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FOREIGN TECHNOLOGY DIVISION

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SURVEY OF COMPUTERIZED INFORMATION RETRIEVAL
SYSTEMS IN THE U.S.S.R.

PROJECT HAVE STORK

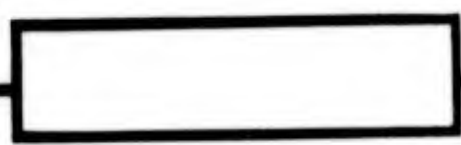
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SURVEY OF COMPUTERIZED INFORMATION RETRIEVAL SYSTEMS
IN THE U.S.S.R.

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Preface

The purpose of this report is to review computerized information storage and retrieval systems in the Soviet Union. Its scope includes Soviet capabilities and limitations, computer systems used, general descriptions of algorithms and techniques, and identification of personnel and facilities.

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SUMMARY

Purpose

To review computerized information systems (CIS) in the U.S.S.R.

Conclusions

1. Current systems in the U.S.S.R. are on a level of development corresponding to systems in the U. S. of four to five years ago (1964-1965).

2. The principal limitations of current systems in the U.S.S.R. are inadequate hardware and software. Factors limiting future systems will be the availability of hardware, particularly communications equipment, terminals, and random access mass storage devices. Unless these problems are solved quickly the U.S.S.R. will fall further behind in usability of information systems.

3. Current and near future systems in the U.S.S.R. will use manually assigned index terms with a fully inverted index on random access storage (magnetic drums). These will still be run in a "batch" mode.

Factual Data

Information on representative Soviet CIS obtained from translations of Soviet articles, was analyzed on a case by case basis to determine the significant system characteristics.

Discussion

Only a few systems are well documented. The systems are similar to many U. S. systems. No discussion of CIS with "conversational" terminals was found, probably on account of their unavailability.

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SECTION I

SOURCES OF INFORMATION

The information sources used as the basis of this report were translations of articles appearing in Soviet literature. The sources of the translations were:

- (1) Foreign Technology Division (FTD) of the Air Force Systems Command (AFSC)
- (2) Joint Publications Research Service (JPRS) of the Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce
- (3) Soviet Cybernetics, Recent News Items, a monthly publication of the Rand Corporation.

A book (report) listing Soviet computers and their characteristics was used as an additional source of data^{(1)*}.

All material used was unclassified. The work described in the articles was carried out during the years 1964 through 1967. A number of the articles reviewed were unedited machine translations obtained from FTD. These were provided at the request of the author to supplement the edited translations available.

* Superscript numbers in parentheses refer to items in the Reference List.

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SECTION II

ALGORITHMS AND TECHNIQUES

Due to the small number of Soviet computerized information storage and retrieval systems for which documentation is available the following approach will be taken:

- (1) The system will be identified
- (2) Algorithms and techniques will be discussed
- (3) Comments on the system will be made.

1. Experimental Information Retrieval System⁽²⁾

a. Identification of System

This system consisted of a bibliographic card file and an inverted index put on the URAL-2 computer. They used a descriptor dictionary of about 1,200 words. The work was done at the Central Bureau of Scientific and Technical Information and Patent Certification (TSBNTI) of the All-Union Scientific Research Institute of Radiation Technology (VNIIRT). The work was done in cooperation with the Computer Center of the Central Statistical Administration of the RSFSR (Russian Soviet Federative Socialist Republic).

b. Algorithms and Techniques

Descriptors and documents were represented by four decimal digit codes. The inverted index was maintained on magnetic tape, one descriptor with its associated accession numbers per zone (block). The descriptors (codes) were put on tape in order of growth (frequency of use of the descriptor). The input for

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both updating and retrieval was on punched cards with the numbers punched in row binary. The ordering of the descriptor-accession number pairs was done using an internal core sort, comparing codes in positions 1 and 2, 2 and 3, 3 and 4, etc., and transposing when necessary. The intersection of accession lists corresponding to descriptors in a query was done as follows: For each accession number in one of the lists, the other lists are searched by a linear interpolation scheme to see if the same accession number occurs. The article discusses generalized Boolean expressions and gives an example of one, with no nested parentheses, describing how the set operations would be carried out on the sets of accession numbers. It's not obvious the system has this capability but it may have "not" logic.

c. Comments

As a first effort this experiment was probably very worthwhile. No mention is made of generic relationships between terms, roles, links or any attempt to measure noise (false drops) or losses. They did mention they used 10 to 16 descriptors per document and 4 to 6 descriptors per request.

