasn’t always that way.

The history and prospects of computer development in the U.S.S.R. can be divided into four 10-year periods. The ’50s were characterized by the first generation computers, their applications to the most urgent scientific and technological problems, and pioneering works in computer design, software development, and basic applications concepts.

In the ’60s, the second generation computers appeared, a foundation for the regular production of computers and their components was built, and all branches of the computer business were identified and formed.

In the ’70s, a broad expansion of third-generation computers into all sectors of the national economy is taking place. In all major organizations, computer applications have been developed to the point of regular service, and data bases are being computerized.

In the ’80s, a global network of computers, terminals, and switching centers will be established. This network will allow an integration of data bases and their transmission at electronic speeds. All business units of the national economy, without exception, will be involved in computer applications through a network of multi-access computer utilities. Public computer applications (schools, medical service, public libraries, home terminals) will start to grow on a large scale.

Computer development is subject to a number of long-range national programs with well-established goals.

The first program is for computer production. Since 1971, computer production has been considered a separate industry sector and separate statistics have been kept for it. The total sale price of computers manufactured in 1970 was 710 million rubles. The program for production in the 1971-1975 period assumed a growth rate of 2.6 times the 1970 level; the actual rate is greater than this. (See Fig. 1.)

The main component of this boom is the production of ES EVM (or “Ryad”) computers. These machines are produced through a joint venture of the seven socialist countries acting as a kind of large-scale multinational company. Twenty thousand people participated in ES EVM design and production preparation; 70,000 are involved in production.

The second program is for computerized automation of manufacturing and management. Systems for these applications are called Automated Control Systems in Russian terminology. Industry is the main field for introducing them, and they are accordingly classified as:

- automated process control systems (APCS)
- plant automated management systems (PAMS)
- branch automated management systems (RAMS)
- regional automated management systems (RAMS)

The last three correspond to the En-
We found the only thing mini about the 3000 was its price.

When we asked the EDP center manager of another major manufacturing company about the 3000, that was what he had to say. He also had this to say:

"Our computer needs include both scientific and commercial applications. We were phasing out our teleprocessing terminal and our Environmental Monitoring Division's computer. So we started looking. We spent several months studying computer systems, and rated them on speed, versatility and ease of operation. The result of our study showed that the HP 3000 provided these requirements and had the best cost/performance ratio. We didn't fully realize the potential of the 3000 until we started programming it. We have experienced a significant cost savings in the seven months we've had the 3000 and we expect a greater savings in the months ahead. We really like the interactive CRT for programming and data input. Being a multi-programming system we can have many users on at the same time. The power and speed of the 3000 is equal to a large machine. It's no mini. Calling it the Mini DataCenter is more accurate. I'd definitely recommend the 3000 to other potential users. In fact, we already have. We feel they would be money ahead!"

We're glad these and other users of the HP 3000CX set us straight. We called it a minicomputer because its state-of-the-art technology lets us sell it for a minicomputer price. From now on we'll call it a Mini DataCenter.

We want you to get the whole story. Write us for your copy of our HP 3000CX Mini DataCenter booklet. We know you'll find it interesting, informative, and maybe a bit surprising.

HP Mini DataCenters. They work for a living.

September, 1975
The Minsk-32 is a very popular inexpensive computer with reasonably good software; it is the primary machine for management information systems.

M-220 and BESM-4 are workhorses of the '60s for engineering and small scientific applications.

The MIK-2 has no direct counterpart in Western computers; it combines a microprogrammed byte-oriented mini-computer with an alphanumeric display and a light pen. Besides being used extensively for engineering calculations and analytic manipulations, it can also be used as an intelligent terminal.

The NAIRI-3 is very popular as a small, compact configuration for engineering and design departments. It has a large read-only memory where a subroutine library and Algol compiler are stored. Recently it has been given an emulator for the Minsk-22, the predecessor of the Minsk-32.

ES EVM (Ryad) models do not require any specific comments. They use integrated circuits and have performed

**APPLICATION DEVELOPMENT IN THE U.S.S.R.**

1951 Scientific application (MESM)
1953 Math tables (BESM)
1954 First public computing service (STRELA)
1956 Language translation experiments (BESM)
1957 Economic calculation (M-2)
1958 Medical application (STRELA)
1961 Process control (DNEPR)
1964 Bank office (URAL)
1966 Chess program (M-220)
1967 Plant management information system (Minsk-22)

The first scientific computations were done during the checkout of the BESM computer. The economic calculations were also a self-serving step, from the hardware's viewpoint, as they were done as part of a study to introduce the computer into economics. Also of interest is the chess program; it beat an American program running on a 7090 in a four-game match.
The Elite 1520A Video Terminal.

