SOVIET CYBERNETICS REVIEW

EDITED BY WADE B. HOLLAND

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Readers of *Soviet Cybernetics Review* should note that Vol. 1, 1971, of *SCR* will include a comprehensive index, published subsequent to this year's final issue.

HIGHLIGHTS

The feature article in this first issue of the subscription edition of *Soviet Cybernetics Review* is the first popularly published version of a trip report by well-known Rand computer scientist Barry Boehm. Invited by the USSR Academy of Scientists, Boehm was given a surprisingly complete tour in October of most prominent Soviet computing centers. His report, generous in detail, provides a readable overview of computing problems and successes in the Soviet Union. In revealing conversations with Soviet computer experts, Boehm searches for causes of the current hardware-software lag, and probes for news on developing projects the Soviets hope will close this gap in the near future.

With Rand since 1959, Boehm now heads the Computer Systems Analysis Group in the Computer Sciences Department. His interests include systems analysis and man-computer interaction, particularly as applied to space flight. He is widely published in both domestic and foreign scientific journals, including *Datamation* and *Astronautics and Aeronautics*.

Agricultural Network

There are several areas of the national economy in which important strides in the application of computers are being made. One is agriculture, and the director of the recently founded All-Union Scientific Research Institute of Cybernetics under the USSR Ministry of Agriculture discusses the implementation of the first stage of an agricultural computer network (p. 51). A Main Computer Center for the Ministry is under construction, and the first link of a branch information and computing network is being established in Podol'sk. Eventually it is hoped to provide every agricultural enterprise and state farm with access to computers and to install a comprehensive system of automated data flows by which more effective management and planning of agricultural production for the nation as a whole will be realized.

There is increasing awareness in the Soviet Union of the potential problems of permitting such ministry-wide computer systems to be developed. Eventually, each ministry will have its own computer network, designed according to local specifications. It will be extremely difficult and costly to then implement a nation-wide network that attempts to incorporate all these separate systems into one interacting unit. A common approach by the ministries to management systems, especially when computers are an important component, is suggested (p. 47) by two authors who either do not understand the problems or choose to ignore them. It is unlikely that the ministries will voluntarily surrender their data processing functions, or even the design of such activities, to the general interest or to a "super" computing agency. The authors also reflect naivete in their proposal that all ministries be equipped with the same kind of computer.

The Soviet railways are also increasing their activity in the area of automation. A survey of some of the work already completed and other projects underway reveals interest in a number of different areas (p. 29). Much of the effort concerns highly technical areas of railroad operation, but in one instance the passenger will be the first to enjoy the benefits of a new system. This is the "Express" seat reservations and ticketing operation, to be controlled from a central computer in Moscow linked to some 150 ticket sales windows. Seat assignments and confirmations will be made immediately, and an automatic device will print the ticket at the reservations counter. The system is similar to the Sirena system being implemented for Aeroflot.

Our Brief Items section contains a brief article on a new aspect of the Aeroflot reservations system. Passengers

Highlights, continued . . .

in flight to Moscow will be able to obtain seat reservations for the next leg of their journey before landing at Vnukovo Airport. Planes will carry equipment for transmitting reservation requests for on-board passengers and for receiving seat confirmations.

Organizational Chart

Of interest to all concerned with Soviet studies will be an organizational chart of the government (p. 60). It identifies all the all-union ministries and the ministries of the union republics, plus the important agencies. Readers may wish to make special note of this chart for future reference.

One government agency recently equipped with a new computer is USSR Gosplan, the state planning body. Its Main Computing Center recently moved into a new 12-story building in Moscow, and a journalist takes us on a tour of the facility (p. 19). Pictured is one of Gosplan's computers, believed to be its ICL System 4-70, purchased this past year from the English. In an interview with the Center's director, the interesting statement is made that Gosplan does not plan to make a "cult" of computers. Bitter words are uttered about "mountain-top economists" who are using computers and computational mathematics to do "super-idealized" and "ultra-optimized" planning. It could be conjectured that such remarks signify a reaction to some of the more advanced goals of cybernetics research.

Some of the practical problems faced by industrial automation projects are brought out in the experience of the First State Bearing Plant to implement a fairly ambitious management information system (p. 25). The system was coupled with a high degree of mechanization and retooling of this large and important factory. Many obstacles were encountered, and in many cases needed equipment was found to be nonexistent. Suggestions are made for organizing firms responsible for all phases of industrial automation, similar to construction firms that handle all aspects of a building project.

The use of computers in construction in Moscow is detailed in an account of a new automated system for planning and control of projects (p. 61). Mobile data collection and transmission stations at construction sites will provide communication to central computers. The system is being implemented with help from the East Germans.

In an article that discusses automation implementation on a broader scale, an eminent Ukrainian economist identifies specific ways of closing the R&D gap (p. 21). One addresses the problem of "rigid" organizational structures in Soviet R&D. He proposes "hybrid" structures that permit groups of specialists from various areas to be brought together in one team to work on a specific problem or R&D project.

A series of brief notes on computational aspects of recent Soviet space probes includes a drawing of the Luna-16 station (p. 37). Very, very slowly, more information is becoming available on the use of computers in the Soviet space program, and we continue to monitor the press and other media for these small pieces of data.

Three articles in this issue concern technical cybernetics. A brief, popularized article on voice recognition devices identifies several Soviet projects in this area (p. 45). More detail is provided in a popularized article on a voice recognition system developed in Novosibirsk (p. 63). The third item is a short article with a photograph on the Ritm special-purpose analog computer for producing network, or PERT, charts (p. 38). The Ritm machine is not new or particularly sophisticated, but it appears to be highly reliable and useful.

A recent International Symposium on Computer-Based Automation of Scientific Research is the basis for a sketchy article that lists some projects in Novosibirsk that have as their purpose the facilitation of research (p. 53). Mentioned in particular are a light pen graphics system and the AIST multiple-user time-sharing system.

A world-renowned mathematician is the subject of an interesting article that ranges over his views on abstract art to his boyhood ambition to be a forest ranger. Kolmogorov emerges as a complex, unique individual, one of the great scientists of our time (p. 39).

Poor utilization of computers, this time in Uzbekistan, is the subject of an article that is typical of hundreds noted in the Soviet press over the years (p. 57). The reasons for falling utilization indexes are personnel shortages, lack of cooperation among enterprises, and obsolete equipment.
—WH

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BRIEF ITEMS

Investment Planning Computerized

The Main Computer Center of USSR Gosplan has been working since 1968 on a series of programs to calculate capital investment portions of the State Plan for the USSR and for union republics. At some point in the future, all drafts of capital investment plans will be output from the computer in a standardized format, based on data received from enterprises and organizations. Summary indexes for the commodity and achieved production plans have been generated on the basis of a series of standardized input forms, demonstrating the possibility of doing optional plan calculations and of producing integrated development plans for a region.

(From the journal *Planovoe khozyajstvo*, No. 6, 1970, pp. 29-30.)

Ultra-Pure Substances Produced

Scientists of the Institute of Inflammable Mineral Resources have perfected the technology of producing semiconductor materials and, under the leadership of State Prize laureate S. M. Grigor'ev, have designed an original device which makes it possible to obtain ultra-pure organic substances so necessary in modern electronic equipment, including computers.

(From the article "Sverkhchistyj naftalin," in the newspaper *Sotsialisticheskaya industriya*, August 23, 1970, p. 4.

Standard Forms in Effect

The first attempt in nearly 30 years to standardize all documents and forms in the Soviet Union takes full effect as of January 1, 1971. Some 9000 standard forms and documents were introduced last July, and their use becomes mandatory after January 1. Not since the 1930s has an attempt been made to regulate all document handling, and the earlier program was abandoned after ten unsuccessful years. The new system is covered by 27 sets of State Standards, "providing a harmonious system in which literally everything is provided for: what, where, and how to write or print, and how to date, number, and circulate business documents." Some 4 billion documents circulate in the Soviet Union each year; it is estimated that the savings in central manufacture alone of just two—order blanks and decision forms—will save 836,000 rubles each year. The major problem encountered in introducing the new system has been to overcome resistance based on decades of experience with existing, locally designed forms. The new system has been in development since December 1966. One of the organizations participating in the work was the Sigma Association of Lithuania, a manufacturer of document handling equipment.

(From the article "Delovoe pis'mo," in the newspaper *Pravda*, May 23, 1970, p. 2.)

Ukrainian Academy Elects

Corresponding Members elected to membership in the Academy of Sciences of the Ukrainian SSR include V. K. Dzyadyk and I. I. Lyashko (mathematics, including computer technology) and B. N. Malinovskij (computer technology).

(From the journal *Vestnik Akademii nauk SSSR*, No. 3, 1970, pp. 126-127.)

Long-Term Store for Dnepr-2

The long-term storage device for the Dnepr-2 control computer system is an autonomous unit which can be used in various information and control systems with appropriate synchronization of the parameters of input and output circuits. The basic technical data of the long-term storage unit, during parallel operation of two units, are as follows:

storage capacity, 32,768 words; bit configuration, 42 bits; access time, 3.2 microsec; quantity of address lines in the matrix, 512; cabinet dimensions, 500 × 1388 × 1775 mm; weight of two units, 600 kg. The electronic portion of the device is based on Mir-1 elements. The application of long-term storage devices in the Dnepr-2 computer system decreases the cost of storing one bit of information by 5.5 times, in comparison with the cost of storing one bit of information in the immediate-access store.

(From the article "Dolgovremennoe zapominayushchee ustrojstvo upravlyayushchej vychislitelnoj sistemy 'Dnepr-2,'" in the journal *Mekhanizatsiya i avtomatizatsiya upravleniya*, No. 3, 1970, p. 31.)

Econometric Models Constructed

The Main Computer Center of USSR Gosplan is developing a system of econometric models which includes the most important divisions and indexes of the national economic plan and which can be used for multivariant planning calculations. One of the main models of this system is the large-scale dynamic interbranch optimal planning model. This model is used to determine and optimize major economic indexes and proportions (branch and interbranch) of the process of expanded reproduction on the national economic—i.e., macroeconomic—level.

The model will make it possible to investigate the process of expanded reproduction on the basis of the most important factors, indexes, and relationships, including the movement of gross industrial output, national income, accumulation funds, overall interbranch production capabilities, and the consumption fund based on consumer requirements. A number of experimental calculations have been conducted on the basis of the model for 1975 and 1980, and the model is being improved and adapted for practical application.

(From the article, "Econometric Model of Optimal National Economic Planning," in the journal *Voprosy ekonomiki*, No. 6, 1970, p. 62.)

Svetlana Plant

The Svetlana Plant has been in operation for over 50 years, and continues to play an important role in the USSR electronics industry. The Svetlana Design Bureau is one of the largest vacuum tube designers in the USSR. In addition to developing receiver and amplifier tubes, the Design Bureau is the leading organization for the development of generator and modulator tubes. Since 1962, the Svetlana Plant has been the leading plant of the Leningrad Association of Electronic Instrument Construction, which unites a number of enterprises and is a powerful scientific-technical and production electrovacuum facility with important national-economic significance.

(From the article "Sostoyanie i putvi razvitiya optoelektroniki," in the journal *Radioelektronika*, No. 4, 1970, p. 452.)

Automatic Circuit Design

The Institute of Technical Cybernetics of the Belorussian SSR Academy of Sciences has developed a device for automating documentation of circuits—an automatic circuit designer. The device consists of four units: a unit for converting images to electrical signals on a vidicon, a scanning and synchronizing unit, a unit for controlling changes in parameters of electrical signals, and a unit for converting modified electrical signals into images and recording the images on light-sensitive paper. The new device will greatly decrease design time for new radio parts, most of which are still being designed manually.

(From the article "Voprosy avtomatizatsii podgotovki dokumentatsii na elektricheskie skhemy," in the journal *Vestsi Akademii navuk BSSR*, No. 2, 1970, p. 79.)

Kirillin on Computer Development

Academician V. A. Kirillin, Deputy Chairman of the USSR Council of Ministers and Chairman of the Council's State Committee on Science and Technology, presented a report at the Fifth Plenum of the All-Union Council of Scientific Technical Societies. Kirillin stated that at present, the most important base for improved automation is new computer development, since their high speeds make it possible to rapidly solve complex problems. He stated that Soviet specialists estimate that by 1980 the speed of computers will rise to one billion opns/sec; if laser switches are used, it can be increased to 10^{11} opns/sec. The present capacity of computer storage devices, which is 10^{10} symbols, will also be increased.

The USSR has a large program for the development of a third-generation computer series, Kirillin said, which will be technically more advanced and applicable to production applications.

(continued on p. 75.)

Extensive Tour Yields Report on Current Soviet Computing

Barry W. Boehm
The Rand Corporation

In October, Rand computer systems analyst Barry W. Boehm toured the USSR as a guest of the Academy of Sciences. Boehm traveled 3000 miles through the Russian Republic, Georgia and the Ukraine. He talked with over 50 Russian research scientists and addressed groups of 25 to 300 academicians at Soviet research institutes in Moscow, Kiev, and Tblisi. Following is Boehm's appraisal of Soviet computing's present and probable future capabilities, and a vivid account of the people and places he visited.

Hardware Lag

There is a serious lack of computing power for scientific and general-purpose applications in the USSR. The BESM-6 is still the most powerful Soviet machine, roughly equivalent to the IBM 7094. There are not many of them available. They are not being produced very fast. The ones I saw were already fully loaded seven days a week. There is work going on in developing new user terminals, languages, and information systems that will soon require even more computing power. Buying computers from England's International Computers Limited (ICL)* is a near-term solution. An ICL 4/70 and a 4/50 are already installed. More are on order.

By 1972, the RYAD series may begin to provide a range of Soviet machines along the lines of IBM's System 360, but a number of production problems need to be resolved. Some ingenious special-purpose designs continue to be developed at Kiev (Mir, Dnepr, Kiev), but they will not supply the needed general-purpose computing power. The BESM-6 designers are apparently designing something new, but no one I talked to knew much about it or expected anything very soon.

*See *SCR/70/9*, p. 3, for details of USSR's recent $5.7 million purchase.

Flight Hardward Not Far Behind

The Soviets are less far behind in flight hardware than they used to be. They have a fairly compact standard spaceborne computer with 4K (4000) 16-bit words of read-only core memory and 256 words of erasable memory, with a speed of about 100,000 opns/sec. Their next deep-space probes will have magnetic tapes for storing five days' worth of observations for later transmission.

More importantly, their lag between ground computing power and flight computing power is thus much less than the corresponding lag in the U.S. This indicates that estimates of Soviet computing capability for high-priority, special-purpose applications (e.g., space and military) will probably be low if they are based on observations of Soviet general-purpose computing capability and analogies to U.S. relationships.

Software Situation Ragged

For scientific and general-purpose applications, the situation is very ragged. Most machines have ALGOL compilers, but with different variations. One installation uses a communications link between a BESM-4 and BESM-6 because the ALGOL compiler on the BESM-4 produces more efficient code than the one on the BESM-6. Only recently have assembly languages become available on the BESM-4 and BESM-6. Operating systems are generally incompatible between installations. Scientific subroutine packages are available and good, but no similar packages are available for file management.

Institutions Visited by the Author

Location	Number of People	Computers	Comments
Moscow			
Academy of Sciences Computer Center	200	BESM-6, BESM-4, BESM-3M, Mir-1	pretty theoretical orientation
Institute of Space Research	500*	BESM-6, BESM flight computers	interface between space experiments and industry
Institute of Applied Mathematics	500	BESM-6, BESM-4, BESM-4	12 divisions; reluctant to discuss some
Institute of Control Problems	2000*	ICL 4-70, M-220	big push to socioeconomic problems
Kiev			
Institute of Cybernetics	3000*	BESM-6, Mir-2, Dnepr-2, Kiev-67	most imaginative system designs
Tbilisi			
Institute of Control Problems	300	hybrid digital-analog	relatively little computational technology

* The Institutes of Space Research and Control Problems are both planning expansion to 3000; the Institute of Cybernetics expects to approach 8000

Support Services a Major Problem

Support services are virtually nonexistent. Typically, the academically-oriented institutes of the Academy of Science develop the hardware designs and basic operating system software, the electronics industry produces the machines, often after long wrangles with the institutes and production delays—and neither is particularly responsible to the user to provide maintenance or assistance in extending or debugging the software. Again, however, for high-priority special-purpose applications, support is probably a good deal better.

It is surprising that the competitive economy of the U.S. has given birth to SHARE and other computer user-groups, while the Soviet state-oriented system has produced no counterparts.

U.S. Lead Not So Comfortable

Many people within the USSR have indicated the need for stronger coordination of the efforts of the Academy Institutes and industry, and for more user-orientation in the design, production, and servicing of computer systems. As long as this centralization is not carried out, I think the United States will stay comfortably ahead in computer technology and usage. However, as indicated above, our lead in space and military applications will probably be less than our lead in general-purpose computing.

If the decision is made to centralize, the future situation depends on the choice of a top man. Academician Viktor Glushkov is probably the major candidate. But if he were to run the computing industry like he runs the Institute of Cybernetics at Kiev, there would likely be a great deal of concentration on imaginative, high-risk projects and relatively little concentration on the bread-and-butter side of the business, probably resulting in some major successes in some specialty areas, but serious problems in other areas and in integrated, multifunctional systems.

My subjective feeling, based on a combination of first-hand and second-hand impressions, is that the academic community has no other candidates with the combination of national stature outside the computing field, computer expertise, self-confidence, management capability, and inclination for the job of State Computing Coordinator. Andrei Ershov is the major possible exception. I did not hear of anyone within industry who was an obvious candidate. And if they picked a nontechnical director, the result could range anywhere from success to worse chaos. What they need is a tough-minded, pragmatic technical man, like Korolev provided them for their rocket and space program. If they find him, they have the raw technical potential to achieve something near parity in computing with the United States in ten years.

Academy of Sciences Computer Center

The director, Academician A. A. Dorodnitsyn, was out of town. I was met by Zhurin, a computational gasdynamicist. He arranged for the head of computer operations to show me around. Their BESM-6 is a 32K word experimental model. Zhurin says that some factory models have 65K. It was down, with several circuit boards out, being tested. Zhurin was rather vague about percent of down time, but said utilization was about 20 hrs/day. Users' output boxes had about 50 printouts (delivered in rolls; 128 column alphanumeric). Zhurin said the machine was busy over the weekend. The BESM-6 has eight drums (addressible by 500 and 1000 word pages) and 16 tape-drives (1 million words each), some read-only and some write-only. The card reader, punch, and printer looked slow. They had a TV set nearby and said they were planning to hook it up for display, driven by drums. They had just received three Cal-Comp plotters from the Netherlands. Only one has unpacked. Their BESM-6 software is in poor shape; the monitor does not take much advantage of overlapping I/O (no statistics, apparently). For a while they had no ALGOL compiler and had to construct a two megacycle communications link to a BESM-4, so that programs could be compiled there and run on the BESM-6 The current ALGOL compiler does not produce a very efficient code. They still use the hookup for some problems, handled like tape I/O in the BESM-6 operating system.

The computer room was fairly ancient-looking and disorderly. I noticed places where they had run wires along channels chopped in cement floors. The head of operations claimed turnaround time was about one hour for small jobs, overnight for big ones. Users are charged for machine time, and user institutes are allocated limits on available time. Dispatchers (people) monitor job submissions and turn away jobs after the overnight time is filled up.

I had a fascinating hour with the Mir-1 computer: half an hour demonstration by V. I. Steganzov and half an hour of hands-on experience. The Mir-1 is a very impressive achievement, given the hardware capability. Though a bit rough and unforgiving, it's on-line, and the engineers love it. The machine costs about $5000; there are approximately 500 in the USSR, and one in the U.S., purchased by IBM.

In voice recognition, success after several tries

I met V. I. Trunin-Donskoy and B. N. Rudny and saw their voice-recognition system in action on the BESM-3M. Their recognition algorithms are basically an attempt to classify sound patterns in the time-frequency domain. They gave me a demonstration involving on-line verbal specification of names and values of several variables in a gas-flow calculation. Trunin-Donskoy sat at the microphone and read words in one at a time, watching the bit pattern on the BESM-3M console to verify each one. The problem involved reading about 40 words, mostly names of digits in input. Trunin-Donskoy got through with six errors, one of which took five times to correct. Valery Evdokimov (my escort from the Institute for Space Research) tried twice and caused the program to malfunction. Rudny read the program in again and went through with eight errors (two bypassed after about five tries). Evdokimov tried again and got through with about ten errors (about three bypassed after five tries). They said the machine had "demonstration sickness."

Promise of discs and a long life for BESM-6, but how fast is "fast"?

I then talked with N. Moiseev, associate director of the Center and head of groups in mathematical-physics and mathematical-economics. He is pretty theoretical to be in a computer center, but a good mathematician. He said they expect to get a new BESM-6 with 65K memory and two discs in December. They also expect to get a Mir-2 with a cathode-ray tube (CRT) and light pen in early 1971. He said the USSR is getting some ICL computers from England, but did not know where they would be installed—probably in government ministries. They will not use M.R. Shura-Bura's operating system from the Institute of Applied

Mathematics (IAM). They say it involves special hardware. Apparently they are building their own operating system.

I talked with A. Smirnov, who had been at the nuclear physics institute at Dubna the day before. His main concern now is tuning the operating system of Dubna's BESM-6. He was interested in the use of hardware monitors he had seen at the 1970 Spring Joint Computer Conference, but he was vague about the system's configuration and current performance statistics. He was also noncommittal about new generation computers, but I got the feeling he expected to be living with BESM-6s for a good while. I showed a computer graphics film as part of a seminar to about 40 people, including V. Shtarkman and Y. Bayakovsky, who had come over from the Institute of Applied Mathematics. Questions afterward included: "How many man-years did it take to develop?" "How many other places use it?" "Why did you choose IBM equipment?" "Don't you use the Rand Tablet?"

I had lunch with A. O. Smirnov and S. S. Lavrov. Lavrov is working on a LISP compiler that is extremely inefficient right now: it takes 20 minutes on the BESM-6 to run even fairly small programs. When pressed, he was not very specific about "how small." He thinks a software performance analyzer would help, but nothing like it is available. Lavrov also seemed to have some degree of direction over Filippov's JOSS-type project (see below). He was interested in comparisons between JOSS, BASIC, and APL.