2. Selective Dissemination⁽³⁾

a. Identification of System

The purpose of this system was to provide selective dissemination in the area of foreign and domestic (U.S.S.R) report literature in the nuclear science field. The system was developed by TsBMTI, the same group which developed the system described in 1. above, and is the successor to that system. The

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computer part of the system was filled by a rented MINSK-22 belonging to the Central Statistical Administration of the RSFSR. The system was accessing 300 documents per week and searching using 182 profiles.

b. Algorithms and Techniques

This system, like its predecessor, contains a manual card file of bibliographic information. The results of the search, accession numbers, are used to manually retrieve bibliographic cards, copies (made on "ERA" device) of which are sent to the user. The copies contain a detachable stub which can be used to indicate the relevance of the document and to request a microform (microfilming done on "UDM-2") or copy (done on "Electrophot") of the document. The system can process 300 profiles (searches) against 300 documents during one run. During the 1.5-year test period 2,000 copies of original articles were made.

The thesaurus or descriptor list was made by starting with the Euratom thesaurus, removing compound descriptors (e.g. sodium sulfates) and adding descriptors from the Gmelinskogo Institute and the American journal Nuclear Science Abstracts. Also, terms were added for geographic locations, facilities, and adjectives (low, high, weak, etc.). This resulted in about 4,000 terms. Generic relationships are not used and this "hampers search information". The terms can be paired where this makes sense. For example, analysis (code 1533) and chemistry (code 0056) can be combined as 1533.0056 (analytical chemistry) or 0056.1533 (chemical analysis). The report contains a rather lengthy section on indexing techniques.

The searches or profiles contain "and" logic only. They print the results of the search ordered by the number of "hits" allowing a document reference to be printed even if one or two descriptors were absent. They

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mention the desirability of being able to weight the terms in the search and plan to implement this capability. They average 2.5 terms per search and 15 terms per document.

Several pages were devoted to statistics related to "loss" and "noise", indicating noise (false drops) average 70 percent and losses are "insignificant".

c. Comments

The emphasis on language considerations indicates the computer programs for updating and retrieval are workable and an effort is being made to provide a useful, as well as workable, system. It isn't obvious that the pairing of terms was workable in practice.

3. The Automated Information Processing System "Setka-3"⁽⁴⁻⁶⁾

a. Identification of System

This system was developed during 1964-1965 at the Scientific Research Institute of Economic Studies on Radio Electronics (NIEIR). The computer used was a MINSK-22. The field covered by the system is that of computer engineering. The document collection consisted of 20,000 reports for each of which a 250- to 300-character bibliographic entry was maintained on magnetic tape.

b. Algorithms and Techniques

The descriptors were obtained from 1,300 articles from journals on computer technology. The language (descriptor set) has the "basic relations" of "higher than-lower than" known also as generic relationships between terms (e.g. "plastics" and "teflon" have such a relationship). These relationships

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are used during indexing in the following way: If the lower (narrower) form of the term occurs in the document then both the higher (broader) and narrower terms are used to index the document. This is equivalent to the case where a computerized thesaurus showing generic relationships is used during index update to post accession numbers to broaden the forms of index terms. The final descriptor list contained 1,500 terms in 814 "equivalence" classes*.

Experiments were conducted to determine noise and losses and also to determine the effect of the size of the document store on noise and losses. This was done by running searches against the 1,300 documents used to create the descriptor list and an expanded document collection containing an additional 1,060 reports. For both collections losses were 8 percent; for the first noise was 15 percent and for the second noise was 20 percent. The indexing depth for the collections was 8 to 10 descriptors per document. The searches contained from 3 to 9 terms (average 5) which were combined using "and" and "not" logic. The authors cite references to support their feeling that indexing in depth only increases noise without significantly decreasing losses. They also state that 7 percent of the noise was due to deficiencies in indexing with the remaining 93 percent due to false combinations. The figure of 50 percent for noise is mentioned as acceptable with the remote possibility of using role indicators if the noise level exceeds that number. The authors feel the use of roles increases losses without reducing noise significantly.