New from Datamedia.

**Conversational.** The Elite 1520A speaks your application language, and is ideal for interactive programming, data entry, information retrieval and simply anyplace the need for data communication is important.

**Expandable.** The Elite 1520A offers the standard 64-character ASCII set displaying 1920 alphanumeric characters in a 24-line/80-character format, and is optionally expandable to a 128-character set, including upper and lower case. And now, APL/ASCII switch-selectable capability.

**Separable.** This newest video terminal from Datamedia is a stand-alone unit, with the display and keyboard separated for greater applications flexibility.

**Compatible.** It's plug-compatible with Teletypewriter* Models 33 and 35, either via a standard RS232C or an optional 20/60mA current loop interface. Data rates from 50 to 9,600 bps may be accommodated.

**Economical.** No matter which performance yardstick or competitive unit you stack it up against, the Elite 1520A's $1555 price ($1655 with upper and lower case option) in quantities of 1 to 9 (20% lower in quantities of 100) is tough to beat.

**Reliable.** Our practical design approach is the answer, and our list of users worldwide of other proven Elite video terminals can tell you what reliability is all about in a CRT. Or we can tell you.

**Available.** The Elite 1520A is not one of those announced-today, promised-tomorrow, delivered-someday products. It's here. It's available.

**NEW!** APL/ASCII

---

**Datamedia Corporation**

Gaithersburg, Md. 301/948/1670

Los Angeles, Calif. 213/397/3556

**AUSTRALIA**

Intelec Pty. Ltd.

18 Pickford Street

East Bunwood, Vic. 3151

**UNITED KINGDOM**

Mellor Data

Wodgate Road

East Bergholt, Essex

**ITALY**

Eltron s.r.l.

Via Romano, 1

25100 Brescia

**WEST GERMANY**

Video Data Systems GmbH

6451 Bruchkobel

Im Niederried 3

---

*C Teletypewriter is a registered trade name of Teletype Corporation, Skokie, Illinois.
mance characteristics approaching the IBM 360 models 30, 40, 50, and what would be models 60 and 70.

The ES 1010, ELECTRONIKA, and M-6000 are minis.

In the early period of mass production, computers were sold, installed, and put into operation by a manufacturer without any obligation for subsequent maintenance. Recently the manufacturing ministries have established a statewide network of field engineer and software teams which, on a contract basis, take full responsibility for the installation and maintenance of computers. In the U.S.S.R., computers are not rented, but service bureaus are quite widespread.

Developed in 1966, the second generation BESM-6 is still the most powerful Soviet computer.

SOFTWARE DEVELOPMENT IN THE U.S.S.R.

1953 Subroutine library (STRELA, BESM)
1955 Algorithmic language compiler (PP-2, PP-BESM)
1957 Assembler (PAPA, SSP)
1962 Algol 60 compiler (TA-1)
1962 Batch processing monitor (AUTOOPERATOR)
1966 Delivery of first operating systems (MINSK-22, BESM-6)
1967 Systems programming languages (EPSILON, ALMO)
1971 Operating system with batch and multi-access (AIST-O)
1972 Delivery of time-sharing operating systems (OS IPM, DNEPR-2)

The first Russian computers contained read-only memory with built-in libraries of math and conversion functions. Compilers were the first big advance, providing Assignment, Conditional, For statements, subscripted variables, and, strangely enough, appearing before assemblers.

HARDWARE DEVELOPMENT IN THE U.S.S.R.

1951 ENIAC type computer
1952 First logical structure computer (BESM)
1953 First serial production line computer (STRELA)
1960 Transistorized computers (RAZDAN, DNEPR, MINSK-2)
1966 Most powerful computer (BESM-6)
1969 Conversational computer with display (MIR-2)
1970 Integrated circuit computer (NAIRI-3, M-3000)
1971 Time-sharing systems (AIST-O, SIRENA, BESM-6)
1971 Minicomputers (ELECTRONIKA, M-6000)
1972 ES EVM or Ryad computers (1010, 1020, 1030, 1040, 1050)

Though built in 1966, the BESM-6 still remains the most powerful computer built in the U.S.S.R. Its rate is 1 million operations per second. Third-generation computers did not appear until 1970, when the small (and very popular) NAIRI-3 and the medium-scale 360-like M3000 were introduced. The SIRENA system listed as “time-sharing” is for airline reservations.