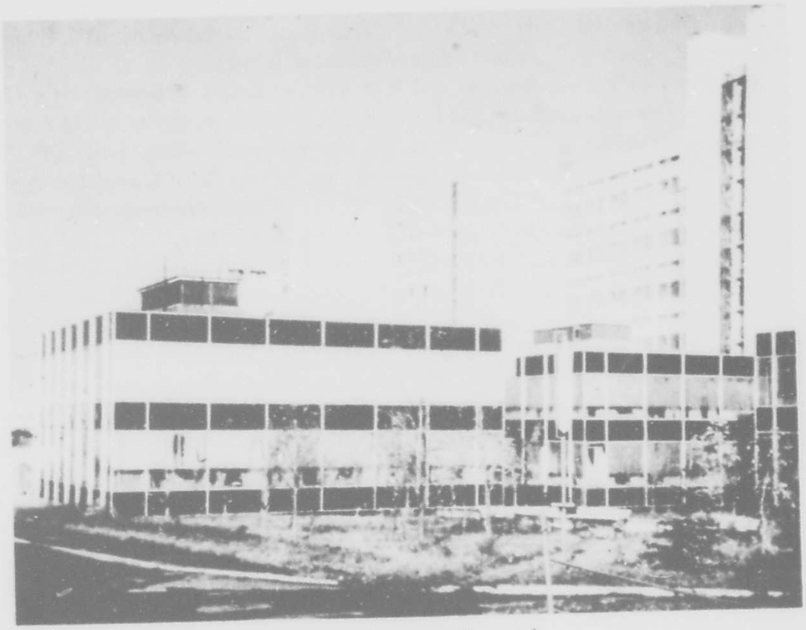
I had some discussions later with Smirnov, Lavrov, Shtarkman, Bayakovsky, and V. I. Filippov; the latter is trying to develop a JOSS time-sharing system (with batch background, using teletype terminals) for the Academy Computer Center's next BESM-6. Bayakovsky knew of my ACM-70 (Association for Computing Machinery) talk on software engineering and asked me to elaborate. This led to a discussion of software certification. They have not followed up much on proof-type techniques such as Yanov's. They feel they are too cumbersome to use in practice and difficult to adapt to program modifications. Their debugging techniques seemed fairly standard. Shtarkman and Bayakovsky are developing graphics systems and trying to work out ways to separately specify procedures and data structures.

Institute of Control Systems, Tblisi

The Institute is located about a mile from the center of Tblisi, housed in a 1950's building in a district of four- and five-story commercial and apartment buildings. The director, Professor V. Chichinadze, is a well-known control theorist and a perfect host. Amid his warm hospitality, the excellent local wine, and the warm Georgian sunshine, it was easy to forget the rain and snow I had left in Moscow. Technically, however, compared to Moscow computing, the Institute is not very advanced. They had a hybrid computer, disassembled: they were putting the digital part together themselves. They are putting it together in pieces because they do not have a large enough budget to buy everything at once. I saw some more work on voice recognition by pattern classification in the time-frequency domain, but more specialized than in Moscow. G. Kapanadze has built a little cart that moves on the floor forward, back, right, left, and stops under voice control; he also had a graphic display of time-frequency patterns with a 14×20 matrix of light bulbs.

Conversations with V. Evdokimov, Institute for Space Research

Dr. Valery Evdokimov is a spacecraft data-compression specialist at the Institute of Space Research. He accompanied me to the Institutes as translator and general-purpose expediter. He was generally available after hours to get the Soviet system to sell me a balalaika, give me Bolshoi tickets, and the like. Personally, the major benefit of the trip was this chance to get to know Valery well, and to be able to compare notes on the way our respective systems worked out things like plumbing services, vacation trips, babysitters, jobs, and schools. We discussed technical topics also.



Institute for Space Research, Moscow

The Coordinating Computer Center for spacecraft is in Moscow. So far, only French engineers and a nontechnical American film crew have been allowed to see it. The Center usually handles only data processing for orbit and trajectory corrections, but life-support and emergency data are routed into the Center and programs exist for performing emergency analyses if necessary. Scientific data-collection is recorded on tape at the receiving antennas and processed later. On long-term missions such as Venus, data are collected and stored on-board on magnetic tape for five days, then read off tape through specially-designed data-compression hardware into a buffer, and sent out when the buffer is full, for another five-day period. Evdokimov said they do not encode data for error detection.

Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

The Institute is only about ten years old, but is now the biggest one in the Academy, with 3000 people. It is crowded into a big three-story, five-year-old building, and gives an inpression of intense activity. An older building across the street houses most of the computers. Graduate students abound, about 40% of them non-Ukrainians. Credit for this growth is given to Glushkov. He has the universal respect of the staff.

The Institute is divided into five departments: Engineering Cybernetics, the largest, under Mikhovsky; Economic Cybernetics, under G. Ye. Pukhov; Biological Cybernetics, under N. M. Amosov; Theoretical Cybernetics, under Glushkov; and System Science.

Their Computer Center contains a BESM-6 and an M-220. ALGOL programs can run on both. They are working on a direct tie between the two, but otherwise the machines are incompatible (e.g., different width tapes). Their BESM-6 was in better shape than the one in the Moscow Academy of Sciences Computer Center. It has 32K core storage, eight drums, 16 tape-drives, 700 chars/min (magnetic) and 600 chars/min (optical) card readers, 420 lines/min, 128 column printers, card punch and paper tape equipment. There are no other terminals, though they are working on making Mir-2 connections. The BESM-6 runs 20 hrs/day, including weekends. They do not have any immediate plans for upgrading. Turnaround time was four hours for small jobs, overnight for big ones. Their average job length is about 30 minutes on both machines. Average input deck size is about 300 cards. The BESM-6 has ALGOL and FORTRAN. The M-220 has just ALGOL. The BESM-6 is multiprogrammed to handle up to three jobs in core. Users are charged for clock time of residence. Fictitious money is charged to Institute people, but external users are charged 100 rubles an hour. They do not complain.

Next I went to see the Dnepr-2, which was designed at the Institute for process control and information retrieval applications (slightly different versions for each). The Dnepr-2 has 65K, 10 or 12 microsec core memory. I saw the information retrieval version, which has ALGOL and COBOL compilers and can support up to 40 tapes and 64 input/query teletype terminals. This one had ten tapes and three terminals. They have developed a query language and use it experimentally via terminals on a data base of the Institute's computer program library, stored on tape and organized by keywords. No more details were available.

Behind in graphics

I went to the Mir-2. The version I saw had the central processing unit (CPU) in two boxes (one 36 in. high, 36 in. wide, 18 in. deep, the other 48 in. × 60 in. × 18 in.) a "teletype" keyboard, a CRT with light pen (about the same size and quality image as IBM 2250 Mod I), small paper tape equipment, and a magnetic card reader. The memory contained 2 billion bits. The CPU was an advanced version of Mir-1, with interpretive translation and execution via special hard-wired operators. First they read in a program via the magnetic card reader, displayed it on the CRT, and erased parts of the program with the light pen. They could not do much else with the light pen, however. No text-editing capability is available, but A. M. Drakh, a bright young software type, said he would have this done in six months. I asked if they could enter some data points and try various least-squares curve fits on the CRT, but they said the least-squares routines had not been converted yet.

I tried to understand how Drakh does his programming, without much success. I think it is raw machine language interfaced with the numerous special-purpose operators built into the Mir-2 hardware.

I sat down at the console, entered a polynomial and scaling information, and got an immediate display of its graph. I could not change scale or anything with the light pen. They said that on the Mir-3, which is being developed, one will be able to do such things. Also, there seems to be a more advanced version of the Mir-2 around that gives more light-pen capability, such as elementary text-editing capability to point at and change characters, but not to insert extra ones. Scale is indicated by numbers at the top of the display screen, not along the displayed axes. It is not easy to change scale, even at the keyboard, with lack of a text-editor. Hard copy is obtained by taking photographs with a special camera mount. Next, I tried differentiation, which is analytic for polynomials through about hyperbolic functions. The graph of the function and its derivative were requested; again, they appeared on the screen within one second. I wanted to numerically integrate the derivative and compare the result with the original function. This is difficult. Apparently, there is no way to address displayed data points at the keyboard other than recalculating them. I tried 500 factorial again; calculation speed was one minute 40 seconds, compared to two minutes 20 seconds for the Mir-1. Symbol manipulation capability on the Mir-2 includes integration, differentiation, substitution, and Boolean operations, but not things like transforms, or the ability to define transformations.

Ahead in ingenuity

The Mir-2 is designed to support connections of up to 32 separate teletype/graphic terminals. However, only one user can use the machine at any time; requests queue on a first-come first-served basis. Users cannot communicate with each other via Mir-2; this makes joint problem-solving activities impossible but ensures data and program protection. They are still working on the interface to the BESM-6. They were not sure what kind of priority structure would be required on the BESM-6 operating system to assure reasonable response times, or what this capability would do to the already fully-loaded BESM-6. However, this is currently the only provision to give Mir-2 users access to large data bases on tapes or existing applications software (other than rewriting it). I entered one program with a loop which would specify a negative square root about halfway through. When this was reached, the system simply stopped, with a red error light on. After Drakh pushed three more buttons, it printed "arithmetic error." They said the lack of specific error responses here was corrected in the advanced Mir-2 version elsewhere in the building. The basic characteristics of the Mir-2 seemed quite similar to those of the Mir-1. They still have a long way to go in exploiting graphics and providing such amenities as filing, text-editing and constructive user aids. But they are a long way ahead of anything I have seen in the USSR in on-line capability, and the design philosophy is quite ingenious, even by American standards.

I had some discussions with Dr. N. N. Pavlov, who works on man-machine problems. He has about a 30-man group. He is interested in quantitative measures of man-computer effectiveness components and Delphi-type techniques for producing a proper set of weights for the different components. His list of components was typical (simplicity, flexibility, reliability, etc). He was interested in my Productive Thought Ratio but appreciated its difficulties; apparently they have not progressed any farther than we have here. He could not think of any controlled experiments they had done.

Professor Z. L. Rabinovitch, assistant director of the System Science Department, talked about matters the Institute should emphasize in the future. These include human engineering of computer systems, organization of computer systems to better support programming and problem-solving processes (e.g., the Mir series), better design aids for computer systems (e.g., system simulation), advancement of programming theory, especially graph theory, and machine intelligence. I noticed he did not want to call "machine intelligence" "artificial intelligence," and asked if he had any examples of good machine heuristics that had come from observing people solving problems. He could only think of introspection, or group discussion of introspection. Our discussion of software certification revealed that there is little activity in this area, except in their production of debugging versions of all their compilers, and in language extendability. The extendability problem is apparently particularly difficult in the Mir series.

I saw a demonstration of Kiev-67 by V. Derkach. This machine has 8K (it can have 16K) of two microsec core, an analog/digital interface to an electron-gun device for on-line control, a keyboard, a nice thin-plate 6 in. × 9 in. numerical display (the symbols are about 1/4 in. to 3/4 in.), and a very precise, bit-addressed (4096 × 4096) reverse-image (purple on gray) storage-tube display, about four inches in diameter, set horizontally at the console. They demonstrated an impressive picture of Lenin on the display, but it took about three minutes to produce, and could not be modified without erasing and rewriting. Very little on-line display modification capability was available; it is all done by programming (x,y) coordinates of elements of the picture. These can include squares, triangles, trapezoids, arcs and sectors of circles. They are read in on cards or paper-tape. They showed the use of the thin-plate display for tracing the path of a program. Apparently, the Kiev-67 is also used to control the electron-gun device in real time, but this was not demonstrated.

Growing pains are evident at Glushkov's Institute

I talked with S. Kozubovsky, a control theory specialist who served recently as Scientific Secretary of the Institute. He said the Institute is feeling acute Parkinsonian pangs; it is harder and harder to get people to communicate with each other. He showed me a plan of their new suburban center, now under construction, with five to six 10- to 12-story buildings for the different departments, and a few more one- to three-story buildings for labs and prototype production facilities. They expect eventual expansion to about 8000 people; the complex as modeled seemed able to support this. He agreed that the communication problems will be even more difficult then. The Institute carries machines through design into prototype production phase, then works with the electronics industry to set up larger-scale production lines. When I asked how Glushkov achieved his prodigious volume of written output, he said that Glushkov writes all his popular articles via dictaphone and a full-time staff writer, who turns the verbal ideas into a draft and gives it to Glushkov for modification.

Institute of Space Research, Moscow

This Institute is located in temporary quarters in several sites around Moscow. A new building is being built. The director is Academician Gyorgy Petrov. The associate director, technical, is Dr. Yuli Khodarev.* The Institute has 500 people and expects to expand to 3000. The staff is evenly divided between physical scientists selecting and conducting spaceborne experiments, and mission planners determining appropriate orbits, data transmission techniques, and spacecraft payload design. They also work with industry people to build and test payloads. Apparently, they are not much involved in booster activities or biological aspects of manned missions. I talked with Dr. P. Elyasberg about trajectory and orbit calculation, primarily optimization. Their use of adjoint equations, gradient techniques, and Kalman filtering seems not much different from ours. They have not had much success in using second-order variations except in computing the choices of stepsize along the gradient. They are apparently not going for the grand tour of Jupiter, Saturn, and Uranus, but are planning a three-year solar probe mission using a Jupiter swingby to attain a path orthogonal to the ecliptic. The Institute has a BESM-6, BESM-4, and Mir-1.

I spoke to some on-board computer people at the Institute. Their workhorse computer has 4K 16-bit words of read-only woven-core memory (about 2 in. × 2 in. × 4 in.), and 256 words of erasable core memory. It executes 100,000 opns/sec. Its operation-code structure includes an 8-bit address and relocation bits. It takes two instructions to reach an address outside the currently active sector. Programming is done by assemblies on large batch computers. Double-word operations and arithmetic registers for 32-bit precision are included. Component density in the CPU is about 100 components/cm^3. Program checkout for the flight computer is done mostly by emulation on a BESM-6. No new techniques for software checkout were indicated. Mainly, they use brute-force testing and interpersonal cross-checking. The same people write and checkout programs. They have had some space missions fail because of software errors. They feel Yanov-type proof techniques do not hold much promise for software certification; they are too complicated. They did not have any statistics, but estimate they spend at least twice as much time debugging as they do coding.

A Meeting at the Institute of Space Research with V. Shtarkman, Y. Bayakovsky, and A. Platonov of the Institute of Applied Mathematics

The 12 divisions at the Institute of Applied Mathematics include about 500 people. Engineering Mathematics has 60, including Platonov; the Computing Center, 100, under Shura-Bura, including Shtarkman and Bayakovsky; and "several other" smaller departments. The Institute has two BESM-4s and a BESM-6, all tied together, so that some BESM-4 application programs can partly use BESM-6 without conversion. All programming was done in either ALGOL or raw machine language until recently, when Bayakovsky wrote an assembler for the BESM-4 (1968), and Shtarkman, one for the BESM-6 (1969). The new operating system for the BESM-6 is still in an experimental stage. Bayakovsky and Shtarkman are now designing a graphics system that will work on an SDS-910 and SDS display tied to the BESM-6; they were very interested in data structures, levels of languages, and other graphics software considerations. Progress is slow, but the two researchers seem quite

*Khodarev was primarily responsible for my invitation as a guest of the Academy. He and I have served as co-chairman of space electronics and data-processing sessions at the last two International Astronautical Congresses competent, and more acquainted with U.S. literature than anyone else I met. Apparently, the system design is not for any particular application; they are trying to make it as general as possible.

Institute of Control Problems, Moscow

This Institute is located across the street from the Institute of Space Research in a new building of similar design. It has about 2000 people, and the most lively and wide-ranging intellectual atmosphere I found on the trip. I talked with the associate director, Professor Emelyanov, who said the Institute is shifting more and more to human-oriented socioeconomic problems, and to a project rather than technical-specialty organizational structure. The Institute works with other government agencies to define the most suitable problems to work on, then they jointly carry out the solution. They tried an interesting three-year experiment with eight people, which indicated it was easier to make a good sociologist out of a mathematician, than vice versa. I talked a little with M. Aizerman, who is getting into socioeconomic problems, with Georgadze, who is working on uses of arrays of homogeneous components, and with S. Berkovitch, who is working on information systems to support economic models. Georgadze's arrays include 10,000-20,000 components, in a 3-D arrangement. He is concerned with optimal arrangement for problems of cryptography, pattern recognition, etc.

Then I discussed computing with A. Leman, V. Arlazarov, and I. Faradisev of the software group. The Institute has an M-220, and an ICL 4-70 has just been installed. They plan to take over complete maintenance in a few months, but to use and stay compatible with the standard ICL operating system, which includes multiprogramming, variable partitions, FORTRAN, COBOL, ALGOL, interactive interpretive FORTRAN from teletype/typewriter terminals, and file management software. Their 4-70 hardware includes seven disc drives. They indicated that this was the first ICL 4-70 in the USSR, and that Gosplan has a 4-50,* and several other government agencies have 1902s through 1905s. They anticipate more 4-70s soon in the USSR, and admitted that Ryad will not be available until 1972, and then only in an austere version. They said with some uncertainty, that upgrading in the next few years would be directed toward an ICL 4-75 or the forthcoming ICL System 4 machines. They noted that Ryad was wrong in repeating errors in IBM 360 design, and cited as examples the insufficient number of general registers, clumsy I/O handling, and some other 360 features which are apparently part of the Ryad design.

They worked on building an associative processor for a while, but discontinued it because hardware switching speeds and flexibility were not good enough to make the design feasible. They hope to try again in a year or so. They were somewhat pessimistic about the ability to produce software which will take good advantage of it, but have done some initial work on associative software. No work in cryogenic computing is going on in the USSR, to their knowledge. Though unversed in the architectural details, they mentioned some work, in Novosibirsk, in parallel processor development—probably a network of homogeneous or compatible general-purpose processors. The lack of microprogrammed computer develop-

*Later checking indicated this was wrong: Gosplan has a 4-70, and two 4-50s are operating in the Ministry of Merchant Marine (Morflot) and the State Committee on Material and Technical Supply (Gossnab) ment in the USSR was cited, but they plan work in this direction. Also, they want to build a system programming language; current languages are extremely poor for interrupt handling, syntax checking, etc. They were quite interested in ECSS (Rand's Extendable Computer System Simulator). They said they use simulation for design of computer systems but prefer to write such simulations in assembly language.

I gave a talk in the morning to about 300 people—the biggest audience so far—on simulation of computers and on man-computer interaction. There were lots of good questions, including some on unrelated topics, such as the state of Illiac IV and cryogenic computing in the United States. Then I talked with Aizerman and his group about their work in cluster analysis. They have a simple but apparently quite effective algorithm based on the distance between the *nth* point considered and the centroid of the previous n-1 points: each relative minimum of the distance function defines the edge of a cluster. They have tried this principally on biomedical problems: a problem with 500 points and 160 variables took 8-10 hours to analyze on an M-220. They felt that with current improvements in the algorithm, this could be reduced to about one hour.

Economics, classification, system performance, MISs indicate variety at the Institute

Aizerman and his group are becoming more involved in trying to apply control theory to economic planning problems. Probably, their first efforts will involve logistics and inventory theory applied to production and maintenance problems in the automotive industry. They were very interested in how Rand organizes work on such problems. I also talked with Dr. Yuri Ivanov, head of their mathematical economics group. He is working on economic planning problems, particularly on milk production in the Altai region. He has not done much in detail (e.g., on data collection requirements), but seems to have a good pragmatic approach. He wants to use this experience to develop a general-purpose economic planning model, in which a manager can specify standard types of plans, enter data on resources, and be presented with an analysis of the resulting performance of the system. Detailed thought about the intricacies of the system is lacking, e.g., functional forms for production functions, user's specification language, interfaces with data bases, etc. He plans to write the model in assembly language for the ICL 4-70, and not to export it. I obtained several papers on work in his and Aizerman's groups.

I returned to the Institute of Control Problems the next day, since my requests to see the Coordinating Computer Center and the Institute for Precise Mechanics and Computer Engineering were turned down, for reasons of "policy," and lack of time, respectively. I talked with Dr. S. S. Lerner, head of an operations research group, and with some of his people, about their work. Here, too, one area is economic planning. They had results which they felt indicated that central planning could be done so as to produce optimal policies on a large scale, which would also be optimal for individual sub-group managers. The results would be based on information supplied by sub-managers and central control on sub-manager's resource requirements and utility function. They said they could prove under these conditions that there was no advantage to the sub-manager to supply false information.

We discussed this and its incentive implications—the talk was half-technical, half-ideological, but quite civilized, although neither of us really convinced the other of anything. Also, they discussed their work on a classification problem: Given two groups of data points, decide with which group a new data point belongs. They have an algorithm and an M-220 program, based on calculating one or more hyperplanes equidistantly separating the two groups of given points. It takes about 20 minutes to solve a problem with 60 points and 40 variables. Almost always, one hyperplane is sufficient to separate the groups; it has never required more than two. Applications have included medical diagnosis and chemical analysis. Medical diagnoses have been as good as doctors', but they would not trust the program on themselves.

We discussed their work on applying operations research methods to computer system performance problems. The research, mainly V. B. Sokolov's, is all theoretical and not too advanced. Some comparative analyses of different replacement techniques for paging processes have been done, so far including only random replacement, longest-length-of-stay replacement, and longest-time-since-last-used replacement. Request statistics are not based on measurements, but reflect reasonable values for parameters in standard distributions, such as Poisson. They are hoping to go farther into analysis of correlated requests, but have no definite plans to interface with measurements.

Also, Sokolov is working on problems of organizing files on tape to minimize processing time. Some work has been completed on single-tape systems for deterministic jobs and on capability to store duplicate files at different locations. They are now working on an analysis of multitape systems; they hope to duplicate file analyses and stochastic problems, and also to try their theories on actual applications. Now that the 4-70 and its discs are around, they would also like to study file organization on discs.

I talked for a while with Dr. Oleg Aven, who has a group in information retrieval and management information systems. They are beginning to work with the ministries of steel production and to develop management information systems, but have no details on frequency and accuracy of information requirements for managers at various levels. They plan to develop systems on the Ministries' machines.

Aven feels that there will be some dependence on English machines in the short run but that in the long run the Ryad and Soviet follow-ons will be able to satisfy demands—if problems of computer production are worked out in the USSR. He authored a *Pravda* article that called for much more centralized production in the computer industry than is needed in other industries.

Aven has seen Ryad in operation, feels it is viable, and also forcasts the delivery for 1972. He says the operating system is very closely patterned on OS/360; it has bugs and incomplete portions, but it and a prototype Ryad machine seem to work well for standard jobs. He sees no problem in disc production: a group in Estonia will provide them.

Further Conversations with Shtarkman and Bayakovsky

We spent a day driving in Shtarkman's car to Vladimir and Suzdal, with computing discussions interspersed throughout. Shtarkman runs a group of about 15 people within Shura-Bura's 100-man division at the Institute of Applied Math. They were primarily involved in developing the assembler and various utilities for the IAM operating system for the BESM-6, but are now turning these programs over to another group, which will have primary responsibility for the operating system. Bayakovsky has a graphics group of about five people under Shtarkman, and Shtarkman hopes to phase as many more people into graphics as he can. Their first effort will be purely experimental, based on the SDS 910 and SDS display that is linked to the BESM-6. The USSR is now producing buffer-refreshed CRT displays (they gave me a brochure on one), but they feel the SDS equipment is more flexible and reliable. Their application areas will involve computer-aided design; although no specific projects were mentioned, they want to have the capability of manipulating three-dimensional representations, and to get experience with hidden-line problems and the like.