Second Generation Machines

<table>
<thead>
<tr>
<th>Soviet Model</th>
<th>U.S. Counterpart</th>
</tr>
</thead>
<tbody>
<tr>
<td>BESM-6</td>
<td>CDC 3600</td>
</tr>
<tr>
<td>MINSK-32</td>
<td>GE 400</td>
</tr>
<tr>
<td>M-220</td>
<td>IBM 7040</td>
</tr>
<tr>
<td>BESM-4</td>
<td>-</td>
</tr>
</tbody>
</table>

Third Generation Machines

<table>
<thead>
<tr>
<th>Soviet Model</th>
<th>U.S. Counterpart</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAIRI-3</td>
<td>-</td>
</tr>
<tr>
<td>ES EVM</td>
<td>IBM 360</td>
</tr>
<tr>
<td>1020</td>
<td>30</td>
</tr>
<tr>
<td>1030</td>
<td>40</td>
</tr>
<tr>
<td>1040</td>
<td>50</td>
</tr>
<tr>
<td>1050</td>
<td>“60”</td>
</tr>
<tr>
<td>1060</td>
<td>“70”</td>
</tr>
<tr>
<td>ES 1010</td>
<td>MITRA-15</td>
</tr>
<tr>
<td>ELECTRONIKA</td>
<td>DEC PDP-8</td>
</tr>
<tr>
<td>M 6000</td>
<td>HP-2116B</td>
</tr>
</tbody>
</table>

THE SOFTWARE

For every Russian computer, there is both “official” and “unofficial” software. Official software is delivered by a manufacturer as an integral part of the product. This software is not separately priced and its cost influences the price of a computer quite indirectly. Unofficial software usually appears as a result of some user activity and is accumulated at a particular installation either through exchange agreements or through user association efforts.

Official software, in turn, consists of basic and secondary software. Basic software is part of the design specifications prescribed by a general contractor. For national economy applications, such a contractor is the State Committee for Science and Technology. The basic software is usually a compromise between users’ insatiable demands and manufacturers’ available resources. The manufacturer gets big pieces of the basic software from subcontractors—some academic or educational institutes.

The secondary software has usually been successfully developed by one user for his own purposes, and later, as a result of formal recommendation by some authoritative committee, is accepted and ratified by the manufacturer.

In the established Russian terminology, a well developed software system consists of three parts: the operating system, the programming system (including compilers, debugging means, and other man-machine interface aids), and application packages. Data base management is not yet technically stable and falls into operating or programming systems depending on the designer’s philosophy.

The MINSK-32 has a sound example of a well integrated software system of reasonably high quality. Most users adopt the official software without modification. The size of the system is over 225K words, available in 175 modules. A high integrity also charac-
Sooner or later you’ll switch to key-to-disc.

It’s in the cards.
U.S.S.R.

terizes the software system for ES computers. Its first release, delivered in 1972, consists of 600K instructions and is close to DOS/360.

Operating systems

Official operating system versions provide support for batch multiprogramming on single processor, large and medium scale computers. These operating systems are of reasonably high quality with respect to effective performance. The overhead time for the DISPACK operating system for BESM-6 is no more than 9%; the idle time is no more than 8% and the multiprogramming factor is over 1.6.

Some actively used unofficial systems have much broader capabilities. The operating system of the Institute of Applied Mathematics for BESM-6 provides a combination of multiprogrammed background batch processing with a multi-access foreground, and adopts a multiprocessing architecture. A universal time-sharing operating system for the Minsk-32 has been developed but not yet ratified.

Operating systems for small cpu's and minis provide a combination of the main program calculations with operator dialogue. The official OS for the DNPR-2 also has some multi-access features. There may be only several dozen time-sharing systems in operation, but their number is growing very rapidly. The most usable terminals are standard RFT teleprinters from DDR, terminals based on a CSSR electric typewriter "Consul," and Hungarian alphanumeric displays called "Videotons."

Programming systems

It should be noted that the Soviet Union has become the home for ALGOL. ALGOL and ALPHA, its extension into complex and vector-matrix arithmetic, are the primary languages for scientific, engineering, and educational purposes. Its popularity is depicted in a breakdown by language type of all the jobs run at the Computation Center of the Siberian Division of the Academy of Sciences (which has 3,000 users) during April 1974:

- ALPHA: 35%
- ASSEMBLER: 20%
- ALGOL: 13%
- FORTRAN: 12%
- EPSILON: 9%
- Others: 11%

One of the reasons for ALGOL's and ALPHA's great popularity is the fact that they have lent themselves to the construction of so many efficient Russian compilers. Although I have no elaborate statistics to prove that efficiency, a case study of one program for meteorological calculations supports my claim. Dr. G. R. Kontarev from the Novosibirsk Computation Center, during his visits to the U.S. and France, had chances to run his program without changing the basic algorithm through several different computers and compilers. The results of the tests are shown in Fig. 2.

A few words about the fates of FORTRAN and COBOL are appropriate. FORTRAN appeared in the U.S.S.R. as a direct result of scientific exchange, but not until the second half of the '60s! Its first implementations were for the Minsk-22 and BESM-6; they were done in response to the demands of physicists who had visited Cern, Switzerland, and were eager to use programs developed there.

The sale of western computers to the U.S.S.R. also resulted in the gradual growth of the use of FORTRAN. I am not sure we are experiencing a FORTRAN boom, but FORTRAN as well as ALGOL and COBOL are "by law" obligatory parts of every basic software set for general purpose computers.

The need for developing a common business-oriented language became apparent in the U.S.S.R. in the beginning of the '60s. The first responses to the demand were ALGOL adaptations to data structure description known under the names of ALEG and ALEGEM.

<table>
<thead>
<tr>
<th>LANGUAGE</th>
<th>COMPUTER</th>
<th>PERFORMANCE</th>
<th>PROGRAM RUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCTAL</td>
<td>M-220</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>ALGOL</td>
<td>BESM-6</td>
<td>1000</td>
<td>2</td>
</tr>
<tr>
<td>FORTRAN</td>
<td>CDC 6600</td>
<td>3000</td>
<td>6</td>
</tr>
<tr>
<td>OPTIMIZED FORTRAN</td>
<td>CDC 6600</td>
<td>3000</td>
<td>4</td>
</tr>
<tr>
<td>ALGOL</td>
<td>CII</td>
<td>1000</td>
<td>12</td>
</tr>
</tbody>
</table>

Fig. 2. The relative efficiencies of various compilers was tested by running a meteorological program through several machines without changing its algorithm. The ALGOL-based ALPHA compiler on the second-generation BESM-6 stacks up nicely, even against optimized FORTRAN on the CDC 6600.

Some implementations of these languages are still in use.

Meanwhile, patient work on COBOL and its adaptation to the Russian language led to a "minimal" COBOL for broadly used implementations on the DNPR-2 and Minsk-32. Now a draft of Russian standard COBOL has been prepared which corresponds to the ANSI version.

PL/1, ALGOL 68, and SIMULA 67 languages are not yet in use, but about ready. And almost all time-sharing operating systems have Russian as well as English versions of JOSS and BASIC.

Applications packages

The first applications packages were in the lines of standard subroutine libraries. Later, large application programs were created in the "black box" style with a monolithic structure which made adaptation and modification difficult. Recently a new concept has been accepted, that of a structured and open applications package taking the form of a dedicated operating system.
For years, keypunch and cards have been a perfectly fine combination for data entry. But nowadays, throughput is the name of the game. And if you’re still playing with cards, you’re not holding a winning hand.

Enter Inforex.

Inforex is the world’s leading manufacturer of key-to-disc data entry systems. So far we’ve installed over 3000 systems throughout the world. And almost all of them were conversions from keypunch.

The reasons for our success are simple.
Our “no frills” design approach and our enormous amount of experience allow us to make the conversion from keypunch to key-to-disc at the lowest cost of any manufacturer anywhere. And do it with a minimum of trouble to the user.

Once the system is installed, we back it up with an extensive and highly effective field service organization. So if you need help, we’re no further away than your phone.

And thanks to the remarkable efficiency of the Inforex systems, your computer can receive purer data, errors can be virtually eliminated, and throughput can be increased to a level that keypunchers can only dream about.