Independent digging is a must

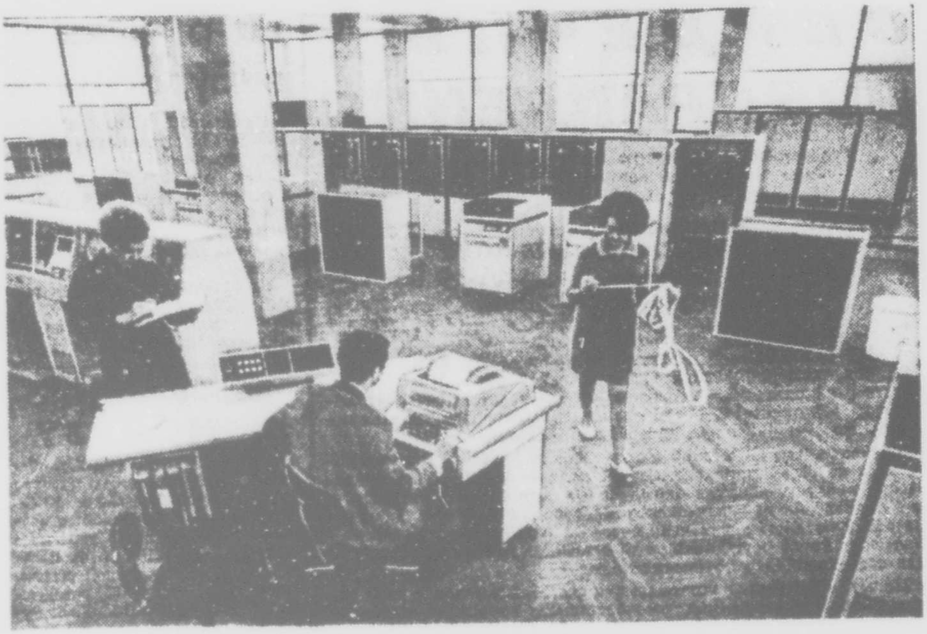
They were particularly interested in U.S. experience with various graphic data structures, and were well versed on material appearing in ACM Communications and *JCC Proceedings*. Surprisingly, though, they have to dig up the material almost all by themselves. Services like VINITI (All-Union Institute of Scientific and Technical Information) work well for physics, but there is hardly anything provided to keep them up to date on published literature in computer sciences. They follow European computing literature, but feel that the real action is in the U.S. They had recently attended a USSR-hosted international symposium in Tallinn (Estonia) on programming languages and operating systems, but said it had not been too productive.

Uncertainty for IAM's system, hope for Ryad

The IAM operating system is still in experimental status with a number of bugs and problems to be worked out. Shtarkman believed that more time should have been spent in the system design phase on several important aspects of interrupt handling, I/O control, job control language, etc. Now, deficiencies in these areas are becoming evident, and further progress on the system will be slow and limited. For example, no job control langauge really exists for the system; jobs either fall into certain standard patterns (FORTRAN compile, load, execute), or the programmer must construct his own sequence in assembly language. This provides flexibility for programming experts, but will strongly limit its acceptability for less experienced programmers, particularly in business. They said the system has some chance of becoming a standard for the BESM-6, but are not sure.

They thought the Ryad system is the best hope for the future, but also expressed doubts about early production capabilities. They, like Aven, see little problem in disc production, and foresee BESM-6 disc drives available in quantity soon. They said there was a possibility that Lebedev's Institute of Precise Mechanics and Computer Engineering would come up with something useful in a BESM-7 or BESM-8, but have no details. Unlike the researchers of the Institute of Control Problems, they felt the Ryad decision to follow IBM 360 hardware and software was, in general, good: the lower development risks and compatibility were worth the price of repeating known weak points in the 360 design. They were not impressed with the Mir series, referring to some of the difficulties with extendability and user interfaces that I had seen. In my judgement, however, the series is fairly impressive, especially considering that the on-line alternatives in the Soviet Union are essentially nil.

Czech ZPA-600 computer being assembled in computer plant near Prague.



One of the computer halls in the new 12-story building for USSR Gosplan's Main Computing Center. The machine is unidentified, but is believed to be the new ICL System 4-70 configuration recently purchased for Gosplan from the English.

Source: Pravda, Nov. 29, 1970, p. 3.

Gosplan Pledges "No Cult of Computers"

V. Parfenov

A new 12-story building has been erected on one of Moscow's central thoroughfares. The Main Computing Center of USSR Gosplan is located in it. Movement of the Center into these quarters coincides with the tenth anniversary of the Center's existance. . . .

"Now we have at our disposal reliable and high-speed methods for the economic calculations needed for planning," stated M. E. Rakovskij, Deputy Director of USSR Gosplan, in opening his description of the Main Computing Center. "Computers permit us to do rapidly what recently could not be done even by a large group of specialists.". . .

The discussion of the role of electronic machines in processing plans was continued in the new building of the Main Computer Center. The director of the Center, Nikolaj Ivanovich Kovalev, a great proponent of this work and a broadly educated engineer, scientist, and economist, familiarized us with the work of his staff.

". . .Calculations of demand for construction materials by builders have already been fully translated for the computer. . . . Ministries need not submit orders for materials. Our Center itself prepares a summary report for Gosplan on construction materials for each ministry. If a disagreement arises between Gosplan and a particular industrial branch, the issue is resolved by the computer—it produces a detailed analysis. . . ."

The plan for each branch of the economy is calculated today with a precise accounting of the demand for equipment. . . . The Main Computer Center rapidly and with greater precision evaluates consumer demand for goods. A collection of methods has been developed that permits levels of demand to be determined not only during the following year, but also for the end of the five-year period and for even longer periods. . . .

. . .Although computers are efficient, their capabilities are only partially exploited. Gosplan's Main Computer Center, together with a number of institutes, is creating a grandiose system for calculating the entire national economic plan, in which machines will not only solve individual problems but will also relate them to each other.

Translation of excerpts from the article "Plan rasschityvayut mashiny" ("Machines Design the Plan"), in the newspaper *Pravda*, Nov. 29, 1970, p. 3; translated from the Russian by Wade B. Holland.

. . .The hall where the computers are in operation produces a great impression. Crossing the threshold of this gigantic building, one thinks he is in the world of the future. Through a window, on an ideally clean parquet floor, in an atmosphere of strictly constant temperature and humidity, are the units of the electronic machines—the "brains"—spaciously distributed and constructed of lifeless materials. The machines operate three shifts a day.

An operator, sitting at a console, quietly conducts a "conversation" with—a machine, just as if to do so were nothing at all. He pushes a button, and a response appears on a screen: "Ready. Request input data." The man inputs a program to the computer. And immediately it demands, "Mount tape No. 6." Then, "Mount disc No. 2."

All goes normally, while the operator clearly issues orders to the computer. But if he suddenly slips—for example, if he mounts the wrong tape—a notation appears on the screen, "No program." Thus the machine reacts to man's error.

"Of course, far from all planning problems can be translated into the formal language of mathematics," notes Kovalev. "There are many socioeconomic problems that cannot be expressed in the form of formulas. While we are enthusiastic about the immense capabilities of computers, we do not make a cult of them. Plans are developed by people, for people. People program the operation of the machine and use the results of that operation. They reserve to themselves the establishment of goals, they develop the socioeconomic perspectives for a given period. We are not attempting to alter the theory of socialistic planning, as some mountain-top economists, creating some sort of super-idealized, ultra-optimized plan with the help of mathematical methods and electronics, are trying to do. But if Gosplan fully masters this new, powerful planning instrument, then this will help in the development of a balanced, comprehensively validated national economic plan."

Commentary

This journalist's report on the opening of Gosplan's new 12-story Main Computing Center is mostly taken up by descriptions of the kinds of planning tasks for which the computers are used. There are some interesting aspects, however.

The computer described, and shown in the accompanying photograph, is believed to be Gosplan's new ICL System 4-70 machine, recently purchased from the English. We have been unable to secure a photograph of this machine for comparison against the depicted computer. But the machine shown is totally unlike any known to be in production in the Soviet Union. A disc storage unit is clearly visible in the background, and the text account of the operator's interaction with the system refers to mounting discs. Since no sizeable Soviet computer is known to be equipped with discs, and since the ICL machine at Gosplan has four disc units, it is reasonable to conclude that this is in fact Gosplan's new ICL system.

In the concluding paragraph, the Center's director is quoted to the effect that they are not making a cult of computers. He criticizes "some mountain-top economists, creating some sort of super-idealized, ultra-optimized plan with the help of mathematical methods and electronics." It is not clear whom he is referring to, but it could be the Central Statistical Administration, the proponents of the State Network of Computer Centers, or some staff members at the Central Economic Mathematics Institute, which has been severely criticized recently for its work in this area. It could hardly be accidental that this statement crept into the author's turgid description of the computer center's operation.—WH

Scientific Research Requires Scientific Management

G. Dobrov
Doctor of Economic Sciences, Kiev

The diversity of problems in the management of scientific systems—laboratories, institutes, academies, or branches of knowledge—is truly immense. All of them, however, can be reduced to three basic problems: maximum utilization of material and human scientific resources, intense acceleration of scientific potential for solution of new problems, and determination of the most promising areas and trends of research.

As indicated by experience, the art of efficient management of a scientific group depends primarily on the ability of the director to provide a systems approach to the solution of specific problems and to correctly organize these problems. When each investigation is examined as a part of a set and is related to other investigations, the scientific capabilities are more fully and rapidly utilized. With this approach, scientists benefit from new ideas and methods which in turn stimulate their own development. It is the comprehensive search, in the course of which the achievements of related sciences are considered, that as a rule leads to the solution of more complex problems and utilization of advanced methods of investigation.

Inadequacies Shown

Studies recently conducted in the Ukraine and in Leningrad indicate that the overall nature of scientific work at all levels of the organizational structure is clearly inadequate. Unfortunately, complete coordination among research institutes or among sections within an institute has so far not been achieved. Interaction is especially poor among scientists at a number of higher educational institutions and some newly established Academy science centers.

Another acute organizational problem in the management of science is the completion of the entire cycle of research developments, from fundamental research, to technical realiza-

Translation of the article "Managing But Not Correcting" ("Upravlyat' a ne ispravlyat'," in the newspaper *Pravda*, October 15, 1970, p. 2; translated from the Russian by Irene Agnew.

tion and introduction of results into the national economy. **Too often, success achieved during the theoretical research stage is not followed through by the subsequent links—designers, engineers, technologists. As a result, a discovery that has great potential often does not reach the sphere of production.** In some cases, this obvious gap can be eliminated by establishing needed special services at scientific research institutes that would ensure the completion of the R&D cycle. In the majority of cases, **it is necessary, in our opinion, to develop a state-wide program during the next five years for establishing regional and interinstitute design bureaus, open-shop computer centers, etc.**

The mechanism for managing scientific systems includes one element, the essence of which has been appreciated only in the last few years—i.e., the procedures and actions of decision-making. Here too, a scientific approach is required, and scientifically formulated and practical principles must be applied.

"Hybrid" Structure

The feasibility of converting from the rigid organizational structure of scientific research institutes in which each department or laboratory is established "once and for all" has been proven. A "hybrid" structure should be adopted, with permanent subdivisions which provide for continuity and purposefulness of research, and are supplemented by departments and laboratories established specially for the solution of specific scientific problems. The latter, and there are many of them, can be formed, financed, and reorganized depending on specific problems. **The necessity of distributing resources according to the long-range significance of the research projects, and not for supporting existing staffs or specific subdivisions, is obvious.** There is a great need for increasing the number of engineering-technical and auxiliary personnel, for improving their training, and for increasing their role in the scientific process.

Research achievements are directly related to the effectiveness of scientific publications, especially periodicals. A study has shown that articles remain in editorial offices here twice as long as with analogous foreign journals. To decrease delay it is necessary to introduce new publication rules in some journal editorial offices. Only abstracts of articles up to four to five pages should be printed, and complete texts should not be typeset but reproduced and mailed to interested persons or organizations upon request.

It is known that the rate of growth of the production of instruments for modern science must be 1.5 times greater than the rate of increase in the number of workers in the area. In the USSR as a whole, this index is still low, and in some organizations it is much less than one; this leads to an actual decrease in efficiency in the intellectual resources of science.

Modern instruments become obsolete so rapidly that in four to five years, as a rule, they are hopelessly outdated. At the existing rate of scientific-technical progress, the so-called "careful" policy of using instruments (several hours a week only) is absurd. It would be more efficient to purchase fewer but better instruments, and use them to the fullest capacity, without worrying that they wear out, and in two or three years of full utilization to replace them with new and more advanced instruments.

On the other hand, obsolesence of an instrument does not mean that all its parts become unusable. Many can be successfully salvaged and used in new instruments. Unfortunately, the existing rules of writing-off instruments and equipment deprives institutes of this possibility, and valuable parts go to scrap metal.

Automating Research

It is necessary to significantly improve existing methods of planning experiments and processing results. Manual data processing delays research, increases cost, and decreases the volume and reliability of new information. Work conducted in the area of automation of experimental data at the Institutes of Physics, Electrical Welding, and Physiology, all of the Ukrainian SSR Academy of Sciences, indicates that the application of computers makes it possible to deeply and comprehensively analyze experimental data and increase processing accuracy. This significantly decreases the duration of experiments and increases labor efficiency. Wide-scale automation of data processing is a long-standing problem and its solution cannot be delayed.

Large savings are realized in the transition from uncoordinated and small experimental production and computational bases in scientific research institutes to the establishment of multiuser bases serving groups of scientific institutions. This is also true for the shops for repairing and adjusting scientific instruments. The prompt supply of scientific research institutes with materials, reagents, etc., which was experimentally tried by the Leningrad Scientific Supply agency, was a complete success. The time has come to establish similar services in a number of republics and also in Siberia.

It must be emphasized that there is a difference between the concepts of "management" and "correction." The same measures, but undertaken too late, will actually result not in management, but in correction and cannot be effective.

Here, an important role belongs to the establishment of services for continual monitoring of R&D trends, and for forecasting requirements in managerial activity. So far, this principle has been clearly underestimated. Large-scale forecasting projects have not been methodologically oriented, and are uncoordinated and without representation on the State Committee on Science and Technology of the USSR Academy of Sciences or an appropriate problem scientific council.

It has been thought that scientific management could be successfully formulated by the director [of an institute] on the basis of everyday experience and "common sense." But this is a delusion. The personnel managing science must be specially trained and selected from among gifted and professional specialists. As an experiment, the training specialists of this type was started by the Economics Faculty of Leningrad University. Training in the management of science is available only to scientists in Kiev and in one or two other Soviet cities. Of course, this is clearly inadequate.

To manage, one must be well informed. However, when the question of scientific information is raised, it refers only to supplying researchers with information on the achievements of their colleagues. Meanwhile, the volume, complexity, and responsibility of the management of science are not treated as a specific scientific problem. Here, first of all, a synthetic processing of information on the operation of scientific institutions, on the formulation of trends, on comparative evaluation of levels, on preparation of different solutions, and on forecasting based on continual improvement in the accuracy of forecasting hypotheses is required.

Scientists and cyberneticists of the Ukrainian SSR Academy of Sciences have recently proposed a program for developing an information system for the management of science—the *UPRAN* system (management and forecasting of the development of the Academy of Sciences). The time has come to face this problem on a state-wide scale.

Commentary

The "science of science," the "management of research," and other such phrases have become increasingly common in the Soviet literature in recent years. This concern for greater productivity in research is coupled with the increasing attention being given to improved productivity and quality in industrial production. Our lead article in this issue of ***SCR*** examines recent actions by the USSR Academy of Sciences to make R&D more responsive to national priorities.

The present article is in some ways typical of many that appear from time to time in the popular press. One point stands out, however, indicating the possibility of change in the organizational structure of R&D establishments. The author, a respected Ukrainian economist and scientist, recommends that the "rigid" structures of research organizations give way to task-oriented teams assembled to attack particular problems.

Perhaps the only action in Soviet science more difficult than establishing a new organization is the disestablishment of one that has outlived its usefulness. This is just as true for subunits within institutes as it is for institutes themselves. Once established, a group can maintain its existence almost indefinitely. And funding tends to be based largely on staffing, rather than on productivity or demonstrated need. Dobrov would establish certain permanent units within a research institute (perhaps such as the departments that are usually found in American research organizations) that provide for continuity and the broad directions of the research program. Within these larger units would be organized groups (probably analogous to research teams) that maintain their integrity only throughout the life of a given project. Each would be organized on an *ad hoc* basis and treated individually in terms of staff, financing, structure, etc.

Dobrov also mentions the problem of inadequate provision of research instruments and equipment, and the paradoxical problem of low utilization of available items (the policy of not wasting these valuable resources). He asks for improved production, fuller utilization (taking complete advantage of an item before it becomes obsolete), and "recycling" of salvageable components from outdated or worn out instruments.

Finally, he deals with several suggestions foi improving the management and conduct of research at higher levels than the research institute. These include the establishment of multiuser equipment maintenance and repair depots, experimental-production shops, computer centers, and supply organizations. Services for continual monitoring of research and R&D trends are needed, as well as improved facilities for forecasting scientific and technical needs. Training of managers and directors of R&D activities is an acute problem, the solution of which involves not only better education and the development of a cadre of specialists in this area, but also better methods of information processing and data collection and dissemination.

In the final sentence, Dobrov mentions *UPRAN*, a management and forecasting system proposed for the Ukrainian Academy of Sciences. No further information is provided, and we have seen nothing else on this system.

In summary, Dobrov's article can be taken as a series of concrete suggestions for implementing the new emphasis of the Academy of Sciences on applied R&D and for improving the efficiency and utility of scientific research.—WH

Control System Installed Despite Severe Problems

F. Chajkin
Deputy Director for Economic Problems,
First State Bearing Plant

A radical production retooling and reconstruction has taken place during the past five years at the First State Bearing Plant. Large-scale mechanization of production processes, dictated by high output growth rates, led to changes in production control methods.

At present, almost 40% of all bearing production occurs in automated shops. The immense productivity of these shops requires systematic control and monitoring of the technological processes, continual flow of information, and constant analysis. The volume of this information increases every year. Suffice to point out that today some 20,000 various materials, 70,000 instruments, and up to 30,000 different spare parts are accounted for at the plant. Of course, it is only possible to process and analyze this information with the application of computers.

Just a few years ago, plant management was based on punchcard equipment which was used for production planning and accounting. Tabulators were used to maximum capacity, but their limited speed was inadequate for rapid operations. Data were received from sections and shops with some delay and could not be collected and projected into a comprehensive and overall picture; this made it impossible to effect efficient production control.

Thus, inherent conditions made it necessary to automate information collection, transmission, and processing with the application of computers, and to develop a plant automated production control system.

A portion of the work on the system was completed this year. Its area of application is extremely broad and encompasses the management of shops, planning, material-technical supply, accounting, reports and finances, output of finished production, etc.

Shop Operation

Here is how the system is used in the No. 2 automated shop. Information on the output of finished production, equipment downtime, and losses from defects is collected by special

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Translation of the article "ASUP: Advantages and Problems" ("ASUP: Vygody i problemy"), in the newspaper *Moskovskaya pravda*, August 15, 1970, p. 2; translated from the Russian by Irene Agnew.

electrical sensors, installed in machines or conveyers, for initial storage in machine-readable form. Then, all data are transmitted to the computing and information center for further processing. As a result, each day, by 9:30 am, the head of the shop receives six reports. They indicate the course of plan fulfillment for the shift and from the beginning of the month, defects by section and shift, metal on hand, equipment downtime, etc.

The head of the shop can obtain this information not only in the morning, but anytime during the day, within five minutes of his request.

The information is objective and extremely accurate: not more than one error occurs per million characters transmitted to the computer. Its other feature is the speed of transmission. Thus, measures to eliminate deviations from the normal course of production can be taken quite rapidly and not "post factum," as is often the case.

After the introduction of the system, equipment downtime in the shop decreased by half, and production output increased 20% and reached the plan quota before the end of the plan period.

Workers at all plant services have benefited from the system. The system helps mechanics plan equipment maintenance more accurately, allows rate setters to calculate stocks for technological operations, and permits foremen and section heads to calculate plan fulfillment for a day, ten days, or a month in advance. The system computes production capacity of the main and auxiliary shops, the efficiency resulting from the introduction of new equipment, payrolls, and hundreds of different operations.

The following example demonstrates the efficiency of the system. In the last few years, production volume at the plant increased three times. Without the system, this would have required 400 additional accountants. The plant has only 110. The additional work load is carried by the equipment of the computing and information center.

The introduction of the system sharply decreased plant losses and increased labor productivity by 5-6%. The plant shows annual savings of almost 500,000 rubles from the introduction of the system. Further development of the system should show additional annual savings of 600,000 rubles, and expenditures for the development of the system should pay for themselves in three or four years.

Advantages and Problems

Thus, the advantages are obvious; an important task has been accomplished. Of course, the plant did not accomplish this by its own effort. Dozens of plants and organizations participated in the development of the system. . . .

The plant is grateful to all of them for their help, but at the same time the following observation must be made: **the client-enterprise should not have to deal with dozens of institutes, assembly organizations, and plants, but only with one firm—a general contractor. This is the case in construction, and the development of automated production control systems is essentially a form of construction. Unfortunately, there is no general contractor to handle the complete set of tasks: planning, production, assembly, and adjustment.** And here is the result.

When the First State Bearing Plant started to develop the system in 1965, it immediately required so-called peripheral equipment for collecting, storing, initial processing, and transmitting information to the computer center. First the "sense organs" of the system were required—i.e., sensors for tabulating output in the automated shops. It was found that no one serially produced dust- and moisture-proof sensors capable of counting fewer than 20 items. Each enterprise produces them individually for their own needs in small batches. Our plant required them by the hundreds. It was necessary to form agreements for the development of such devices with a number of scientific research institutes. A year and a half later, we had still not received sensors with the required specifications. One type of sensor counted an extra item when shavings were present, another could not separate one item from the other.

Finally, it was necessary to organize a brigade at our own plant to produce the required mechanism.

Much time was wasted, and much expense was caused because these devices were not produced serially—and, incidently, are still not being produced to this day! Is it practical for a plant involved in its own business—production of bearings—to have to organize the manufacture of electronic instruments? Obviously not. It is also unreasonable because similar devices are required by dozens of other plants that produce similar products. Consequently, serial production of devices for counting parts is not only a necessity, but a potential source of profit for their producer.

No Storage Units

Similar difficulties occurred in the development of information storage devices. No one is producing them serially. A storage device model was developed by the Scientific Research Institute of Computing Machines, but no mass production or testing of equipment was organized. It is not enough to develop a device, it must also be assembled and adjusted. Who could do this? There was no reliable information on the capabilities of assembly organizations. To find the necessary firm, people had to be sent on numerous trips.

Similarly, the plant, as a machine construction enterprise, did not have the funds to purchase needed quantities of electrical engineering equipment. Cables, instruments, etc., had to be "knocked out" with great difficulty. Obviously, this could have been avoided if all work on the development of the automated production control system and the material funds were concentrated in one organization.

Apparently, such an organization exists today. It is the Proektavtomatika Association of the USSR Ministry of Instrument Construction, Means of Automation, and Control Systems. True, planning, assembly, and adjustment of equipment is done by specialists from this firm, but only if the client supplies the electrical engineering equipment, the designs, and materials. Again, this means that the client plant has to maintain a staff to order equipment and provide for its assembly, and workers for making cables and instruments.

These difficulties slowed down the work. For example, it took some two years to develop and assemble a comparatively simple initial information storage device. The absurdity of such a delay is especially obvious when we compare this to the production of computer storage devices. Production of the complex Minsk computer can be completed in one month. This is not surprising. After all, it is serially produced. The representatives of the producer have only to adjust the standard machine to local conditions. Two years vs. one month. This comparison alone attests to the necessity of organizing serial production of all equipment for automated production control systems.