There’s a whole series of Inforex key-to-disc systems to choose from: Systems 1301, 1302, and 1303. One of them is just right for your present needs. And as you grow, your Inforex system will grow with you. Because we have a line of compatible systems that will take you as far as you want to go.

For more information, give us a call or mail us the coupon today. Because if there’s ever been a time for switching from keypunch to key-to-disc, this is it.

Inforex.

Like we said, it’s in the cards.

For years, keypunch and cards have been a perfectly fine combination for data entry. But nowadays, throughput is the name of the game. And if you’re still playing with cards, you’re not holding a winning hand.

Enter Inforex.

Inforex is the world’s leading manufacturer of key-to-disc data entry systems. So far we’ve installed over 3000 systems throughout the world. And almost all of them were conversions from keypunch.

The reasons for our success are simple.
Our “no frills” design approach and our enormous amount of experience allow us to make the conversion from keypunch to key-to-disc at the lowest cost of any manufacturer anywhere. And do it with a minimum of trouble to the user.

Once the system is installed, we back it up with an extensive and highly effective field service organization. So if you need help, we’re no further away than your phone.

And thanks to the remarkable efficiency of the Inforex systems, your computer can receive purer data, errors can be virtually eliminated, and throughput can be increased to a level that keypunchers can only dream about.

There’s a whole series of Inforex key-to-disc systems to choose from: Systems 1301, 1302, and 1303. One of them is just right for your present needs. And as you grow, your Inforex system will grow with you. Because we have a line of compatible systems that will take you as far as you want to go.

For more information, give us a call or mail us the coupon today. Because if there’s ever been a time for switching from keypunch to key-to-disc, this is it.

Inforex.

Like we said, it’s in the cards.

For years, keypunch and cards have been a perfectly fine combination for data entry. But nowadays, throughput is the name of the game. And if you’re still playing with cards, you’re not holding a winning hand.

Enter Inforex.

Inforex is the world’s leading manufacturer of key-to-disc data entry systems. So far we’ve installed over 3000 systems throughout the world. And almost all of them were conversions from keypunch.

The reasons for our success are simple.
Our “no frills” design approach and our enormous amount of experience allow us to make the conversion from keypunch to key-to-disc at the lowest cost of any manufacturer anywhere. And do it with a minimum of trouble to the user.

Once the system is installed, we back it up with an extensive and highly effective field service organization. So if you need help, we’re no further away than your phone.

And thanks to the remarkable efficiency of the Inforex systems, your computer can receive purer data, errors can be virtually eliminated, and throughput can be increased to a level that keypunchers can only dream about.

There’s a whole series of Inforex key-to-disc systems to choose from: Systems 1301, 1302, and 1303. One of them is just right for your present needs. And as you grow, your Inforex system will grow with you. Because we have a line of compatible systems that will take you as far as you want to go.

For more information, give us a call or mail us the coupon today. Because if there’s ever been a time for switching from keypunch to key-to-disc, this is it.

Inforex.

Like we said, it’s in the cards.

For years, keypunch and cards have been a perfectly fine combination for data entry. But nowadays, throughput is the name of the game. And if you’re still playing with cards, you’re not holding a winning hand.

Enter Inforex.

Inforex is the world’s leading manufacturer of key-to-disc data entry systems. So far we’ve installed over 3000 systems throughout the world. And almost all of them were conversions from keypunch.

The reasons for our success are simple.
Our “no frills” design approach and our enormous amount of experience allow us to make the conversion from keypunch to key-to-disc at the lowest cost of any manufacturer anywhere. And do it with a minimum of trouble to the user.

Once the system is installed, we back it up with an extensive and highly effective field service organization. So if you need help, we’re no further away than your phone.

And thanks to the remarkable efficiency of the Inforex systems, your computer can receive purer data, errors can be virtually eliminated, and throughput can be increased to a level that keypunchers can only dream about.

There’s a whole series of Inforex key-to-disc systems to choose from: Systems 1301, 1302, and 1303. One of them is just right for your present needs. And as you grow, your Inforex system will grow with you. Because we have a line of compatible systems that will take you as far as you want to go.

For more information, give us a call or mail us the coupon today. Because if there’s ever been a time for switching from keypunch to key-to-disc, this is it.

Inforex.

Like we said, it’s in the cards.
either occupying all computer resources or acting as a subsystem of a general-purpose operating system.