It is apparent that the time has come to establish at enterprises of the USSR Ministry of Instrument Construction, Means of Automation, and Control Systems the production and assembly of standard systems and all necessary hardware. This is especially needed since the introduction of computing equipment for control processes is proceeding at an ever increasing rate at many enterprises of the USSR.

Commentary

There have been many references in the popular press and in the technical literature to the control system being implemented for the First State Bearing Plant. The present article is the first we have seen to document the multitude of problems encountered in designing and installing the system. Frequently, this project has been held up as a prototype for converting a large-volume production enterprise to automated methods. It would appear that it would be better advertized as an example of how to succeed in the face of adversity.

The lack of coordination and of a central responsibility for installing automated production control systems is a problem frequently mentioned, but the point-by-point detailing of specific areas where the plant encountered set-backs makes the issue more meaningful.

It should be emphasized that the system is not in its present state a true production control system. It is a management information system based on automatic recording of production data. The computer center processes the data for purposes of providing analyses, reports, and recommendations for management, and the basis of which corrective measures can be implemented by management. The computers do not appear to be on line to either the production machines or the data collection instruments. Data are collected first in "storage devices" and then transmitted to the computer center. Based on our knowledge of Soviet terminology, it is probable that these "initial information storage units" are in the same category as papertape punches, and the storage is on tape or some similar medium.—WH

Automatic Machine-Tool Monitoring System

The Computing-Information Center of the Kuibyshev Diesel Locomotive Construction Plant in Kolomna has designed and built an automated system to monitor 260 machine tools. The system alerts the appropriate service unit in case of machine failure. At the end of the shift, the accumulated information is sent for further processing by computer. In six months of operation, the system has reduced downtime in the fuel apparatus shop by 1000 hours and increased production by 3%.

(Ek. gaz., No. 29, 1970, p. 12, Elektronnyj dispetcher)

Soviet Railways Automating

A. P. Petrov
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. . .Computers have been used in railroad transport for more than ten years. However, during this time technology has made great strides, from first-generation, vacuum-tube computers to the semiconductorized computers of the third generation that are based on integrated micromodular circuits. Simultaneously, a transition has taken place away from vague concepts regarding the purposes and capabilities of cybernetic methods in transport, resulting in the development of a comprehensive system of planning and control computer centers on the USSR railroads and in regularized, large-scale execution of various calculations using computers. The greatest strides (although still not meeting today's requirements) have been made in the management of the transport process as a whole—more precisely, in long-term operational planning and the solution of engineering problems; the least progress has been made in the sphere of accounting.

Scientific research, experimental design work, and production operations are being conducted along two main paths. The first consists of computer-aided solution of operational problems, statistical record-keeping and bookkeeping, documentation, calculation of norms, and scientific and engineering calculations which are executed more efficiently by computers. The second involves the development of a set of computerized automated systems for managing the transport process and for accounting.

Optimal Planning

The application of computers is based on new mathematical methods, and, therefore, it was not accidental that the first problem to be solved with computers was that of optimal planning of transport (attaching destination points to shipping points for similar loads) and the compilation of schedules for regular freight flow destinations. This problem was solved at the Institute of Complex Transport Problems, technical colleges, and the Central Scientific

Translation of excerpts from Chapters 3 and 5 of the book *Operation of Railroads Utilizing Computer Technology (Ekspluatatsiya zheleznykh dorog s primeneniem elektronnoj vychislitel'noj tekhniki)*, Transport Publishing House, Moscow 1969, pp. 41-45, 99-100, 105; translated from the Russian by Irene Agnew

Research Institute of the USSR Ministry of Transportation, where a program for its rapid solution was developed in the form of PERT schedules. The actual development of schedules for regular freight flows for different types of freights (lumber, construction materials, etc.) shows that great savings can be achieved in the tons/kilometer index. As with many other tasks, this one, for which appropriate hardware and software have been designed, is characterized by inadequate supply of raw data: in quarterly and monthly transport plans there is no information on destination points of freight transported directly; no standard system has been established for preparing data and its coding. All this hampers regular calculation of freight flows for the entire railroad network.

Among the large-scale problems that can be solved with the aid of a computer is the calculation of a plan for assembling freight trains. This intriguing problem, which drew the attention of a number of railroad transport specialists and mathematicians, is of major scientific and practical interest. Computer-based calculation of train flows and a PERT schedule for train formation have been under development since 1960. In 1966, on the basis of the completed experiments, three programs (developed by the Central Scientific Research Institute of the USSR Ministry of Transportation, Moscow Institute of Railroad Transport Engineers, and the Khabarovsk Institute of Railroad Transport Engineers) were selected as best satisfying the requirements of large-scale regular calculations.

Other problems include compilation of a plan for forming trains with containers and small shipments. The methods and computer programs developed for this at the Central Scientific Research Institute of the USSR Ministry of Transportation take into account the conditions for forming container sets and determine the optimal order for loading them onto trains according to the formation plan; this results in acceleration of freight delivery and turnover of containers, and savings of millions of rubles.

Traction calculations are being executed according to a PERT approach with a program developed by the Institute. . . . Computation speed on machine-readable data using a computer operating at a speed of 10,000 opns/sec is about 100 km/min.

Scheduling

One of the most difficult problems is computerized compilation of train schedules. Satisfactory programs for two-way sections and a specific schedule for passenger trains have been developed. . . . Experimental one-way schedules have [also] been compiled. . . . The various methods being used. . . (modeling based on probability methods, representation based on linear programming problems, the step-function method) are not fully developed, and research continues. An experimental design for a traffic system for long-distance and local passenger trains under development at the Central Scientific Research Institute of the Ministry indicates a real possibility for practical application of methods that take into account both transport expenditures and the time lost by passengers.

[Several] organizations are conducting multivariant calculations based on computers —e.g., selection of the most profitable way of increasing traffic capacity, standardization of train weight norms, and other technical-economic investigations. Every month, computers are used to calculate technical norms for the distribution of trains at different railroad junction points and to analyze the utilization of rolling stock. . . .

The technological processes of some marshalling stations and the maintenance of rolling stock at depots are being developed with the help of network planning and control methods. . . .

On the basis of statistical and accounting calculations, it is possible to determine the freight traffic density at all network sections. . . ., and to calculate wages for locomotive brigades, and piece-rate and time-rate wages for workers. So far, payroll calculations are executed only for several depots of the Moscow and Gorky Railroads, although the capability exists for conducting these calculations for other depots as well, and for introducing payroll calculation programs for other categories of workers. Algorithms and programs have been developed for centralized calculation of freight train inventories, freight and passenger transport, etc.

Mechanized Accounting

The development of algorithms and computer programs for planning the operational projects and for engineering and scientific calculations is proceeding on a large scale; however, the development of statistical and accounting calculations and computations of material and technical supply lags behind that of technologically advanced foreign countries. This can be explained not only by high efficiency in the solution of operational problems and insufficient attention to the application of computers for other types of calculations, but also by the important fact that mechanization of statistical and accounting operations in the railroads of the USSR had been successfully accomplished by the predecessors of computers—by using keyboard and punchcard machines, grouped at the 29 railroad mechanized accounting works, 64 machine accounting stations, and 236 machine accounting bureaus. In 1966, 453-million punchcards were processed at the mechanized accounting works and machine accounting stations. In addition to advanced punchcard systems, these organizations are equipped with electronic calculators, electronic multiplication attachments to tabulators, and other equipment.

The mechanized accounting works execute statistical calculations for the loading and dispatch of freight, for passenger and freight transport, and for distribution of the resultant income; the operation and utilization of rolling stock; fuel and power expenditures of locomotives; calculations of premiums for locomotive brigades for fuel and power economy; payrolls; availability and movement of materials; and important incidental tasks—e.g., processing of materials from the annual inventory of freight trains, various surveys, etc.

Regular processing of large-scale flows of information (5-15 million decimal numbers for each railroad each day) requires the use of cybernetic control systems, consisting generally of a computer, an automated data transmission system (organizational communications) from peripheral stations to the computer and back, and a set of computer programs.

Experimental System

In 1960-63, the All-Union Scientific Research Institute of Railroad Transport, together with industrial organizations, developed a computer-based experimental system of accounting automation and transport process management for the Moscow Railroad. The system is capable of processing information transmitted from line subdivisions to a large computer center equipped with advanced computers. The system includes automated equipment for transmitting data based on error-free and highly reliable codes, the necessary software and programs, and equipment for transmitting and processing data for the operational forecasting of train flows. The system provides daily and shift planning of train and freight operations, operational-statistical and accounting calculations, and long-term planning of railroad operations.

The scientific research and experimental-design projects were coordinated according to a single plan, and included analysis of domestic and foreign experience and investigation of the goals of the system and the methods of achieving them. Information flows and the basic parameters of the system were determined. All this involves computers and instruments for data transmission, scientific-technical and design projects on the selection and development of instruments, development of methods for obtaining initial information, algorithmization of basic problems and computer programming, design projects related to the construction of a computer center for the Moscow Railroad, and a data processing system. A large, collective effort made it possible to establish a general functional diagram of the automated system and subsystems, its technical parameters and design implementation, and to verify in practice the research results using a Ural-4 computer installed at the Central Scientific Research Institute of the Ministry and experimental data transmission instruments.

Computer centers constructed on the basis of these investigations are operating at the Moscow, Gorky, and other railroads; computers are being used in a number of other railroads as well. The needed organizational communication equipment has gone into production. An "Area Automatic Dispatcher," which functions as a subsystem in relation to the computer center, is being tested on a segment of the Moscow Railroad; this is a domestic invention.

The Sverdlovsk and, later, the Moscow, Gorky, and Southwestern railroads initiated the use of railroad computer centers for the compilation of operational (current) plans for marshalling stations (Sverdlovsk, Orekhovo-Zuevo, Gorky, etc.). Thus, computers of the Center and the Sverdlovsk Marshalling Station are connected via telegraph communication channels with 30 stations of the Sverdlovsk, South Urals, and Gorky Railroads.

Two Minsk-22 computers have been installed at the Leningrad-Moscow Station of the October Railroad for planning the operation of the Leningrad junction and obtaining various information-reference data (an information-planning system). At the Orekhovo-Zuev Station of the Moscow Railroad, a control computer has been installed that will highly automate a number of executive functions of management.

The conclusions from this experience will result in the development of a standard system and its distribution to all large junctions and main marshalling stations of the network.

Experimental models have been prepared for a freight transport system. A system of recording and reserving seats for trains on extended runs is being developed, and provides also for automation of ticket-window operations and compilation of reports on passenger transport.

Automated Trains

Much work has been conducted on automatic control of train traffic. The first "automatic engineer" model appeared in the USSR in 1956; in 1958 it was successfully tested on the railroad. A computer installed in the locomotive compared the time of the run assigned by the program to current (actual) time values based on speed and sensors located along the roadbed; a traction regime was selected by the computer. Today, an "automatic engineer" system is used in the subway system. . . .

Computer centers handle the bulk of the problems concerning long-term, average-term, and current planning of projects, and statistical and accounting computations. The system is used to transmit initial data on freight operations, train and locomotive depots, and accounting reports from stations and depots to the computer centers. The machines compile current (daily-shift and several-day) plans on train and freight activity of the railroad and its departments, and obtain accounting indices of passenger freight and baggage transport and the income from transport operations. Also computed are the number, condition, and utilization of trains and locomotives, and indices on labor and wages.

The plans and directions developed by means of computers are transmitted via office communication channels (information communication) to the various railroad units for execution. Computer centers also calculate basic technical standards determining the operational activity of the railroad (the plan for formation and traffic schedule of trains, traction calculations, monthly technical norms, etc.). The distinguishing features of the system are: concentration of data processing at the railroad computer centers; automated transmission of data via a reliable, error-free code (one error per 10^6 transmitted characters); and advanced data processing equipment based on appropriate computer programs.

Computing Equipment

A computer center's equipment consists of two general-purpose standard computers, an auxiliary smaller computer (not always required), and parallel devices and EDP equipment for the solution of simple problems for which it is impractical to use computers. The required capacity of computers and data transmitting devices is determined by the quantity of raw data (for each railroad, 8-15 million decimal numbers per day) and the efficiency of its processing.

The operation of a computer center with data processing equipment must be conducted in the following manner. Raw data from line stations and economic units (large stations, departments, depots) is transmitted to the computer center; data is transmitted back to the economic units only on standard forms (code diagrams), each consisting of a strictly determined number of characters. At the line stations and economic units, data is transferred from initial documents to papertape via a tape punch with error control. The tape is inserted into the transmitter, and from this point on all transmission is conducted automatically. A programmed (scanning) device at the railroad department and remote signaling devices read the initial data by connecting one after another to the channels between the railroad department and the computer center, the transmitters of the line stations, which are connected to a group channel between the line stations and the railroad department. Transmission begins after an automatic exchange of signals which establishes the readiness of the computer center's receiver. The information from the economic units is transmitted to the computer center in a similar manner, but without alternate interrogation. A comparatively small portion of information is separated at the railroad department and recorded on a roll teletype; the information can also be reproduced on regular punchcards after recoding. . . or on papertape The main portion of information, however, is transmitted via the railroad department directly to the computer center for recording, first on papertape and then on magnetic tape. . . .

Main Computer Center

The first railroad computer center was established in 1963 at the Moscow Railroad; later computer centers were organized in a number of other railroads. The Main Computer Center is linked via a communication network to all of the railroad computer centers and is used for automatic planning and management of transport processes and for accounting on a network-wide scale. Some of the important work of the Main Computer Center includes a system of forecasting train flows, unloading operations, and the operational status at the network several days ahead for the purpose of regulating loads (according to type and designation) and train lengths. The forecasts are compiled daily, five to seven days ahead, on the basis of actual availability of loaded and empty cars, the expected loads going to different destinations, and traffic norms for groups of cars going to different destinations. The Main Computer Center collects and processes information received from the railroad computer centers and outputs the results to the main administrations of the Ministry of Transportation. . . .

"Express" Reservations System*

Next year at the corner of Krasnoprudnaya Street and Davydovskij Lane [in Moscow], construction will begin on a 22-story building, part of the reconstructed Komsomol'skaya Square. In this high building near the Administration of the Moscow Railroad will be located the enormous electronic "brain" of the "Express" automated ticket-accounting operations center. It will be linked by high-speed telegraph communication channels to 155 operator panels at railroad terminals, stations, and agencies.

Users may be located several thousands of kilometers away. For example, a passenger in Mineral'nye Vody or Chelyabinsk will be able to buy a ticket from Moscow to Riga. The operator-cashier translates the data from the customer into the language of numbers, and in fractions of a second they arrive at one of the center's computers. Information on the availability of space and passenger trains ten days in advance has been stored in the computer.

The computer instantaneously "considers" arriving requests and then issues an answer which can be read on a special panel. A ticket-writing machine is then activated, and after a minute or two the prospective passenger has all his travel documents in hand. Current status information is also displayed on a special stand suitable for general viewing.

Express will save rail transport 7.5 million rubles a year. Operational expenditures will be lowered and the occupancy of train coaches will be significantly increased.

The technical plan for the automated ticket accounting center was completed under the leadership of A. I. Yatskevich by a group of specialists in the Radio and Communications Section of the "Giprotranssignalsvyaz'" Institute in Leningrad.

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*This section is a complete translation of the article "Elektronnyj kassir," from the newspaper *Sotsialisticheskaya industriya*, September 15, 1970, p. 4.

Commentary

In a country as vast as the Soviet Union, the transport industry plays a major role in maintaining national viability and internal communications. The development of various modes of transportation has been one of the keystones of Soviet development, ranking in importance with electrification, industrialization, chemicalization, etc. The railroad system is vital to the movement of goods, as well as being the principal mode of passenger transport.

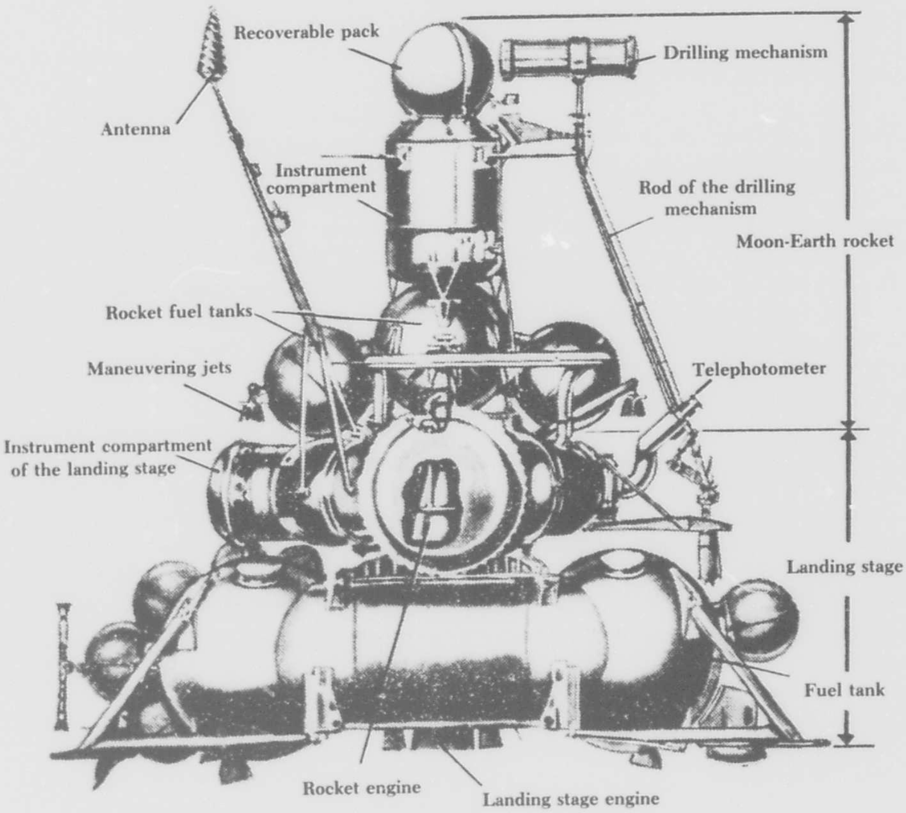
There is an unusually large number of research institutes concerned with the problems of railroad transport, and increasingly over the past decade their attention has turned towards computational methods for introducing modernization into the railway system. Notwithstanding the importance of the railroads to the country, it cannot be said that railway automation, especially where computers are concerned, has been an especially high-priority item in the total Soviet scheme. As the author of the present article points out, this is partly a result of the high degree of mechanization accomplished prior to the computer era.

The Soviet railway system was in disarray after World War II, and its rebuilding through the late forties and the fifties allowed it to take advantage of that era's most advanced mechanization technology. Thus, in comparison with other sectors of the economy, railway transport has not been until recently in need of modernization.

Railway automation has centered around the Moscow-Leningrad-Sverdlovsk lines, the backbone of east-west transport in the Soviet Union. Ural computers, especially the early Ural-2 and Ural-4 models, have predominated, and their use has been largely in railroad research institutes. What the present article reveals is a concerted effort to put into practical application some of the results of this research program.

The article is superficial, doing little more than vaguely identifying areas in which computational methods are being studied or applied. A number of organizations are identified in portions of the text not translated as being major contributors to research and development programs. Most of these are institutes directly connected with the transportation industry. However, one is the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences. Although its own publications reveal little interest in this subject, it appears that some not insignificant studies have been undertaken in the area of developing techniques for railway automation. These include a program based on PERT techniques for traction computations (in operational use), and an experimental system for scheduling trains on one-way track sections.

Based simply on the computers being used in railway automation and those anticipated for future application, one would have to conclude that railway automation does not enjoy such high priority as airline automation. Whereas Aeroflot systems are scheduled to use third-generation equipment, railway systems appear to be just breaking into the second generation.—WH



Luna-16 Probe
Source: Pravda, Oct. 4, 1970, p. 3.

Notes on Recent Soviet Space Activities

Computing Devices Aboard Luna-16

The landing stage of the Luna-16 probe is an independent, multipurpose rocket unit with a liquid-fuel engine, a system of tanks with fuel compartments, instrument compartments, and shock-absorbent supports for landing on the moon's surface. The instrument compartments [see photo] of the landing stage house the computing and gyroscopic instruments of the control and stabilization systems, the electronic instruments of the orientation system, the radio transmitters and receivers of the radio-measuring complex, a timer that automatically controls the operation of all systems and units, and telephotometers for transmitting information about the drilling site.

The coordinates of characteristic lunar orientation points are stored in a computer housed aboard the Luna-16 probe. The computer analyzes images flown over by the probe, compares them with images stored in memory, and determines the position of the probe, its trajectory, and its speed.

Data are immediately processed by on-board logic devices, which issue commands to the engine.

Tracking of Probes

The work of the ground command and measuring complex was of great importance for the successful fulfillment of the Luna-16 station's flight program. Data from trajectory measurements regularly made by the Long-Distance Space Communication Center were continually processed by a computer.

The flight of the Luna-16 station was monitored by an extensive network of ground measuring points on the territory of the Soviet Union and on ships of the USSR Academy of Sciences. Control of the Luna-16 flight was conducted from the Long-Distance Space Communication Center.

Computer Tracks Zond-8

The Shternberg Observatory has, for the first time, used a telescope for visual tracking. It tracked the flight of the Zond-8 artificial satellite for three consecutive nights following launch. The computer complex, equipped with a Mir computer and an automatic coordinate measuring device, processed tracking data which were then transmitted to the Coordinating Computer Center.

Automated Probes

Academician B. N. Petrov states that the advantages of automatic space probes over manned ones are as follows: (1) the flight of automatic probes is 20 to 50 times less costly, and (2) the risks of manned flights are elimi-

SOVIET CYBERNETICS REVIEW, January 1971

Collection of excerpts from articles appearing in recent issues of the newspapers *Moscow News, Sotsialisticheskaya industriya, Pravda, Izvestiya,* and *Moskovskaya pravda;* translated from the Russian by Irene Agnew.

nated in automatic probes. Thus, he states, in determining new stages of development of space exploration, automatic hardware which has already proven its efficiency will be especially effective in the exploration of distant planets.

The Luna-16 flight proved that the volume of information obtained by completely automatic stations is no less than that obtained by manned spacecraft. At the same time, automatic space stations costs tens of times less than manned spacecraft.

Interstation Communication

The organization of radio communication between automatic lunar stations separated by distances of hundreds and even thousands of kilometers can be solved. One method is developing a satellite communication system using artificial lunar satellites as retranslators. The artificial lunar satellites, collecting information from the automatic lunar stations and transmitting it to earth, could at the same time act as control repeater stations for the operation of the lunar stations. Thus, the problem of interaction between automatic lunar stations, which is especially important for future research on the moon and in space as a whole, would be solved. This radio communication system will be organized within the next few years.

Future Developments

In the near future, scientific research bases with a complete network of small automatic stations will be established on the moon. These stations will be capable of conducting special investigations for many lunar days. The development of such long-term automatic stations will turn the moon into an immense space laboratory.

The theoretical possibility of obtaining rock from other planets, such as Mars, was proven by the Luna-16 flight.

The computational problems of space exploration are so complex that they require the development of qualitatively new theories, methods, and computer hardware.

It is difficult to enumerate all possible studies and investigations that could be conducted in the near future by automatic surface vehicles on the moon. The majority of specialists at present are of the opinion that wheeled vehicles, rather than the "Moon Walker," are best suited for exploration of the moon.

Ritm Network Planning Computer

The Ritm computer is described as a "special-purpose electromodeling machine," and was developed at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences. It has recently been on display at the Exhibition of National Economic Achievements in Moscow.

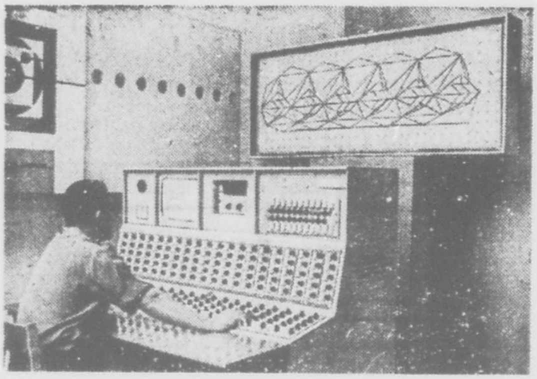
The machine produces a network, or PERT, chart on a display screen almost immediately following completion of input. Simultaneously, quantitative indexes are transmitted to the control console.

The Ritm machine was first noted in 1967, at which time it was already in production, although the number of orders for it, according to press claims, far exceeded projected output schedules. One of its features is its simplicity of operation, requiring only an operator. For schedules requiring more than 200 events, two or more Ritm units can be operated together in a system.

The first Ritm was in operation at about the same time at the Obukhovskij Residential Construction Combine in Leningrad; the Ritm is manufactured in Leningrad. It was first noted on display at the Moscow Exhibition in November 1967.

A Ritm-2 computer forms part of the ATsS Centralized Modular Production Control System (see *SCR/70/8*, pp. 57-58).

(Photo from *Ekonomicheskaya gazeta*, No. 38, Sept. 1970, p. 22; other information from past issues of *SCR*.)



Ritm computer

A. N. Kolmogorov: Mathematician

V. Yankulin
Nedelya Correspondent

When he was young, he wanted to become a forest ranger, but he was not so fortunate. His first scientific paper, which he wrote when he was seventeen, examined the historical and social aspects of Novgorod landownership. But, even earlier, at the age of five or six he says, he discovered by himself his first mathematical principle. It would not be a great exaggeration to say that it was then that Kolmogorov became a mathematician.

When in the twenties he entered the Mathematics Department at the university, applicants were accepted without an examination. He almost yielded to the spirit of the times and also entered the metallurgical faculty. Technology was in vogue then, but one had to pass a single examination—in mathematics. However, in his own words:

"Soon my interest for mathematics outweighed my doubts as to the urgency of the mathematical profession."

Mathematician No. 1

Today, Andrei Nikolaevich Kolmogorov is one of the most popular scientists in the USSR. To list all his honors would require too much space, so I will mention only the most important ones. Kolmogorov is a Hero of Socialist Labor and a Lenin Prize laureate. He was the first recipient of the Bolzano International Mathematics Prize—the "Nobel Prize" of mathematicians. (As is known, mathematicians and their works are not mentioned in Nobel's will, and, therefore, they are not eligible to receive the famous prize.) He is a member of many of the world's academies and scientific societies. Finally, he is recognized by a majority of living authorities as the most important modern mathematician—Mathematician No. 1.

Today's science requires of its members considerable activity in purely formal affairs. It is assumed that an academician must have a directorship somewhere, belong to numerous commissions and committees, chair meetings, consult, and teach. Very little time is left for scientific research. For example, after the recent death of one leading scientist, it was

Translation of the article "The Mathematician" ("Matematik"), in the in the newspaper *Nedelya*, No. 32, 1970, p. 4; translated from the Russian by Irene Agnew.

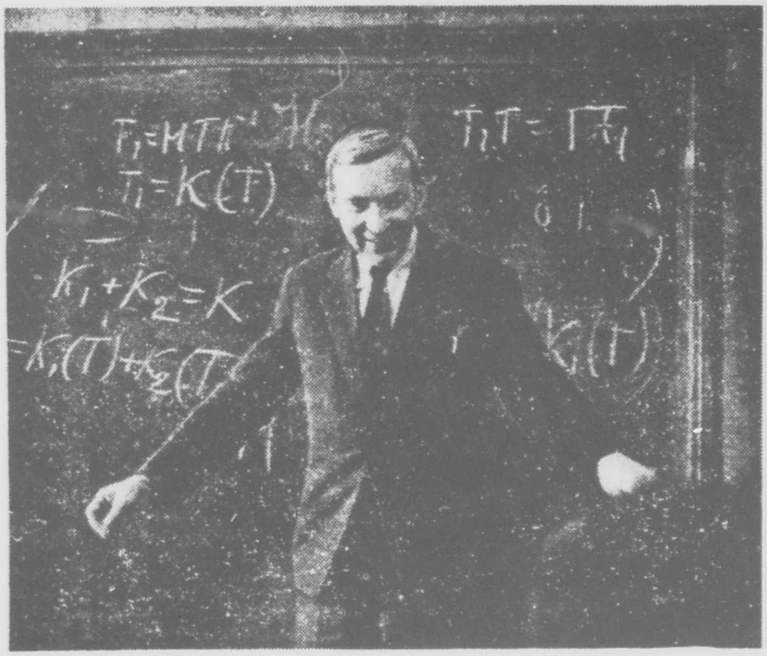
discovered that he held some 50 positions in various institutions. This, of course, was not his fault. Academician Kolmogorov for a long time held only one position, that of professor at Moscow State University.

His refusal to accept the countless offers which undoubtedly he continues to receive demonstrates the independent character of this scientist and his purely human, physiological feeling for what is most essential—for maximum effectiveness in his work. In a study of the efficiency of human thought, one of his associates used Kolmogorov's mental activity as an example of maximum human capability.

Reporters have always complained about Kolmogorov, saying that it is too difficult to come to an agreement with him about an article; and when it came to writing about himself, this was completely out of the question. Only once was one of my colleagues able to get somewhere. But relations between Kolmogorov and reporters are not as simple as they may seem to those who run after celebrities. His popularity, which I mentioned, even among those who hardly remember the basic elements of algebra, helps Kolmogorov to escape all ceremonies, promises, and requests. From his wife you can always find out when he is home. He usually likes to devote the morning hours to conversation. After dialing his telephone number you will hear a slightly gutteral voice:

"Hello, what can I do for you?"

"Andrei Nikolaevich, could you write for our paper (or journal)—"



Kolmogorov: "Humanity has all the possibilities for a kingdom of freedom"

The caller usually follows this with suggestions for subjects, as if they were gourmet dishes selected by a good cook who knows his client's taste. Kolmogorov thinks only for a moment.

"No, you know I have no time. There is so much work."

Sometimes, when the reporter is less informed and more persistent, the conversation is even briefer and less ceremonious. The answer is, "No!" followed by the click of the telephone indicating that there is no chance for further appeal.

Sometimes things are different and Kolmogorov telephones an editorial office himself and offers an article or a theme.

Davydkovo School

Several years ago, Viktor Akhlomov, a photographer, and I were the first reporters to arrive in Davydkovo, a small village near Moscow where on the initiative of Kolmogorov a boarding school for especially gifted children had been organized. Before going to the class of the "chief academician" (as he was called at the school), we were warned that the day before Kolmogorov had asked a reporter from one of the leading newspapers to leave the class. The reason? The reporter asked him to pose. We had better luck. After the lesson, Kolmogorov said that he didn't even notice us, and that we were in no way distinguishable from the other listeners.

The Davydkovo Boarding School was one of the most unusual experiments in our school system, and much has already been written about it. Of course, the name and image of Kolmogorov will always be connected with the students and teachers of this school. Kolmogorov organized the Davydkovo Boarding School, attracted leading scientists of the USSR to teach there, and traveled all over the Soviet Union in search of talent. He has written a textbook for senior classes in secondary schools based on his lecture course at the Boarding School.

Here I would like to return to the question of what Kolmogorov considers to be most important to him. Why does he emphatically refuse the most attractive offers of publishers, yet at the same time write short (about a page and a half) introductions, which are already becoming famous, for translated books of foreign mathematicians. After all, this requires reading volumes of mathematical literature. It was impossible to convince him to read an extra lecture at the University, but as soon as the Davydkovo Boarding School was organized, he spent several days a week there, without any regard to time.

Faultless Intuition

Everyone in this world has his own criteria. And it would be naive to search for deeper meaning in the actions of this man. He is guided by faultless intuition which has become a parable, and which helps him write mathematical formulas, travel, be interested in poetry and art, and select, according to his mood, either the mountains or the sea. It is impossible to describe all this in words, just as one cannot describe Leonardo's Mona Lisa or Tchaikovsky's First.

Here is how he speaks of himself and about his perception, "When I go abroad, I walk, stop in small hotels, and sometimes wait for a local train at the station for a long time. Sitting next to local residents, I listen to what they say. This is how I became acquainted with France, Italy—."

He said this while wondering why one of the young Soviet poets brought from abroad only poetry about airports and bars. We should remember Einstein who made the following remark about one of his students who quit studying physics and became a poet: "He never did have enough imagination."

Another time Kolmogorov said, "We must understand how to construct a continually developing human culture. How to grasp the whole vastness of this concept and to participate in the construction of the most wonderful structure for humanity and mankind. **I am delighted that Soviet poetry has become more alive and shows much good. But I am concerned about the speed at which tastes are changing—like different colors of socks, or the different style of a collar.**

"Why does poetry exist? First of all, to express in words the thoughts of the author, and not for recitation. Certain events can take place in one's life, when a man needs to take strength from the lines of his favorite poet.

"By joining the great human social life, man subordinates his own private life to it. But he needs, roughly speaking, inner slogans for himself. This is the main goal of poetry: to provide arms for organizing the inner spiritual life."

On Abstract Art

And here is Kolmogorov's view on art: **"I see no logical objections about the existence of abstract art. Music which we accept, and most of us love, is abstract. It expresses some new feelings, acts upon the psyche, but has no concrete external images. Why, therefore, shouldn't there be abstract fine art expressed in color and form?**

"In the twenties we conducted the following experiment with twelve-year-old children: We asked them to draw happiness without drawing anything concrete. This was not confusing to them in the least, and the results were beautiful and colorful and could have been hung on a wall. The ancient and complex art of ornamentation, which was very popular in the East, is completely abstract."

It would seem that Kolmogorov is a follower of abstract art. One could easily imagine that on the walls of his office hangs a Kandinsky or maybe a surrealist Dali. However, this man sees everything through his own eyes and much deeper than most persons.

"If we turn to the formal problem of the necessity of abstract art, and if we analyze the interest of today's society, this is what we would see. It is said of classical art: I love this thing, I need it for this or that reason. For example, I had the opportunity once to see Michelangelo's Sistine Chapel, and I would like to see it again. About abstract art, almost no one will say that a particular work is good. I think that in order to understand what we really need, we should very seriously weigh the baggage which we carry and which, by creating, we accumulate. Without this it is impossible to move ahead."

Kolmogorov's concern about "baggage" and the environment in which the next generation will be brought up is not simply a lot of talk. One evening, the first students of the Davydkovo Boarding School were listening to Kolmogorov telling the student-mathematicians not about the theory of functions, but about the art of Michelangelo and Leonardo da Vinci. He brought beautifully published albums of reproductions, and these hearts and minds, earlier enthralled with the magnificence of formulas, understood that evening the grandure of art. This is esthetic upbringing!

Kolmogorov is an outstanding man. There is no doubt about this, and it is felt by everyone who has worked with him or has had a brief or a prolonged association with him. The most indisputable authority, a staggering capacity for work, amazing broad-mindedness, and a reserve of ideas! I will never forget the enthusiasm with which one of his pupils spoke of him: "This is an amazing, deeply interesting person." The young man's eyes sparkled.

And here is what Kolmogorov himself admires.

Foremost Question

"Humanity is going through a period when it has all the possibilities to jump from the kingdom of necessity to the kingdom of freedom. All the material possibilities to do so are now available, which was not so 100 years ago. Whether humanity will make this jump or meet with another fate—this is the primary and foremost dramatic question of our time.

"When people remember Einstein, for some reason they always say that he wore a wrinkled coat. Of course, it is silly to say that he was a good man only because he wore an old coat. But the fact that he signed the appeals for peace, and suffered the fate of humanity until he became ill, this should be known to everyone. This is the mark of a great man."

By coincidence, Kolmogorov also usually wears a cheap, worn suit. Inexpensive suits for 60 to 70 rubles have long become the "a la Kolmogorov" style among mathematicians. But in his own words, this is not where man's greatness is evident. Kolmogorov's concern about the young generation and its talents, about the future of humanity, comprises the immense moral potential which attracts to him students and followers.

For a time, not only among romantics, but even among scientists, a mass psychosis was developing a cybernetic future, where man would be completely replaced by robots. There were fears that the robots will cease to be obedient, etc. Kolmogorov as one of the proponents of cybernetics clearly cast aside such ideas.

Andrei Kolmogorov

Future of Reason

"The future, as I imagine it, will be the kingdom of reason. And man will never push the 'release catch' for developing creatures who are capable of harming him. If the urge for a meaningful and good life continues for several thousand years, humanity will change into completely new forms, which now are difficult for us to understand. Humanity will change, not some rebellious robots." It is for this future that citizen and patriot Kolmogorov is fighting.

One would have to write a separate article, perhaps several, about his students. Kolmogorov's school is a large and renowned group of highly qualified mathematicians. Someone has said that Kolmogorov's school is the school of schools. It includes the Davydkovo Boarding School, and the important Soviet schools in such areas as probability theory, information theory, structural linguistics, functional analysis, and other branches of the ancient tree of mathematics.

Why did he select mathematics? Niels Bohr said that, "mathematics greatly resembles the form of a general language, adapted to express relationships which either cannot or are too difficult to be expressed in words." This universality and beauty of structures, where each explains so many events in our environment, evidently captured the mind and heart of the young Kolmogorov.

His passion for diversity can be seen in his love for sports. "When I was already the age of a professor, I one day skied with my students for ten kilometers. This was near my summer house, but I did not know in what direction I was skiing. I was interested only in the ski tracks. I must say that this fact promoted some interesting thoughts. Some elements of strictly human nature were evident in this aspect of the sport."

At a meeting with students, he remarked that one should select a profession only if he can put his heart into it. Otherwise it is useless to even get involved. "I really wanted very much to become a forest ranger. Too bad that at that time they had chopped down all the forests in our district."

Commentary

Who is really the world's Mathematician No. 1? Few mathematicians would venture such an opinion, but it probably would not be difficult to get mathematicians to each compile a list of the top three or four of their colleagues without any ranking within the list. If this were done, it is quite likely that the name appearing with the greatest frequency would be —Kolmogorov.

It is easy to ascribe an article such as the present one to the journalist's penchant for stating everything in absolute terms. We in the West might even consider as suspect any Soviet claim to primacy in a particular field. Notwithstanding the certain lack of modesty in proclaiming Kolmogorov Mathematician No. 1, it is difficult to escape the fact that such is probably the case. The article is a fascinating look at the character of this man—a man with one of the finest minds of our time.—WH

Voice and Sound Recognition Devices Developed

L. Agayan

. . .The first device capable of recognizing the human voice, understanding the meaning of its commands, and executing instructions was demonstrated at the Institute of Automation and Remote Control of the Georgian SSR Academy of Sciences. The unit was linked to a typewriter, which typed characters and numbers dictated into a microphone, and to a small cart, which on command from A. G. Kakauridze, Doctor of Technical Sciences, moved about the laboratory, stopped, moved forward and backward, turned right and left, accelerated, and slowed down.

This was in 1961. In demonstrating this first model, scientists even then dreamed of the time when similar voice recognition devices would be used for controlling machines and assemblies, or for inputs to computers. Now, after only a few years, at the Computer Center of the USSR Academy of Sciences in Moscow, V. N. Trunin-Donskoj can dictate assignments to a computer: "Listen! Sine! Two! Five! Period! One! Four! Two! Degree! Stop!" True, the assignment so far was not very difficult, and "stop!" did not mean for the computer to stop, but rather indicated the end of the assignment. The last word was hardly uttered when the results were already printed on a sheet.

Another recognition device has been developed at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences. This computer "knows" dozens of words; by combining them it is possible to issue hundreds of different commands. The computer can execute commands given by any voice or, if necessary, will listen only to the voice of its "proprietor." This means that the computer will listen only to the person delegated to control the specific process or machine.

A device with a very fine musical ear was developed at the Bonch-Bruevich Electrotechnical Institute of Communications in Leningrad. It is called an "electronic ear," and can be used for evaluating the sound quality of musical instruments. For example, the

SOVIET CYBERNETICS REVIEW, January 1971

Translation of the concluding paragraphs of the article "Zakodirovannyj zvuk" ("Coded Sound"), in the journal *Scientific-Technical Societies of the USSR (NTO SSSR)*, No. 7, 1970, p. 20; translated from the Russian by Irene Agnew.

machine can evaluate the sound of a new guitar in half a minute, whereas experienced musicians would have to spend hours to grade the instrument.

The *Sezam* voice recognition machines were developed in Minsk. These machines are products of the first practical experiments in using sound perception data, which were conducted by scientists of different specialties working in one common area, bionics.

Commentary

The claims made in this article would lead the uninitiated to conclude that the Soviets are making great strides in the development of voice-recognition automata. Work in this area is underway in a number of research centers in the Soviet Union, but there is as yet little evidence of striking successes. Articles such as the present one, reprinted from a "popular science" magazine, continue to appear in the Soviet press with curious frequency. Our continued monitoring of the technical literature fails to turn up evidence that the systems described are nearly so ambitious or well developed as the popularized articles indicate.

The Soviets appear to have become quite enchanted with the possibilities of controlling computers and various types of machine systems by vocal command. There have even been claims that such systems have been installed in practical situations. However, the work being reported in the technical literature indicates that the Soviets are no further along in these aspects of the overall pattern recognition problem than are researchers in the West.—WH

MSU Opens Humanities Complex

Five Moscow State University humanities faculties recently moved into a new 11-story complex near the main campus. Faculty and students in philology, history, economics, philosophy, and law were included in the move to the facility, which features a conference room system for simultaneous translation of as many as eight languages, central air conditioning, and high-speed elevators.

(*Izv.*, September 3, 1970, p. 6)

Czechs Continue Computer Development

Thirteen ZPA-600 computers are now being assembled at the Industrial Automation Plant in Cakovice near Prague. Recently, the Czechslovakian electronics industry began serial production of the new ZPA-6000/20 general-purpose computer which is capable of executing 12,000 opns/sec. Its two predecessors are now used in higher educational institutions, scientific research institutes, and the industry of Czechoslovakia.

("12 tysyach operatsij v sekundu," *Moskovskaya pravda*, Sept. 11, 1970, pp 3; "V bratskikh stranakh sotsializma," *Moskovskaya pravda*, Sept. 29, 1970, p. 3.)

Common Ministerial Management Systems Advocated

F. Gol'din
Engineer-Economist

S. Skorik
Candidate of Economic Sciences

The complexity of managing the national economy has sharply increased in the past two decades. This can be explained by the accelerated rate of production growth, intensification of the role of scientific and technical achievements, and the expansion and growing diversification of economic relations. For these reasons, old methods of collecting and processing information required for making sound decisions have become inadequate. On the basis of investigations conducted at the Moscow Economic Statistics Institute, the actual volume of production information at machine construction plants exceeds by four to five times normal processing capabilities under existing levels of mechanization.

Therefore, it is especially important to introduce computers in the management of plants, branches of industry, and the national economy as a whole. This technology can produce maximum benefits only given a specific organization of management—in other words, with the availability of an automated system. This is why directors of ministries are concentrating their attention on the development of such systems.

Branch Systems

We speak of "systems," because the designs undertaken by various ministries are significantly different. This fact, and the wide-scale development of branch automated control systems (OASU) and automated production control systems (ASUP), produce problems that in the foreseeable future can have fundamental implications. The solution of these problems will depend to a large degree on the efficiency of management in the national economy. What are these problems?

The main elements of a branch automated control system is the ministerial operation, equipped with advanced office mechanization, and the branch computer center (OVTs), supplied with computers and econometric methods of information processing. Thus, one problem can be formulated as follows: What role in the control process should be played by

SOVIET CYBERNETICS REVIEW, January 1971

Translation of the article "A Single Systems Language" ("Edinyj yazyk sistemy"), in the newspaper *Moskovskaya pravda*, Sept. 9, 1970, p. 2; translated from the Russian by Irene Agnew.

the branch computer center? At present, the answers to this question are varied. Some believe that the center can replace almost the entire ministerial system. Others feel that it can represent an immense "electronic abacus" which will be used by the branch staff for mechanizing the processing of planning and reporting information.

The different points of view are due to different understandings of the man/machine roles in a control system. Those who like paradoxes sometimes even ask: Will not the ministry of the future consist of an administration and the branch computer center? The studies of important Soviet scientists—for example, Academician V. M. Glushkov, and Corresponding Member G. S. Pospelov—and the experience of the USSR Ministry of Instrument Construction, Means of Automation, and Control Systems, the USSR Ministry of the Radio Industry, etc., indicate that such misgivings are completely groundless. A branch computer center must not replace the ministerial staff. It should become the technical base on which the control system is developed and functions—i.e., it prepares required information which is processed by computers. Man executes the main function, that of decision-making.

Calculations conducted at the USSR Ministry of the Radio Industry indicate that its workers use about half their time on computations, one third on document compilation, and only a little over 15% on creative analysis, development, and decision-making. The introduction of branch automated control systems, even during the initial period, will decrease the portion of labor related to computations by 10-15% and the time for compilation and coordination of documents by 15-20%.

Information Pyramid

The information transmitted to various central boards must be constructed according to the "cone" principle. This principle is based on obtaining the maximum volume of data at the lower levels of management, and the minimum at higher levels. For example, if we take the volume of report information on labor and personnel which is transmitted from the branch computer center to the main and functional administrations of a ministry as 100%, then it would be practical to distribute to the heads of these subdivisions 5-10% of the total volume, and to the administration of the ministry, 1-3%. This would be adequate for making sound decisions.

Thus, man will be increasingly freed from executing so-called "routine" and repetitious data processing operations, and will direct this main effort toward in-depth production analysis and more substantive "managerial actions."

Computers are distinguished by their accuracy of output, but only under one condition: they must have reliable, objective data to process. Without reliable information from enterprises, a branch automated control system cannot function. At present, the degree of reliability of information is clearly inadequate—not because of deliberate distortion of facts at the plants or factories, or because of a lack of ability, but for different reasons. First, in many cases **computer technology at enterprises does not correspond to today's requirements, and this naturally leads to errors. Secondly, supply is determined by demand. Up to now, the ministries received the information which to a greater or lesser degree satisfied them. Today, their requirements have increased. People must be trained in accuracy, and a system of rigid data processing control must be developed.**

This is a prolonged process; positive results will be slow in coming because a whole series of measures must be taken. For example, prior to computer processing of reports on the fulfillment of output norms at the enterprises of the USSR Ministry of the Aviation Industry, special instructions were prepared and plant reports were compiled according to these instructions. Nevertheless, after checking the information, the Ministry's labor administration was forced to send special letters to the majority of enterprises describing the specific errors made in the reports.