With our current knowledge, such an applications design is obvious to everybody, but it poses a problem which hasn’t been solved in the

U.S.S.R.

diminishing (and the comparison is getting tougher, now that DATAMATION is being widely circulated within the Soviet Union).

Also, in the Soviet Union there is no tradition of holding annual gatherings of thousands of professionals similar to the U.S. National Computer Conference. Again this might be explained by the size of the territory. However, smaller thematic symposia and conferences are held regularly. And Soviet dp experts travel widely. (For example, the full staff of the Novosibirsk Computer Center numbers 630; they accounted for 600 business trips and 40 visits abroad in a single year.)

Education and training

Higher education, at least from the organizational point of view, effectively corresponded to the appearance of the new branch of knowledge called computer science. Nevertheless, it took about 10 years to establish the necessary basis (computers and professors) in educational institutions for providing mass education in computer science.

At first I should make a few general remarks. In the U.S.S.R., education is provided through universities and "institutes." Universities roughly correspond to schools or faculties of science in European and American universities. Institutes are divided into polytechnical institutes (which correspond to schools of engineering or technical universities), economic institutes, and branch institutes which prepare specialists for specific industries or other sectors of the national economy. Each student graduating from a university or institute gets a kind of degree of a certified specialist.

In the early ‘60s, the major educational events were the opening of a degree in economic cybernetics in universities and in engineering mathematics in polytechnical institutes. The key issue in computer related education took place in 1969 when a formal program in applied mathematics (for universities and polytechnical institutes) and in automated control systems was established. The applied math is our analogy to computer science and informatics in Western schools. The specialty in automated control systems prepares specialists for designing and maintaining such systems.

In 1972 a formal course in applied mathematics was opened at 40 universities and institutes, and one in automated control systems at 50 institutes. Besides this regular education, two and three year courses were opened in 23 universities and institutes for getting a second diploma in these subjects.

Basic courses in computer science include programming and languages, computer architecture, information processing methods, numerical methods, optimization, and operations research.

Students practice on computers three and a half years, typically using an installation providing batch processing with ALGOL and FORTRAN compilers, and, to a lesser extent, assemblers.

In addition to the formal schools, there is a "scientific and technological school" in every center of an administrative region in the country. These schools charge up to 40 rubles for short, intensive courses or seminars on a variety of subjects, including computer subjects. Their average enrollment is between 100 and 200.

Conclusion

I apologize for a fragmentary presentation, but I deliberately preferred to present a collection of more or less concrete information rather than general statements.

On the whole, Soviet computer scientists and engineers are faced with a great deal of work to respond effectively to those challenging problems in this sector of science and technology. Nevertheless, premises to solutions to the problems are being established, the goals have been formulated, and the program of action determined. We hope that this program will be a considerable contribution to world technical and social progress. We are sure that this program of computer development can be a broad platform for intensive international cooperation in science, technology, and trade.

A leading Soviet authority on computers, Dr. Ershov is a professor of Computer Science at Novosibirsk Univ. His professional associations include membership in ACM, U.S.S.R. representative on the IFIP Technical Committee on Programming, member of the IFIP Working Group on Algol, and editorial board member of several Soviet computer journals. He has contributed to many projects including the ALPHA programming system for the M-20 computer, and the BETA universal programming processor.

The information here was first presented at the XXXI Diebold Conference in Rome in 1974.
Expert advice isn't expert unless you've checked out Basic/Four.

Next time someone who's not an expert in the data processing field asks for your endorsement of a small business computer, you're not an expert unless you're thoroughly familiar with the Basic/Four® system.

After all, how good is your endorsement if the pioneer and innovator in the field hasn't been checked out?

So far, over 1,500 businessmen are using Basic/Four mini-based business computers. And Basic/Four business computers are not only doing their accounting and bookkeeping jobs, but generating information they never dreamed possible. Like sales and management reports, instantaneous credit checks, billing, and inventory control.

And doing it all at far less cost than the accounting machine or service bureau way.

Indicative of Basic/Four's leadership, consider the fact that the industry giant just entered the small business computer market. Imitation is the sincerest form of flattery.

Next time someone asks you for your endorsement, be ready. Check out the Basic/Four small business computers. For a complete brochure, write Basic/Four Corporation, 18552 MacArthur Boulevard, Irvine, California 92707.