Common Language

In the USSR, management automation started in the enterprises. Today, it widely encompasses branch staffs, and there is strong evidence that in the future an automated system for controlling the entire national economy will be operating. But to function efficiently, its individual parts, such as the ministerial systems, must be completely coordinated with each other and must "speak the same language." Provisions for this must be made even now, in the first stages of the development of branch automated control systems, since it will be very difficult and costly to change anything in the systems after they are perfected.

It would seem that this idea does not require explanations or proof. Nevertheless, **all ministries are developing their own automated control system designs, which are different from each other according to a number of parameters.** For example, the USSR Ministry of Instrument Construction, Means of Automation, and Control Systems is mainly using the Minsk-22 computer; the USSR Ministry of the Radio Industry is using the Minsk-32 computer. The methods for writing programs for these computers in the majority of cases are different. Thus, the conclusion: **Ministries must be supplied with identical computers. However, this is just one of the conclusions that can be made from examining the problem of unification of branch systems.**

Who then should solve all these problems? **It seems most necessary to establish a single interbranch organization and scientific-research center for coordinating ministerial automated control systems. A "mini" version of such a center has already been established as a department of USSR Gosplan, but because of the limited authority that has been delegated to it and the narrow range of its activity, the center cannot cope with the total problem—a problem that remains unsolved.**

Commentary

Since we are unfamiliar with either of the authors of this article, it is not clear whether they approach their problem with naivete or with the knowledge that somewhere there exists a force to require a common approach by Government ministries to the design and specifications of management control systems. The problem is very real, but the lack of commonality in the systems of the different ministries is hardly accidental.

When the State Network of Computer Centers was first proposed, the various ministries immediately rushed ahead with implementation of their own, local systems. This was their reaction to the needs for such systems coupled with their extreme reluctance to have someone else assume responsibility for them. The ministries feel their prerogatives are seriously undermined if they become dependent on some "super" computing agency for computational support and for management of data collection and transmission functions.

The proposal that all ministries use the same computers is unrealistic. There are not enough units of any one suitable machine to go around. Further, the more recent systems use newer and better computers. If all the ministries were to delay their systems until one, standard machine came along, it is unlikely that any would today have a system of any type at its disposal. The problem is somewhat analogous to requiring all Pentagon agencies to use the same machine.—WH

Rumania Improves Accounting Systems

Rumania is taking measures to improve its economic information systems and to rationalize accounting procedures. New procedures developed by the Ministry of Finance resulted this year in a 20% reduction of data forwarded from enterprises, and 37% from industrial associations. The Ministry has trained and sent to enterprises more than 1200 methodologists and programmers who aid in the introduction of methods for machine processing of bookkeeping data.

(*Ek. gaz.*, No 29, 1970, p. 21)

New Agricultural Computer Center

A new computer center equipped with a Ural-14 computer is being established at the Kharkov Sel'khoztekhnika [Agricultural Technology] Association. An automated supply control system for spare parts for automobiles, tractors, and other agricultural machines is being developed by the Association and Ukrainian Gosplan. The system will serve kolkhozes, sovkhozes, and agricultural organizations in the five surrounding oblasts.

(*Izv.*, June 2, 1970, p. 1, Pomogaet elektronika)

Postgraduate Programs in Automation

Odessa Polytechnic Institute announces postgraduate programs in theory of mechanisms, machines, and automatic lines; engineering cybernetics; computer technology; semiconductor devices and their technology; instruments and devices for automatics and remote control; and automatic control and regulation of thermal power processes.

(*Ek. gaz.*, No 19, p. 23/1, "Sonkursy, aspirantura")

Agricultural Computing Network Being Tested

R. Kravchenko
Director, All-Union Scientific Research Institute of Cybernetics, USSR Ministry of Agriculture

Computers have been introduced in factories and other organizations; now they will also be used to aid farmers.

The All-Union Scientific Research Institute of Cybernetics of the USSR Ministry of Agriculture has been recently organized, a Main Computer Center of Agriculture is being constructed in Moscow, and the first regional computing and information system is being established near Podol'sk. The latter will form the first link of a branch computing and information system for overall management of Soviet agricultural production.

Intensification of agricultural production, further division of labor, and specialization have complicated interbranch and intrabranch relations. Today, the agricultural industry must take into account the various effects of soil and climatic conditions. Only computers are capable of handling the various interrelations and developing and suggesting the best solutions.

Regional System

The system for managing agriculture can be best illustrated by its lower link, the regional computing and information system. It is already being introduced at the Put' Il'icha Sovkhoz in the Moscow district of the Lenin region. The complex will include a computer center, an educational center, and housing facilities. The first sequence of this regional system will serve the Put' Il'icha, Lenin, Gorky and other farms. High-speed equipment will process information received from the farms and issue various recommendations.

Computer capability has already been tested in farming. Specialists of the Put' Il'icha farm compiled a projected plan for the period 1971-75, and then had the projection recalculated on a computer. The computer determined that the farm should concentrate on beef and dairy production, calculated the feed requirements, and suggested the most advantageous

SOVIET CYBERNETICS REVIEW, January 1971

Summary of the article, "A Farmer Behind the Computer Console" ("Zemledelets za pul'tom EVM"), in the newspaper *Izvestiya*, October 13, 1970, p. 3; summarized and translated from the Russian by Irene Agnew

plan for vegetable planting, etc. The computer-based calculations required significantly less time and resulted in 25% greater profit than that of the original plan.

The regional computing and information system will also be involved in the operational control of production, including calculation of long-range plant growing, biological processes in hot houses, crop rotation, etc. Larger systems will be established in oblasts and republics, and will be linked to the Main Computer Center of Agriculture. This center, which in turn will be linked via communication channels to the computer centers of USSR Gosplan and the USSR Central Statistical Administration, will be connected to the union Ministries of Purchases, Land Reclamation and Irrigation, Agricultural Construction, etc.

It has been proven that the economic benefits derived from improved management often exceed those resulting from increased production facilities. A scientific system of management results in an 8-10% increase in productivity, and with perfection of this system the economic benefits can even double. It has been calculated that the economic benefits can reach some seven billion rubles, simultaneously improving the administrative system and decreasing maintenance costs.

Commentary

Although this article may imply that much progress has been made toward formation of a branch computing and information system for managing the entire agricultural production of the USSR, there are problems which must be faced if this project is to succeed.

Heads of regional agricultural administrations have issued numerous complaints, stating that in their excitement to introduce large-scale mechanization in agriculture, the planning organs and trade organizations have decreased the production and sale of such simple devices as calculating machines, tabulators, etc. They claim that the demand for this equipment is not decreasing, but increasing, and that kolkhoz accountants need this equipment to produce accurate documents and reports.

At present, farms cannot depend on the regional mechanized accounting stations under the USSR Central Statistical Administration, since there are too few of these to serve the kolkhozes well, and they become especially overloaded during the peak days of the month. If the regional computing and information system, and later the branch system, is to be supplied with reliable initial data, it is obvious that attention must be given to equipping the farm brigades with calculating machines and other basic office equipment, and to coordinating the work of the mechanized accounting stations. Otherwise, the goal of establishing the branch computing and information system for managing the entire USSR agricultural production will remain an ambitious plan, without producing any concrete results.—IA

Symposium Presents Research Automation Possibilities

A. Melik-Pashaeva
Novosibirsk

An International Symposium on Computer-Based Automation of Scientific Research was recently conducted in Novosibirsk's Science City. Some 1000 specialists from the USSR, other socialist countries, and the U.S.A., Great Britain, France, the Federal Republic of Germany, and Japan gathered to discuss this problem. In an opening statement, Academician G. I. Marchuk, Deputy Chairman of the Siberian Department of the USSR Academy of Sciences, said, "Automation of the scientific experiment is not only the most important reserve for conservation of society's valuable resources of human intellectual power and time, but it also opens previously inaccessible horizons of science."

What is the significance of the intrusion of machines into the innermost and fragile areas of human creativity, intricately woven from the intuition, guesses, logic, and talent of the researcher? Automation of mental activity does not encroach on scientific creativity. The problem can be formulated as follows: To link the intellectual capabilities of man with the technical capabilities of machines. Let us say that we delegate to a computer the examination of 1000 meters of film and the selection of only those few frames related to the creation of a new elementary particle. The computer will spend only seconds on this task, while hundreds of qualified specialists would require many hours of cumbersome and painstaking labor.

But to assign this type of work to a computer is not simple. The problem is further complicated by inadequate man/machine communication. Up to now, the man/machine dialogue required the participation of a programmer-translator who often did not know the essence of scientific investigation, but was only capable of translating human language into the cold numerical language of the machine. In addition, the level of the participants in the dialogue was unequal: on the one hand, there was man with his highly active intellect, capable of immediately encompassing the multiplicity of phenomena; and, on the other hand, a computer, resembling an accurate and pedantic but poorly qualified worker. The computer

Translation of the article "Electronic Aid of the Scientist" ("Elektronnyj pomoshchnik uchenogo") in the newspaper *Izvestiya*, October 22, 1970, p. 5; translated from the Russian by Irene Agnew

is not capable of perceiving all the problems at once, but it can execute a system of simplest operations nimbly and promptly.

Computer developers are striving to expand the capabilities of machines by developing one generation of computers after another. The third generation is in operation now, and researchers are already speaking of the fourth. Computer operations continue to become more complicated as their capabilities are improved. The time is coming when they will be capable of easily handling entire classes of problems. By elevating the intellectual level of computers, scientists in fact are working on the development of an artificial machine intellect.

Graphics

In the darkened hall of the Institute of Automation and Electrometry, a greenish-yellow screen is flickering: the screen is opaque and round like a giant bird's eye. The similarity is further intensified by the "pupil" — a small dot of light. A hand holding an object resembling a pencil nears the screen. The researcher begins to draw on the screen without touching its surface. The dot of light, as if under a spell, obediently follows his movements. Designs, graphs, and text appears on the screen. This is not a miracle, it is the work of a photocell in the "light pen" which is connected to an automatic device. On command, the dot moves and follows the pen, leaving a bright trace on the screen. The automatic device stores the contour of the design, point by point, in the form of digital coordinates.

The photocell also stores the image, but no one would think to say that it "sees." It is a different matter with the computer. It analyzes the image, compares it with the "digital patterns" of other figures, and, depending on the comparisons, selects a program of action. The result appears on the screen in the form of a capacious visual pattern, or, if necessary, a three-dimensional one.

Such devices have a great future. Imagine the profile of an airplane wing projected onto the screen. The designer does not know exactly why (pure intuition!), but for some reason this design does not satisfy him. A few strokes with the "light pen" and that elusive "something," without which there would be no creativity, is discovered. And how will this change affect the lightness and durability of the wing? Precise calculations are required. In seconds, the computer checks the variables and transmits the completed commands to the program-controlled devices that show precisely how the designer's ideas can be converted into metal. Scientists refer to this as man's use of the machine in the course of his thinking. Labor efficiency is increased immeasurably.

This is only one example of mathematical modeling of processes, which more and more frequently is replacing direct experimentation and is becoming a component part of any science.

Computers also participate in direct investigations, thus relieving researchers of prolonged observation. Here, the possibilities of applying a scientist's experience, intuition, and knowledge greatly increase. The data are rapidly processed and compared with previously known data. This results in new scientific ideas and the possibility of knowing the essence of phenomena in more detail.

Today a researcher must master more and more facts in his daily work, and the flow of scientific information increases continually. Thus, the main wealth of man—the total treasure of his knowledge—increasingly becomes inaccessible even to men of science. They use only small grains of information which lie in the sphere of their basic activity. What is the answer? Knowledge accumulated by humanity can become accessible to everyone by means of large information systems

Time-Sharing System

The Novosibirsk Computer Center, linked to nearly all scientific institutes of the Science City, is developing a large automated information station for multiaccess utilization (at present, its small version is being tested). Dozens of scientific workers are simultaneously connected via communication lines to a complex of computers and storage units. Each researcher adds his share of information to the community (this is how it gets its rare encyclopedic qualities); the users are served simultaneously.

It has been calculated that every five minutes a new chemical compound is synthesized in the world. To make sure whether it is independent, its characteristics must be compared to the "birth certificates" of the numerous compounds described in the indexes and catalogues. Data on the chemical characteristics of a substance today can be obtained through the *Spektr* information retrieval system, developed by the Computer Center and the Institute of Organic Chemistry of the Siberian Department of the USSR Academy of Sciences. The BESM-6 computer, executing one million opns/sec, requires 7-10 seconds to compare the submitted "spectrum" of a substance with thousands of others. It is planned to include the Spektr system in the automated information station, so that the Specktr library will be directly accessible to the chemical institutes of the nation. In the opinion of Academician G. Marchuk, Director of the Novosibirsk Computer Center, this work creates a base for research on chemical structures and compounds on a world-wide scale.

The time is near when any inhabitant of this planet will be able, simply by dialing a number or turning a switch, to generate on a screen in his home books, films, music, and precise information on any question. Life will be different from that of today, just as the slow life of the seventeenth century was different from the rapid pace of today's age of TVs and spaceships.

Commentary

On his recent visit to the United States, A. P. Ershov, a leading Soviet authority on programming and the developer of the Novosibirsk time-sharing system mentioned in the present article, called the International Symposium on Computer-Based Automation of Scientific Research one of the two most important conferences in the Soviet Union last year in the broad area of computer technology. The other was the Second All-Union Conference on Programming, held last February, also in Novosibirsk.

Very little has been reported on the Symposium, and no proceedings of the papers presented has been noted. The present article is a hopelessly pedantic, simplistic discussion of the possibilities of automation in the scientific research process. On the basis of Ershov's remarks, the article should not be taken as indicative of the level of the papers and discussions of the Symposium.

Melik-Pashaeva devotes space to a description in a popular vein of several developments in Novosibirsk. The first is a graphics input/output system based on a light pen. Several light pen devices are known to have been developed in the Soviet Union, but they are generally of very limited capability and no production of these devices has been noted. The light pen described sounds more versatile than those previously identified, perhaps on a par with U.S. light pen systems. Very little is known about such a development at Novosibirsk. A light pen system developed in Kiev was revealed last year, but can be used only to identify screen areas for further operations from a keyboard and to erase displays.

The "multiaccess utilization" computer system is the AIST project under development by Ershov and colleagues for several years. Computer inadequacies have caused innumerable delays, and the preliminary AIST-O system is still not operational.

The final major example briefly describes the *Spektr* information retrieval system for data on chemical compounds. It operates on the BESM-6 computer, and eventually will be put on-line through the AIST system.

The Symposium appears to have been much more important and meaningful than indicated by the present article. There were some 400 attendees, representing 200 Soviet institutes; 23 reports by foreign guests were among the total of 120 papers presented. Further information on the Symposium will be published in *SCR* as it becomes available. WH

Pravda Editorial: A Passion for Paper

Technical progress is impossible without sharing experience and exchanging technical information between plants, scientific research organizations, and design bureaus. However, unforeseen difficulties often prevent this exchange. A request for a new design usually yields not the design, but a demand that photographic paper be supplied: design institutes would rather not shoulder reproduction costs. This passion for exchange ("You send us paper, we will send you the designs") is spreading through the USSR like an epidemic. Last year, a Baltic plant sent some 2000 square meters of paper to various organizations in its efforts to obtain designs. This causes unnecessary correspondence, postal handling, and accounting. It must be stopped. It is in direct contradiction to the resolution of the Central Committee of the CPSU and the USSR Council of Ministers, "On Measures for Improving and Lowering the Cost of Administrative Apparatus."

(Pravda, June 23, 1970, p. 2, Vysylajte bumagu)

Computers Poorly Used in Uzbekistan

N. Gladkov
Pravda Correspondent

It is difficult today to find an industry in Uzbekistan that does not use various computing equipment. Let us take as an example the digging of a new canal or reservoir in one of the Republic's new areas—tens of thousands of hectares are being thus developed annually. To do this, it is necessary to know in advance about changes in subterranean water levels. Compiling a forecast by traditional hydrological methods would be a time-consuming task, but Tashkent scientists with the help of computers have prepared and delivered to design institutes many maps showing changes in subterranean water levels. Computers are used to develop complex systems of vertical and horizontal drainage, determine norms for water supply, etc.

There are some 40 hydro-engineering complexes on the Zeravshan River, and about 200 in the area-wide canal system. In the near future, all information received from these complexes will be processed by one electronic "controller." It will determine where at any given moment there are water shortages or overages, and where locks should be opened or closed. The computer will issue optimized plans for the most efficient mode of using water in this large river's basin.

The advantages of using computers are obvious; they have hardly any opponents. But what are the actual results? The computer of the Republic's Central Statistical Administration operates more than 20 hours/day; on the other hand, the computer of the Ministry of Power Engineering and Electrification operates less than seven hours/day, and the computer at Tashkent State Design Institute of Transport operates five hours/day. The situation is even worse with other types of computing equipment. At the Ministry of Local Industry, each calculator operates only 1.3 hours/day; at the Uzbek Coal Combine, 1.9 hours/day; at the Ministry of Industrial Construction Materials, three hours/day. **This year, the average utilization factor of computing equipment has even decreased, compared to last year. At present, one-fifth of all calculating machines in the Republic are idle.**

SOVIET CYBERNETICS REVIEW, January 1971

Translation of all but the last paragraph of the article "A Help or a Burden?" ("Pomoshchnik ili obuza?"), in the newspaper *Pravda*, October 16, 1970, p. 2; translated from the Russian by Irene Agnew

Could it be that so much computing equipment has been delivered to Uzbekistan that a portion of it is simply superfluous? Not so, judging by orders from ministries and departments the demand for computing equipment increases every year. What then is the crux of the matter?

Lack of Personnel

It is already common knowledge that one of the reasons for poor utilization of equipment is an acute shortage of trained personnel. Yu. M. El'man, Director of the Computer Center of the Republic Central Statistical Administration states, "This large and important task went wrong from the very beginning. First the equipment was obtained, and only then was the problem of training personnel approached. As time went by, many directors got used to the idea of idle machines. If a tractor or a combine will not go out into the field, the machinist or engineer will have to answer for it. But high-cost machines are idle and no one has to account for the situation."

Everyone complains about the shortage of personnel, but when this problem was discussed with Farkhad Umarov, Director of CSU's Tashkent Training Combine, he did not act surprised and brought out a curious document that proves (to put it mildly) that the heads of many ministries and departments are not very much concerned with the training of needed specialists. The Central Asia Sovkhoz Construction Administration, one of the largest water conservation organizations in Central Asia, according to its own report should have sent 15 persons to take computer operator courses. But only two were sent, and these two left without completing the training. Ninety persons should have been sent for training from the Tashkent Main Construction Administration, the principal construction organization in the city, but so far not one person has been sent. The Ministry of Light Industry has not sent anyone for training.

The absence of qualified personnel is not the only barrier in the way of efficient application of computing equipment. Practice indicates that machines can operate with the greatest efficiency if they are concentrated in one place—i.e., in machine computing stations; but they account for only one-third of all machines. The remaining are used at half-capacity. Naturally, bookkeepers, economists, and engineers are striving to consign primitive calculators and sliderules to museums. On the other hand, computing equipment should not be completely removed from individual use. A balance is needed. In several ministries—Commerce, Cotton Processing, and Light Industry—the majority of calculating machines have been given to administrative workers and are used only a small portion of the time, and then inefficiently.

A number of enterprises are incapable of fully utilizing their computers. But at the same time, they are unwilling to cooperate with other plants and factories. There are more than 130 machine accounting stations and bureaus in the ministries and departments of the Uzbek Republic; however, only 16 of them serve more than one enterprise.

Still another problem. Computing equipment has been used in Uzbekistan for many years. But there are no facilities in the Republic for repair and maintenance. Plans have been made to construct a plant for this purpose in Tashkent, but they are proceeding very slowly and no one knows when it will go into operation. The machine accounting stations are often short of ordinary paper for printing devices; carbon paper has to be re-used several times. The situation with respect to the supply of spare parts is also poor.

In 1968-69, the Republic received 6100 large and small calculating and computing machines, which should have freed about 17,000 workers. But their numbers increased by 5300 persons during the same period. Now they comprise more than one-fourth of all administrative personnel. These figures should provoke thought. . . .

Petroleum Ministry Introduces 3-Level System

The USSR Ministry of the Petroleum Industry has reported the development of ASU-neft', an automated system designed to employ computer hardware, modern automatic equipment for collecting, processing, and transmitting information, mathematical economic methods, and optimal decision-making methods. According to Minister V. D. Shashin, the system will follow the new three-level branch management structure (ministry, territorial production association, and enterprise). Standardized approaches and designs for automatic control systems for associations and enterprises are being used. Compatibility of data, software, and hardware systems at all levels has been insured.

After initial processing at the local enterprise level, technical and economic information is sent to the middle echelon, the association's multiple-user information computing center (KIVU). There, the data are processed and analyzed, and recommendations are worked out. The highest operational component of ASU-neft' will be the head information-computing center (GIVTs) at the Ministry.

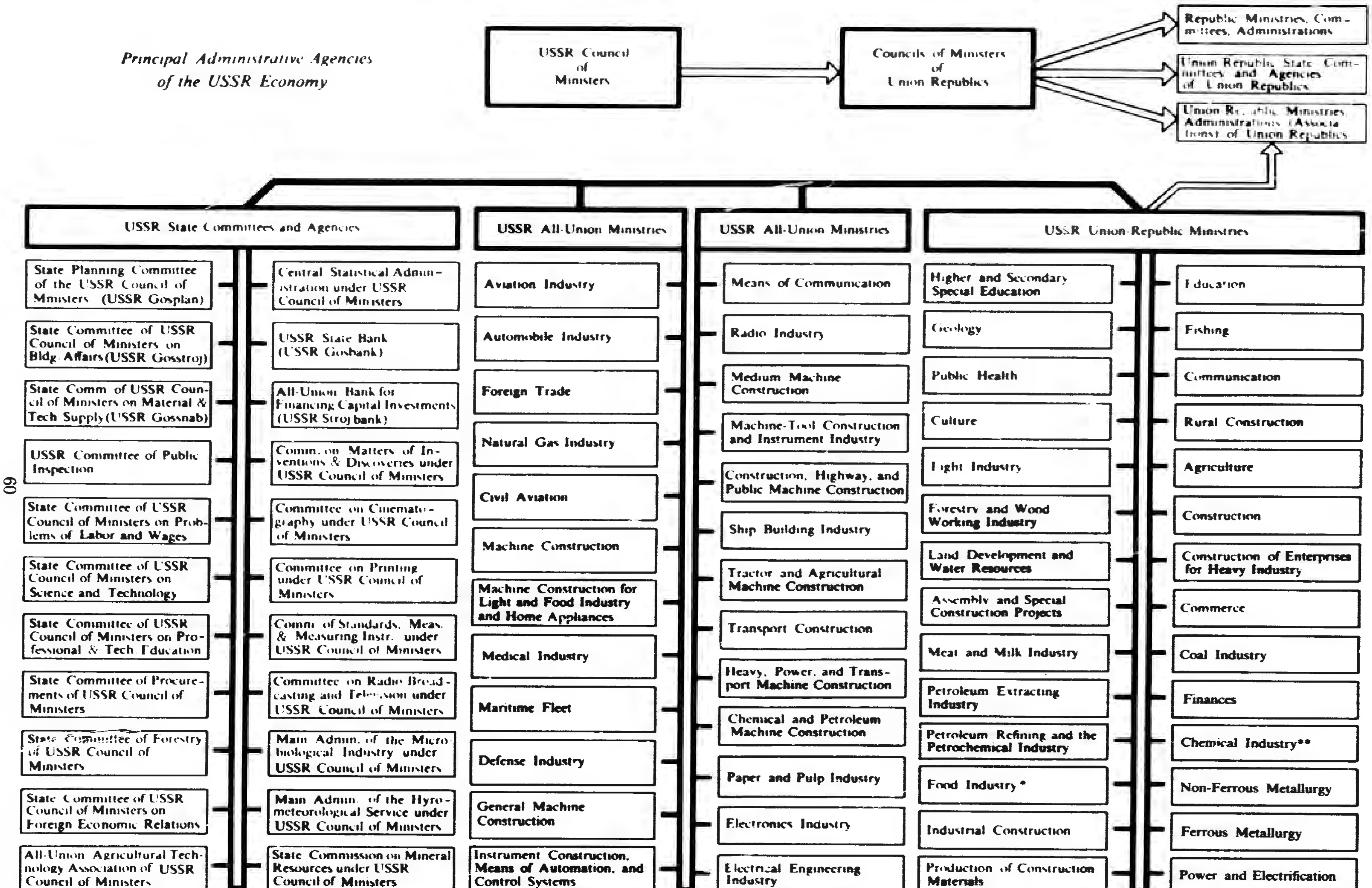
Basic work on the design of an automated management system at the association level has now been completed. One such multipler-user computer center is already in operation, and a number of programs for the solution of production planning and regulation problems are being introduced.

A system for initial dynamic technical accounting and bookkeeping in petroleum and gas extracting administrations and drilling administrations has been installed in Kuibyshev. Forms for primary documentation have been developed, taking into account the requirements of the automated system.

The Ministry's head computer center has begun operation with the processing of statistical information. Preparations are being made for the introduction of subsystems for dynamic management of associations, as well as of enterprises directly subordinate to the Ministry.

(Ek. gaz., No. 31, 1970, pp. 4-5, Strukturu upravleniya otrasl'yu—na uroven' novykh zadach)

Principal Administrative Agencies of the USSR Economy



Translation of organization chart, "Principal Administrative Agencies of the USSR Economy" ("Osnovnye organy upravleniya narodnym khozyajstvom SSSR"), in the special supplement to the newspaper *Ekonomicheskaya gazeta* entitled *Economic Reform in the USSR (khozyajstvennaya reforma y SSSR)*, Pravda Publishing House, Moscow, 1969, pp. 12-13; translated from the Russian by Patricia L. Stephan.

***As of June 1970, the All-Union Ministry of the Petroleum Industry**
****As of June 1970, an All-Union Ministry.**

On-Site Stations Aid Construction Automation

M. Loktyukhov
Candidate of Technical Sciences,
State Prize Laureate

The current stage of Moscow's reconstruction includes a high degree of labor industrialization, the construction of a large number of buildings and other engineering projects, and housing construction on a large scale. Thus, the requirements for planning and management of construction have greatly increased. It has become obvious that without mechanization and automation of computing tasks, it is practically impossible to conduct operational and precise calculations of daily construction requirements and to provide hourly transport schedules for the delivery of materials to the numerous construction sites. Electronic aids have become necessary.

An automated system for planning and control of construction is being introduced at the Moscow City Main Administration of Housing and Civil Construction. It was developed by the Scientific Research Institute of the Moscow Main Construction Administration, together with the scientific research and design organizations of the USSR Ministries of the Radio Industry and Communications.

The automated system will be used for planning, management, and monitoring of construction throughout the large territorial organization. The scope of its activity will embrace more than 200 enterprises and supply centers, 400 building and installation administrations and trusts, and more than 5000 construction projects with an overall annual volume of work exceeding one billion rubles.

On-Site Facilities

Plans have been made to establish a computer center equipped with advanced high-speed computers. Some 300 dispatcher stations—180 stationary and 120 mobile—each equipped with automated hardware for collecting and transmitting information, have been designed for use in enterprises and at construction sites.

SOVIET CYBERNETICS REVIEW, January 1971

Translation of the article "Electronic Service for Construction" ("Elektronnaya sluzhba strojki"), in the newspaper *Pravda*, October 9, 1970, p. 2; translated from the Russian by Irene Agnew.

Adjusted quarterly and monthly schedules will serve as the basis for developing operational-production documentation for organizing construction. This documentation will include hourly installation-transport schedules; daily schedules; supplies required for special projects; delivery schedules for mixes, concrete, and asphalt; and optimal plans for earth moving. Later, this documentation will be delivered to the executors—i.e., to the trusts and administrations, to construction sites and projects, to enterprises and supply bases.

According to our calculations, the development of the automated system for planning and management of construction will require 10 million rubles. However, these expenditures will soon pay for themselves. As a result of optimization of production processes, the automated system will make it possible to decrease production costs by 2.6-4%, and will result in 38-40 million rubles annual savings.

A significant portion of the computing and communications hardware has already been assembled. Central dispatcher control consoles serving all subdivisions have been installed. Algorithms and programs have been developed for solving several problems, including the execution of installation-transport schedules, hourly delivery schedules for mixes, etc.

Plants of the USSR Ministry of the Radio Industry have started to produce and deliver instruments for the collection and transmission of information.

A significant volume of work related to the development of norms, data bases, algorithms, and programs is yet to be completed, and the interaction of dispatcher services must be organized. A number of scientific research and design projects, particularly for developing a large-capacity memory for storing standard information, must be undertaken in the further development of the system.

By introducing the automated system for managing construction in Moscow, it will be possible to assemble prefabricated elements and building sections directly from transport facilities.

GDR Cooperation

A scientific and technical cooperation agreement has been established with the German Democratic Republic in the area of improving management of the construction process. In the course of the three-year collaboration, there has been an active exchange of scientific-technical information, algorithms, and programs.

The first sequence of the automated control system for managing construction will be put into operation at the end of 1970.

How Do You Hear Me, Computer?

Galina Shpak
APN Staff Writer

A switch was flicked, and a voice resounded in the silent room. "Attention, this is the computer speaking. Listen to an excerpt from Alexander Korneichuk's play 'The Front.'"

After completing the dialogue, the computer issued a number of difficult sound combinations and then sang a popular Russian song.

This performance by an electronic computer took place in the conference room of the Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences [in Novosibirsk]. Enhancing the "intellect" of a computer is a thrilling problem, the concern of many research centers throughout the world. The problems interest mathematicians, physicists, psychologists, linguists, and physiologists. For 25 years the computer has been a blind, deaf, and dumb instrument performing nothing but mathematical operations. Today, with numerous ultra-high-speed computers in operation, the machine must be able to speak.

This requirement has given rise to a new study in the field of cybernetics—automatic pattern recognition. A number of research institutions in the Soviet Union have been working in this area for several years. At the Siberian Department's Institute of Mathematics, it is the laboratory headed by Nikolaj Zagorujko, Doctor of Technical Sciences.

Specialists attempt to teach the computer to draw logical conclusions and to answer questions without access to answers prepared in advance—i.e., they want to imbue it with some elements of intellectual behavior. Computers must be able to perform the functions of a machine operator, a bibliographer, or a translator; to store and output information on request; to control intricate production processes. In many of these applications, the important thing is not to push control buttons, but to issue oral commands to the computer or to ask it questions.

SOVIET CYBERNETICS REVIEW, January 1971

Edited version of the article by the same title in the English-language publication *Science and Engineering*, the Novosti Press Agency (APN) newsletter, No. 37, Sept. 25, 1970.

200 Words

The Institute of Mathematics is concerned with machine speech in its various aspects. These include, what was said, who said it, and in what emotional state was it said. What is said involves the identification of a limited set of words. What size vocabulary must the computer possess to be able to understand a person and answer him? As an example, in order to solve an applied problem for the Murmansk fishing port, the Siberian mathematicians decided that 200 words would suffice. In fact, a vocabulary of this size is sufficient to input any mathematical problem to a computer.

However, successful use of a system of this type depends also in large measure on who speaks the words. A computer may have a small vocabulary and be able to understand any speaker, or it may know a great many words but only be able to identify them when spoken by a particular person. The machine at Novosibirsk knows 200 words. The answers it gives are correct 96% of the time. But it functions under one condition: it needs rehearsing and tuning to the voice of the speaker. The scientists are now working on methods of teaching the computer to adapt to any accent or voice pitch. And unlike the robots of science-fiction, the Siberians consider that a machine can speak with feeling and intonation.

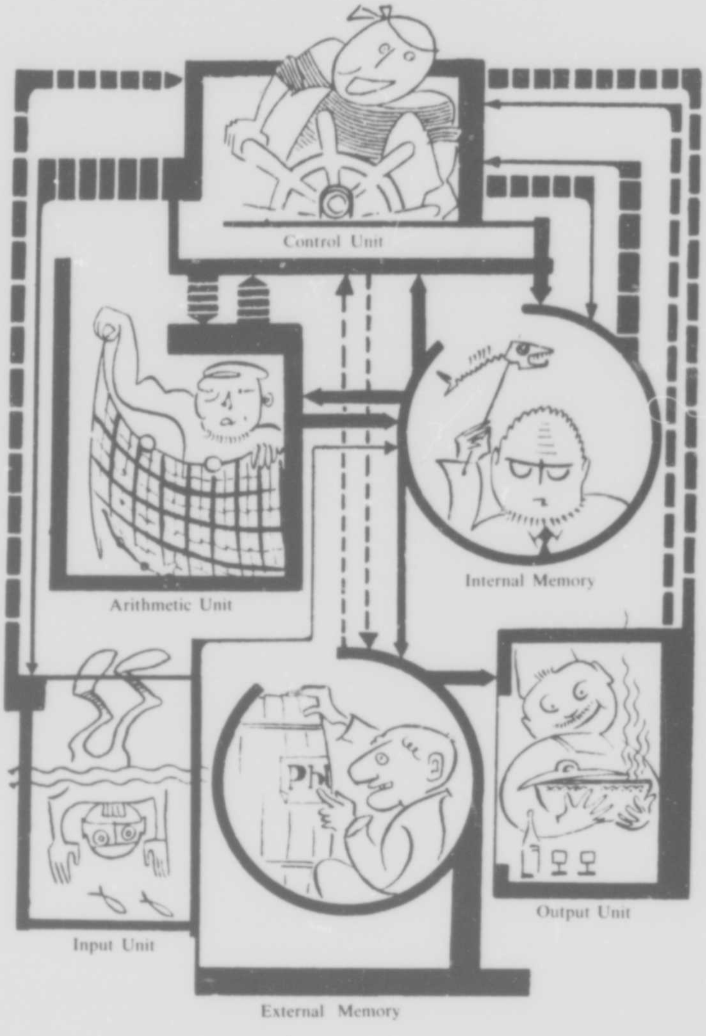
Dr. Zagorujko performed some interesting experiments while on a scientific visit to the Royal Technological Institute in Stockholm. He input to the computer's memory characteristics of Russian sounds. He then checked the quality of the machine's pronunciation on the phrase, "Sasha has come back." At first the machine's responses seemed to simply copy the input phrase. But then it asked, "Has Sasha come back?"

It responded with a question. And afterwards, whenever his colleagues at the Laboratory greet Zagorujko, they do so by asking, "Has Sasha come back?"

A different method in the attempts to make the machine a true companion for man is to teach it to distinguish not words, but various sound patterns—phonemes. There are not many of them—40 or 50 in the Russian language. But they are highly unstable, and this leads to another problem: teaching the machine to recognize boundaries between sounds and words and to apply correct stress where needed.

The problem of automatic pattern recognition is infinitely broad. Those studying its various aspects pursue both applied and purely scientific goals. Nikolai Zagorujko comments, "Language is the bearer of the meaning of all information. By analyzing its structure, we can also fully understand the structure of the brain. We consider language to be the key to the brain. True, the linguists hold a different view. Language is so complex, they say, that it would probably be better to study the brain first. It is an extremely difficult problem, the solution to which must be on a multidisciplinary basis. A study of speech as the form in which language is manifested opens great opportunities. This is where physical, psychic, and physiological procedures come together. The problem is interesting also because it includes the mysteries of other auditory signals. That is why we do not give up on the idea of studying the 'language' of fish, dolphins, and even mechanical devices."

One cannot help but think that someday, in answer to the question, "How do you hear me, Computer?" the machine will answer sarcastically, "And how to YOU hear me?"



Block Diagram of a Computer
Source: Ekonomika i organizatsiya promyshlennogo proizvodstva, *No. 1, 1970, p. 166.*

CONFERENCES

Fifth Congress of the International Federation on Information Processing, Ljubljana, Yugoslavia, August 23-28, 1971.

The basic purposes of the congress are to facilitate the exchange of information on achievements and problems and to stimulate research in areas encompassed by IFIP. In accordance with a practice established for IFIP congresses, the program will include two types of papers: invited papers, intended as one-hour surveys of broad areas followed by half-hour discussions of recent achievements in areas of special interest; and submitted papers, comprising the main part of the program and dealing with original works or new results in information processing.

To facilitate the presentation of papers, the Program Committee has divided the subject into seven main areas with a list of themes for each. It is desireable that submitted papers deal with those themes or related themes within IFIP's sphere of interest. The seven main areas are as follows:

Computational Mathematics

Mathematical Principles of Information Processing

Computer Software

Computer and Computer System Hardware

Management and Administrative Systems

Technological Applications of Computers

Natural and Humanitarian Sciences

The Program Committee Chairman is V. M. Glushkov, Institute of Cybernetics, Kiev.

IFIP 71 will be held on the grounds of the Ljubljana Fair. Computers from various countries, peripheral units, and other equipment will be on display. A demonstration of computer-generated graphics and of machine-produced music are planned. *(Zhurnal vychislitel'noj matematiki i matematicheskoj fiziki,* No. 2, 1970, pp. 541-543.)

All-Union Conference on Philosophical Problems and Prospects of Cybernetics, Moscow, October 1970.

The conference was organized by the Scientific Councils on the Complex Problem of Cybernetics and on Philosophical Problems of Modern Science, and the Institute of Philosophy of the USSR Academny of Sciences. Scientists form Moscow, Leningrad, Minsk, Novosibirsk, Kazan and other cities participated.

Academician A. I. Berg, who spoke at the opening session of the conference, analyzed the current status of cybernetics research in the USSR and emphasized that cybernetics is becoming a powerful accelerator of scientific-technical progress.

Of great interest was the report on biocybernetics presented by Academician V. V. Parin and E. S. Geller, Candidate of Philosophical Sciences. This new science utilizes the methods and means of cybernetics in solving the mysteries of animate nature. The results obtained are used for the solution of technical problems. Soviet engineers have designed machines to simulate the movements of a whale and a penguin, space orientation instruments, and systems for collecting and processing information based on brain functions. *(Pravda,* October 6, 1970, p. 3.)

All-Union Scientific-Methodological Conference on Teaching the Subjects of Computers and Mechanized Processing of Economic Information, Moscow, November 1970.

The conference was organized by the USSR Ministry of Higher and Secondary Specialized Education for professors and teachers in higher educational institutions who are conducting original scientific-methodological research and have specific information on the subject of the conference. High-interest reports were selected for presentation at the conference, and curricula of courses on computers and mechanized processing of economic information for all economic and engineering specialties were presented for discussion. All reports, decisions, and other materials have been submitted to the Scientific-Technical Council of the Ministry of Higher and Secondary Specialized Education.

All-Union Scientific Conference on Structural Mathematical Methods of Modeling Language, Kiev, September 1970.

The USSR Ministry of Higher and Secondary Special Education decreed that the conference be held in Kiev in September 1970. The Ministry of Higher and Secondary Special Education of the Ukrainian SSR was called on to prepare the conduct the conference at Kiev State University, and to provide Kiev State University with the necessary means to prepare and conduct the conference.

The Organization Committee for the conference consisted of the following members:

I. I. Lyashko (Chairman), Corresponding Member of the Ukrainian SSR Academy of Sciences, Professor, Kiev State University.

A. V. Gladkij (Deputy Chairman), Doctor of Physico-Mathematical Sciences, Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences.

F. A. Nikitina (Deputy Chairman), Docent, Kiev State University.

A. A. Medvedev (Scientific Secretary), Senior Engineer, Kiev State University.

V. V. Akulenko, Docent, Kharkov State University.

A. A. Bel'tskij, Professor, Kiev State University.

M. I. Beletskij, Candidate of Physico-Mathematical Sciences, Kiev State University.

L. S. Kazachkov, Candidate of Technical Sciences, Institute of Cybernetics, Ukrainian SSR Academy of Sciences.

E. V. Paducheva, Candidate of Philological Sciences, All-Union Scientific Research Institute of Technical Information.

V. I. Perebejnos, Candidate of Philological Sciences, Institute of Linguistics, USSR Academy of Sciences.

V. Yu. Rozentsvej, Docent, Moscow State Pedagogical Institute of Foreign Languages.

E. F. Skorokhod'ko, Senior Scientific Associate, Institute of Cybernetics, Ukrainian SSR Academy of Sciences.

A. A. Stochnij, Candidate of Physico-Mathematical Sciences, Institute of Cybernetics, Ukrainian SSR Academy of Sciences.

V. A. Uspenskii, Professor, Moscow State University.

S. K. Shaumyan, Doctor of Philological Sciences, Institute of the Russian Language, USSR Academy of Sciences.

Yu. A. Shrejder, Candidate of Physico-Mathematical Sciences, All-Union Scientific Research Institute of Technical Information.

The Organization Committee was charged with: (1) the preparation and conduct of the conference in October 1970 [sic]; and determination of the length of the conference and the number of participants in accordance with the plan for 1970 all-union conferences and meetings; (2) attracting participation of leading scientific workers of higher educational institutions and scientific research institutes, and coordinating lists of scientists and specialists invited to participate in the conference with the Scientific and Technical Council of the USSR Ministry of Higher and Secondary Special Education; (3) selecting papers of the greatest interest for the conference; (4) planning recommendations that contain concrete and generalized recommendations for the introduction into practice of leading experience on the given problem, and coordinating in a preliminary manner with appropriate ministries and agencies on which their implementation depends; (5) presenting to the Scientific and Technical Council of the USSR Ministry of Higher and Secondary Special Education within two weeks after the conference a report on its work, the resolutions adopted, and other materials prepared for the purpose of implementing the resolutions. *(Byulletin' Ministerstva vysshego i srednego spetsial'nogo obrazovaniya SSSR*, No. 6, June 1970, pp. 7-8.)

Third Symposium on Sciometry and Scientific-Technical Forecasting, Kiev, January to March, 1970.

The symposium was conducted by the Department of Complex Problems of Sciometry of the Council for the Study of Productive Forces of the Ukrainian SSR Academy of Sciences, together with the Kiev Interbranch Council of Scientific and Technical Societies. Some 400 persons participated, and 120 papers were read. More than half of the reports were devoted to the problem of scientific and technical forecasting. The materials of the symposium indicated that Soviet scientists are expanding the theoretical bases of forecasting and using mathematical modeling, computers, and advanced software in the preparation of forecasts. The Mining Institute of the Siberian Department of the USSR Academy of Sciences, the Computer Center of Ukrainian Gosplan, the State Committee on Science and Technology of the USSR Council of Ministers and other organizations reported on specific research in the area of forecasting.

Seminar on the Problems of Electronics, Herzeg Novy, Yugoslavia, June 1970.

The Seminar on Problems of Electronics was held in Herzeg Novy, Yugoslavia, in June. Specialists from a number of countries participated, including the Soviet Union. They exchanged experience in the development and application of electronics and automation. *(Sotsialisticheskya industriya,* June 24, 1970, p. 4.)

International Symposium on Theoretical Principles of Information, Moscow [1970].

The recent symposium was attended by some 300 specialists from Bulgaria, Hungary, East Germany, Poland, Rumania, the USSR, Czechoslovakia, and Yugoslavia, as well as representatives from CEMA and the International Center of Scientific and Technical Information.

The purpose of the symposium was to pool research results on theoretical principles of information, as obtained in CEMA countries, and to elucidate the most promising trends for research in this field. Semantic studies are an important trend in the elaboration of the theoretical principals of information. Extensive application of logical and linguistic semantics to the analysis of specific features of natural and artificial information languages is quite promising. A number of papers presented a comparative analysis of applied information-retrieval languages and methods for compiling reference dictionaries which have been developed recently in CEMA countries.

Many reports were devoted to the development of mathematical and cybernetic models of information systems used in the transmission and analytical-synthetic transformation of scientific information.

The further application of methods from such allied fields as psychology and sociology is quite promising, too. A number of reports examined initial results obtained using these methods. *(Science and Engineering,* APN Newsletter, Novosti Press Agency, No. 34, September 4, 1970, p. 4.)

Symposium on Physico-Chemical Methods in Microelectronics, Novosibirsk, November 11-13, 1969.

The more than 200 specialists attending the symposium heard some 150 papers dealing with synthesizing and analyzing inorganic materials, as well as standardizing methods for physico-chemical control of impurities in integrated circuity. These control methods would be suitable for mass analysis of microelectronic element reliability and instability. There was wide discussion of experimental and theoretical results in the development of various methods of controlling inorganic materials and microelectronic elements (contactless measurement of electrophysical parameters). Methods of micro-X-ray spectral, electronographic, electron microscopic, X-ray, spectrophotometric, luminescent, and photoelectrical analyses, and methods of internal friction, ellipsometry, as well as analytical chemical control (amalgam polarography with accumulation, mass-spectrometry, radioautography, amalgam chronotensiometry with accumulation, extraction chromatography, etc.) were examined. *(Vestnik Akdemii nauk SSSR,* No. 3, 1970, pp. 116-117.)

All-Union Conference on Defects in the Structure of Semiconductors, Novosibirsk, September 29-October 4, 1969.

The conference was organized by the Institute of Semiconductor Physics of the Siberian Department and the Scientific Council on the Complex Problem of Solid State Physics of the USSR Academy of Sciences. This was the first such conference on lattice defects in semiconductors to be held in the Soviet Union, and was attended by over 150 scientific and engineering-technical workers from 19 Soviet cities.

The following main themes were discussed: lattice defects in thin films of semiconductors, diffractional methods of investigating defects in semiconductors, acoustical properties of semiconductors with defects, radiation defects, dislocations in semiconductors, impurities and thermal defects, and electrophysical properties of semiconductors with defects.

In evaluating the work of the conference as a whole, it can be said that it facilitated the coordination of Soviet research and permitted the determination of two main directions for future work: (1) a search for ways to eliminate the harmful influence of defects on the properties of semiconducting crystals, and (2) a study of the possibilities of using individual defects or ensembles of them for purposeful change of semiconductor properties in a broad class of materials. *(Vestnik Akademii nauk SSSR*, No. 3, 1970, pp. 106-108.)

All-Union Conference on Problems of Technical Diagnosis, Moscow, October 20-23, 1969.

The conference was organized by the Scientific Council for the Complex Problem of Cybernetics of the USSR Academy of Sciences, and by the Institute of Automation and Remote Control. More than 100 papers and presentations were heard by 550 representatives from 214 scientific research, planning, and industrial institutions, as well as higher educational institutions.

The foundation of technical diagnosis as a scientific discipline began over ten years ago. Its basic task is the efficient organization of processes in the inspection and reconstruction of the technical state of complex objects, installations, and systems under production, operation, storage, and back-up conditions. The conference operated in three sections: "Analysis of objects of diagnosis and optimization of diagnostic procedures," "Diagnosis of the state of discrete objects," and "Technical means of control and diagnosis of defects."

The reports and discussions testified to the fact that a large number of investigators and engineers in many scientific institutes, higher educational institutions, and enterprises are working in the area of technical diagnosis. Recently, individual questions in the construction of mathematical meodels of objects of control have been studied, methods have been worked out for the construction of programs of inspection for various classes of objects (especially for combined discrete and continuous dynamic installations), and methods for optimizing processes of inspection programs taking into consideration the probabilities of the states of the objects of control and the costs of individual inspections have been proposed. Research is being conducted to estimate the efficiency of technical diagnostic systems and to analyze human activity in those systems, and research related to the design of hardware for inspecting objects of control is being intensified.

However, work on technical diagnosis is being done disparately and communication among various organizations is poor. Only a few of the methods developed have been brought to practical introduction. The theoretical and practical problems of diagnosis for discrete installations with memory are being solved slowly, holding back the effective solution of problems in the inspection of such complex objects of control as computers and control machines. Little research is being devoted to the diagnosis of the technical state of mechanical installations and systems.

The resolution adopted by the conference pointed out problems that deserve special attention. They include the search for, creation of, and application of new mathematical models of objects of control which are effective both from the point of view of the solution of large-scale diagnostic problems and of the formal description of complex (including continuous) dynamic systems. It is also necessary to develop theory and methods of investigating the optimum design of control systems containing as subsystems diagnostic control and inspection systems, methods of estimating the degree of efficiency of technical diagnostic systems, and effective methods of writing verification programs for discrete devices with memory.

An extremely important task is the creation of new and the development of existing methods of checking the efficiency of and localizing defects in objects controlled by an interchangeable program, including computing and control machines. New methods of solving problems of discrete optimization are needed, primarily problems of constructing optimal and optimized inspection programs for objects of control.

Of great significance are the automation of the processes of constructing programs for the inspection of control objects, the search for new ideas and principles of designing built-in and external hardware for inspecting complex objects, and principles of constructing combined systems for monitoring data processing equipment based on optimal combination of programmed and hardware diagnostic means. Among the paramount tasks cited were problems of forecasting the technical state of complex objects of control, as well as the development and practical introduction of methods of designing objects of control taking into account the specifications of the efficiency in organizing their inspection in production, operation, and storage conditions. *(Vestnik Akademii nauk SSSR*, No. 3, 1970, pp. 108-109.)

Mathematical Economic Methods of Regional Forecasting and Mc deling of Territorial Economic Systems, Uzhgorod, late 1968.

The conference was organized by the Scientific Council on Cybernetics of the USSR Academy of Sciences, the Central Economic Mathematics Institute of the USSR Academy of Sciences, the Computer Center of Ukrainian SSR Gosplan, the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, the Institute of Economics and the Organization of Industrial Production of the Siberian Department of the USSR Academy of Sciences, Uzhgorod State University, Ivano-Frankovsk State Pedagogical Institute, the Bureau of the Coordination Council on Population of the Scientific and Technical Council of the Ukrainian SSR Ministry of Higher and Secondary Special Education.

Academician N. P. Fedorenko, Director of the Central Economic Mathematics Institute, opened the conference, dealing in detail with questions of the optimal functioning of economics. Deputy Director on Science of the Computer Center of Ukrainian SSR Gosplan, Candidate of Geographical Sciences, M. L. Polonskij, presented the basic methodological principles of designing territorial automated systems.

At the conference's plenary sessions and in its ten sections, some 200 papers and reports were presented dealing with methodological problems of modeling and designing territorial automated planning systems, the mathematical theory of economic models and numerical optimization methods, probability-statistical systems and methods, models for forecasting the development of cities, as well as the optimal distribution of various branches of the national economy. The present source dwells on the work of Section VI, "Territorial Demographic Forecasting Models and Analysis of the Distribution of Population and Labor Resources" (V. V. Onikienko, Candidate of Geographical Sciences, Chairman).

Many papers noted the necessity for the further introduction of mathematical methods and computer technology in the analysis of population problems and the improvement of existing models and systems for forecasting quantitative and qualitative indexes of population and labor resource productivity. In order to increase the significance of demographic research, the participants of the section emphasized the necessity of expanding the training of demographic specialists in the country's higher educational institutions, the publication of a journal, and the expansion and improvement of primary information on the given question. *(Vestnik statistiki*, No. 5, 1969, pp. 83-84.)

Computer Center for Kazakh SSR

A nine-story building has been built in the center of Alma-Ata to house the Computer Center of the Statistical Administration of Kazakhstan. Several computers will occupy the lower floors, and engineering and technical services will be located on the upper floors.

(*Sots. ind.*, Sept. 26, 1970, p. 4, EVM—novosely)

NEW BOOKS

Source Language for the SIRIUS Automatic Programming System

I. R. Aksel'rod, L. F. Belous, *Vkhodnoj yazyk sistemy avtomaticheskogo programmirovaniya SIRIUS*, Kharkov University Publishing House, Kharkov, 1969, 68 pp.

The book describes the source language of the SIRIUS automatic programming system developed by the authors at the Computer Center of Kharkov State University. The system is used to solve problems that include a wide range of analytical operations and problems of numerical analysis. In describing mathematical problems in languages which allow the assignment of alphbetical-analytical transformations, fundamentally new possibilities for the solution of these problems become apparent. These are related to the introduction of analytical operators—formal differentiation and integration, operators for the introduction of similar terms, simplification of analytical expressions, removal of parentheses, series expansion, replacement of variables, substitution of expressions, etc.

The SIRIUS system, in contrast to ALGOL-type languages, allows the description and solution of problems by methods in which a practical compromise can be achieved between analytical and numerical systems for solution using computers.

On the other hand, with the development and wide-scale utilization of these languages, analytical approximation methods for the solution of problems using computers will undoubtedly develop, just as the development of computers has led to the development of numerical methods for computerized problem solution.

Fundamentally new problems arise in the application of these languages with advanced computers. Due to their limitations, the algorithms developed for execution of analytical transformations cannot be used with all alphabetical-analytical expressions permissible in the language, but only with a few of these expressions. For example, there is no integration algorithm in an analytical form that is applicable to any integrand function. The same, but to a still greater degree, applies to the operators *max, min, lim*, etc. Difficulties of this type are characteristic of the ordinary formula language of mathematics. Thus, it is necessary to introduce symbols in the language that signal the effectiveness of the execution of analytical actions as applied to specific objects, and to examine the computers as partners with whom it is possible to conduct a dialogue. The man/machine dialogue consists of questions compiled by the computer, or the results of the execution of individual instructions by the computer, and human commands. Human commands are provided for in the source language of the SIRIUS automatic programming system, which is essentially a system of dialogue programming.

The characteristic feature of the language is that a program solution program written in this language contains two types of information—non-algorithmic (initial) information, and algorithmic information, which are distinctly separated from each other. Under the first type of information is understood the set of formulas, equations, and expressions written according to the rules of the generally established linear notation, descriptions, and some special objects. The second type of information, used strictly for the problem solution algorithm, consists of sequential instructions made up of Russian imperative phrases which begin with a verb in the imperative mood (with some natural exceptions).

Instructions written in the SIRIUS source language are not a fixed set of various macrocommands, each executing a narrow and completely fixed purpose. So-called standard instructions, which comprise the basic portion of instructions written in this language, are constructed according to a uniform principle. The rules for their compilation are, when possible, selected in such a manner that instructions which have no meaning in the Russian language are not acceptable in the SIRIUS system.

This description of the SIRIUS language system is a preliminary report and the system itself is of an experimental nature.

The syntax of the language is described by means of the Backus metalinguistic language, used in the report on the ALGOL-60 language.

The metavariables were selected in such a way that they approximately reflect their semantic meaning. Many metaformulas, for the purpose of convenience, are repeated several times.

The first part of the book gives a general idea about the language and its capabilities by means of program examples. The second part of the book contains the formal description of the language.

An Analysis of Time-Shared Computer Systems

A. L. Scherr, *Analiz vychislitelynkh system s razdeleniem vremeni*, Mir, Moscow, 1970, 135 pp., translated from the English by E. S. Kovalev and V. I. Rybachenkov; edited by A. N. Myamlin and V. K. Smirnov.

The book examines a model of the user, characteristics of the hardware and solfware of time-sharing computer systems, program modeling of a service system, modeling of the operation of magnetic disc and drum memories, and an analytical model for multiprocessor systems. An appendix includes brief characteristics of a time-sharing system developed at the Massachusetts Institute of Technology and a general description of the principles of its operation.

The introduction to the Russian translation states that in spite of its small size, the book contains much useful material. The inclusion of the appendix makes it possible to understand a number of problems discussed in the book. The information on hardware and software portions of time-sharing systems, and algorithms for the individual components of the modeling program increase the value of the book. Scherr's work concerning vital problems of computer technology—e.g., the development of quantitative methods for the analysis of complex computer systems—will be of interest to specialists in computer technology and students specializing in the development and application of computers.

Computer Systems, No. 34

E. V. Evreinov and Ya. I. Fet (eds.), *Vychislitel'nye sistmy*, vyp. 34, Nauka, Siberian Department, Novosibirsk, 1969, 150 pp.

This collection, prepared by the Siberian Department of the Institute of Mathematics of the USSR Academy of Sciences, includes articles on the development of algorithmic methods for designing computers and computer systems.

The book contains the following articles:

S. V. Piskunov, S. N. Sergeev, and B. A. Sidristyj, A Language for Describing Algorithms of Computer Operation

B. A. Sidristyj, An Equivalent Transition from the Description of Computers in the F-Language to a Microprogramming Description

I. V. Ilovajskij, Construction of a Computer Functional Circuit by Description of its Operational Process

V. A. Tyurenkov, Some Algorithms for the Construction of a Shortest Circuit

M. I. Kratku, The Degree of an Information Graph

V. G. Khoroshevskij, Tenacious Homogeneous General-Purpose Computer Systems

E. G. Khoroshevskaya, Evaluation of Nonstationary Reliability and and Reducibility Functions of General-Purpose, Homogeneous Computer Systems

A. G. Shigin, Some Problems of Program Modeling in Designing Computers

I. I. Dzegelenok and A. G. Shigin, Generation of a Forecasting Filter on a Programmed Model of a Computer

I. I. Dzegelenok, V. Kubera, V. G. Popov, A. L. Syrkin, and A. G. Shigin, Experiments with the "Konsilium" [Consultation] Heuristic Program for A-Automata

I. I. Dzegelenok and A. G. Shigin, Behavior of an A-Automata in a Nonstationary Discrete Medium

The book will be of interest to specialists involved in computer design, program modeling, and theory of computer systems.

Computer Systems. No. 37.

N. G. Zagorujko (ed.), *Vychislitel'nye sistemy*, vyp. 37, Siberian Department, USSR Academy of Sciences, Institute of Mathematics, Novosibirsk, 1969, 76 pp.

This collection of articles describes various aspects of the problem of automatic pattern recognition, particularly problems of the theory of pattern recognition and methods for analysis of complex recognition systems.

A recognition algorithm based on dynamic symbols and an algorithm based on utilization of a redundant signal for increasing recognition reliability are presented.

The collection includes the following articles:

B. P. Gavrilko, N. G. Zagorujko, and K. F. Samokhvalov, Refinement of the Simplicity Hypothesis

N. G. Zagorujko, Comparison of Resolution Functions According to Power and Expenditures

G. Ya. Voloshin, Resolution Rules in Hierarchical Recognition Automata

V. S. Lozovskij, Approximation of the Response of a System in the Z-Plane and a Format Analysis of Speech

N. G. Zagorujko and K. F. Samokhvalov, Recognition of Situations According to Dynamic Characteristics (the "DIP" algorithm)

G. Ya. Voloshin, I. V. Bakhmutova, and A. A. Prokopenko, A Network Algorithm for Recognition of Phonemes According to Segment Sequentialness

V. N. Elkina, L. S. Yudina, and A. G. Khajretdinova, Statistics of Two- and Three-Phoneme Combinations in Russian Speech

V. M. Velichko and N. G. Zagorujko, Automatic Recognition of 200 Vocal Commands

This book should be of interest to specialists working on the development and application of recognition methods.

Devices for Storing Discrete Information

L. P. Krajzmer, *Ustrojstva khraneniya diskretnoj informatsii*, 2nd ed., rev. & enl., Energiya, Leningrad, 1969, 312 pp.

This is a completely revised edition of a book originally published in 1961. In this edition, the author concentrates on newly developed storage media—magnetic film, cryogenic and optoelectronic elements, ferrite-core storage devices, etc., and almost completely eliminates elementary explanations related to circuitry which have already been described in detail in many other books. Three new chapters devoted to problems common to all storage devices, a separate chapter devoted to permanent storage devices, and three chapters devoted to new long-range trends in information storage techniques have been added in the new edition.

The book is of interest to engineering technical workers involved in computer technology, automation, and related areas, and students of electrical engineering higher educational institutions specializing in these areas.

Cybernetics and Problems of Teaching

A. I. Berg (ed.), *Kibernetika i problemy obucheniya*, Progress Publishing House, Moscow, 1970, 387 pp.

This is a collection of translations on the application of cybernetic methods in teaching, with an introduction by Academician A. I. Berg who also edited the book. Berg states that this collection of articles on foreign studies of the problem of improving teaching methods and using advanced computer devices for this purpose contains a number of valuable ideas, concrete methods, and experimental data.

Berg's introduction is followed by an introductory article by A. N. Zakharov and A. M. Malyushkin in which they discuss programmed instruction in general and briefly examine the translated works. They state that in publishing the foreign studies, they fully realize the limits of applying programmed instruction and hardware for regulating teaching and upbringing in general. The application of programmed instruction is especially limited in the solution of complex problems of ideology and personal development.

The book contains the following translations:

G. Pask, Teaching as a Control-Engineering Process

A. Hormann, Gaku: An Artificial Student

H. Sydow, Search for a Structural and Metric Description of Problem Situation States in the Process of Solution (Translation from the German)

N. Prywes, Man-Computer Problem Solving with Multilist

J. E. Coulson, Computer in Research and Development on Automated Instruction

W. R. Uttal, Computer Machines: Real Time Simulation of the Tutorial Dialogue

E. A. Peel, Programmed Thinking

D. Tollingerova, Programming and Control of Instruction (Translation from the German)

E. Stons, Strategies and Tactics in Programmed Instruction

P. Hodge, A Proposed Model for Investigating the Instructional Process: The Relationship between Learning Theory and Educational Practice

T. Birkin, Human Information Processing and the Structuring of Teaching Materials

J. A. Swets, J. R. Harris, L. S. McElroy, and H. S. Rudloe, Computer-Aided Instruction in Perceptual Identification

W. Feurzeig, Computer and Automation

Elisabeth Barraclough, The Application of a Digital Computer to the Construction of Timetables

James Hartley, Some Guides for Evaluating Programmes

1970 State Prizes in Cybernetics

Winners of State Prizes for 1970 include the following in the cybernetics field.

For development of the Minsk second-generation family of general-purpose computers and mastery of their serial production: Chief Engineers Viktor Vladimirovich Przhiyalkovskij, Igor' Kirillovich Rostovtsev, and Mikhail Emel'yanovich Ekel'chik; Georgij Pavlovich Lopato, Candidate of Technical Sciences, Director; Yurij Vladimirovich Karpilovich, Chief Technologist; Yurij Grigor'evich Bostandzhyan, Guiding Engineer; Gennadij Dmitrievich Smirnov, Deputy Chief Engineer; Leonid Ivanovich Shunyakov, Deputy Shop Head; Nikolaj Anatol'evich Mal'tsev, Section Head; Gennadij Konstantinovich Stolyarov, Laboratory Head of the Institute of Mathematics of the Belorussian Academy of Sciences. [All but Stolyarov are with enterprises of the USSR Ministry of the Radio Industry.]

For development and industrial mastery of the first comprehensively automated shop for continuous pouring of ingots from oxygen-free copper in the metallurgical industry, guaranteeing a sharp increase in the output of high-quality cable: Nikolaj Pavlovich Kabanov, Head of the Main Administration of the RSFSR Ministry of the Construction Materials Industry; Vitalij Sergeevich Shchukin, Director of the Gor'kij Glass Works, Borskoe; Georgij Aleksandrovich Babinov, Nikolaj Mineevich Bystrov, rolling machinists of the Gor'kij Glass Works; Pavel Ivanovich Moryashov, Head of the Main Administration of the USSR Ministry of Construction; Boris Grigor'evich Kart, Administration First Deputy Head; Vladimir Vladimirovich Erekhinskom, Administration Deputy Head; Vadim Aleksandrovich Odintsov, Administration Chief Technologist; Valentin Alekseevich Drozdov, Candidate of Technical Sciences, Laboratory Manager of the Central Scientific Research and Experimental Design Institute of Industrial Buildings and Installations; Ivan Nikolaevich Dmitriev, former Manager of the Dzerzhinskij Trust No. 4.

(*Sotsialisticheskaya industriya*, November 7, 1970, pp. 3-4, O prisuzhdenii Gosudarstvennykh premij SSSR 1970 goda v oblasti nauki i tekhniki)

Brief Items, continued . . .

He stated that Soviet scientists are just as qualified as American specialists, but that the work of scientific institutions can be significantly improved by increasing instrument construction. USSR Gosplan, together with the State Committee on Science and Technology of the USSR Academy of Sciences and the Ministry of Instrument Construction, Means of Automation, and Control Systems, is currently devising ways for accelerating instrument construction in the USSR.

(From the article "Budushchee rozhdaetsya segodnya," the journal *Nauchno-tekhnicheskie obshchestva SSSR*, No. 6, 1970, p. 1.)

Ministry Expands Computer Use

The Ministry of the Machine-Building and Instrument Industry has examined the progress of the introduction of computers. The results indicate that computer hardware and econometric methods provide great possibilities for the mechanization and automation of engineering and managerial operations and for increasing the level of planning and control at the Ministry's enterprises.

The Ministry has found it necessary to expand the range of problems being solved by its Information-Computer Center, improve the quality of processing of production-economic information of enterprises, distribute subsystems for collection, processing, and output of operational information to all enterprises, expand the number of obtained and processed production-economic indexes, and develop the software required for the execution of the economic-analytical projects of all basic subdivisions of the Ministry.

It has been decided to establish in the next few years a series of information-computer centers, to introduce automated control systems at a number of large plants, and to organize multi-user computer centers in a number of cities.

(From the article "V Ministerstve stankostroitel'noj i instrumental'noj promyshlennosti," in the journal *Vestnik mashinostroeniya*, No. 6, 1970, p. 82.)

Airline Mechanization Falters

Mechanized methods of accounting, based on punchcard equipment and keyboard computers, have been used by the mechanized accounting stations and bureaus of the USSR Civil Aviation Administration for more than five years. Most mechanization of accounting and planning projects has been developed by the staff of the Scientific Research Laboratory of the Economics, Organization, and Planning of Civil Aviation of the USSR Higher Aviation School. Since 1965, when the Laboratory was established, 18 projects for mechanized accounting and planning for various production and maintenance enterprises have been developed, including seven projects based on punchcard equipment and 11 based on the keyboard devices of the Askota-170 system.

However, the process of mechanized processing of initial economic and accounting documentation in Civil Aviation is still inadequate. In a number of enterprises, the introduction of mechanization has been unsatisfactory. Some enterprises are not equipped with even the simplest mechanization devices. This leads to poor utilization of expensive computing equipment, inefficient use of service personnel, and slow improvement of the quality of economic information. Since the scientific research and design organizations of Civil Aviation are now developing automated control systems, it would be practical to simultaneously improve the quality of accounting and planning mechanization, and use it as a base for subsequent introduction of automated control systems.

(From the article "Mekhanizatsiya uchetno-planovykh rabot," in the journal *Grazhdanskaya aviatsiya*, No. 7, 1970, p. 23.)

In-Flight Reservation System

It is now possible for a passenger in flight to Moscow to reserve a seat on an airplane leaving Moscow's Vnukovo airport for the next leg of his trip. The operation is conducted from aboard 60 aircraft. The airline stewardess fills out a special form, the information from the form is transmitted via a special code to the Central Dispatcher Service of the Vnukovo Airport and is processed on a

Minsk-23 computer. The computer searches for a seat and transmits the answer to the point of query. Thus, the passenger is guaranteed a seat for the next portion of his journey prior to landing at Moscow.
(From the article "Servis Vnukovskogo aerporta," in the journal *Grazhdanskya aviatsiya*, No. 7, 1970, p. 28.)

New Mathematics Organizations

Significant organizational changes have taken place within the Ukrainian SSR Academy of Sciences in the area of mathematics. Mathematics departments have been established at the Physicotechnical Institute of Low Temperatures to support research in modern geometry, mathematical physics, and functional analysis. The Donetsk Computer Center, noted for its work in differential equation theory and probability and functions theory, recently became the Institute of Applied Mathematics and Mechanics. Finally, a Mathematics and Mechanics Sector was formed at the Physicotechnical Institute in Lvov.

Academician Yu. Mitropol'skij, of the Ukrainian Academy, urges further reorganization. He calls for total improvement of existing centers, increased communication among branch institutes, expanded graduate enrollment in mathematics, and new mathematics departments in industrial centers, particularly Dnepropetrovs'k and Odessa.
(From the newspaper *Radyans'ka Ukraina*, Aug., 11, 1970, p. 2.)

Economist Novozhilov Dies

Prof. Viktov V. Novozhilov, an eminent Soviet economist, died recently at the age of 78. A Lenin Prize laureate, Novozhilov had been a laboratory chief at the Leningrad Branch of the USSR Academy of Sciences' Central Economics and Mathematics Institute.
(From *Izvestiya*, August 21, 1970, p. 4.)

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10. ABSTRACT

Featured in this issue is a report by Barry Boehm of Rand, who was invited by the USSR Academy of Sciences in October to tour prominent Soviet computing centers. His detailed account provides an overview of computing problems and successes in the Soviet Union. Also of special interest is an organizational chart of the Soviet government that identifies all-union ministries and ministries of the union republics, plus important agencies. A survey article on the automation of Soviet railways reveals a number of different areas of railroad operation. In an article discussing automation implementation on a broad scale, an eminent Ukrainian economist identifies specific ways of closing the Soviet R&D gap. A recent International Symposium on Computer-Based Automation of Scientific Research is the basis for an article listing several projects in Novosibirsk intended to facilitate Soviet research--in particular, a light-pen graphics system and the AIST multiple-user time-sharing system.

11. KEY WORDS

USSR--Cybernetics
Rand Periodicals
Computers
Economics--Foreign