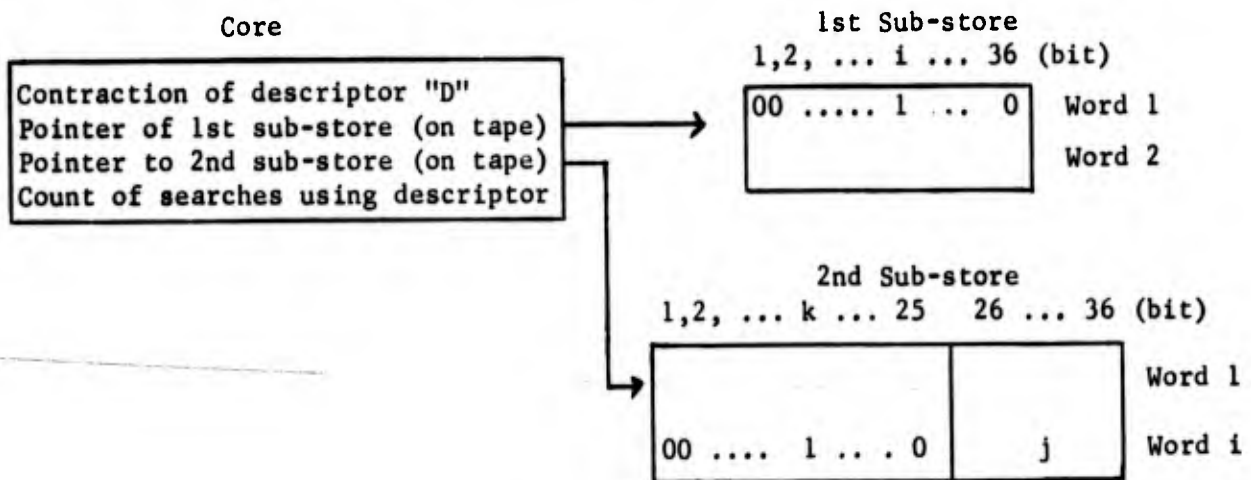
Words selected to become descriptors were normalized, that is, expressed in nominative case, masculine gender, and singular number. Standard word combinations were abbreviated. After this the descriptors were "hash-coded"

* The classes are made up of descriptors having similar meaning or relating to the same subject. One descriptor from each class is used for indexing and retrieval.

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into a single 36-bit word. The 6-bit representations of the characters in the word were added (binary add with no carry), the 1st character added starting in bit 1 (left most), the 2nd character added starting in bit 2, etc. Words longer than 31 characters produced a truncated hash-code or "contraction". This resulted in only one ambiguous contraction for every 200 descriptors. Since the contraction of a descriptor with k letters contains 31-k zero bits on the right, this permitted the contractions to be grouped by the number of letters in the original descriptor. Within groups the contractions were ordered by (decreasing) number of documents posted. A positional coding scheme is used to indicate the document numbers associated with a given descriptor. This scheme is outlined below; the use of the "1st sub-store" seems completely redundant, since if n words were required in the 2nd sub-store than the first n bits of the 1st sub-store would all be 1 and the rest 0.



This example associates Document Nr $(j-1)*25 + k$ with descriptor "D".

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e. Comments

The feelings of the authors about the inverse relationship between recall and precision (losses and noise) and the effect of roles, links, etc., on recall are supported by the Cranfield study⁽⁷⁾. This work is often referenced in the Soviet literature.

The method of storing document accession numbers is highly machine dependent but would be relatively easy to implement for any particular machine. In view of the effort made in reducing the physical storage requirements of the index it is notable that no mention was made of similar effort, or even desirability, directed toward the 5- to 6-million-character bibliographic file.

4. Machine Retrieval Using a Multi-List File Structure⁽⁸⁾

a. Identification of System

The system was developed by the Laboratory of Mathematical Simulation of the Cardiovascular Surgery Institute, Academy of Medical Sciences, U.S.S.R., in conjunction with the Chair of Computer Engineering at the Moscow Energetics Institute. A MINSK-2 computer was used. The subject area was cardiovascular surgery.

b. Algorithms and Techniques

The descriptor language uses the devices of generic relationships between terms, equivalence classes (associating one descriptor with a group of synonyms), and "logical syntactic relationships". The latter concept seems to be a broader form of the role indicator concept and includes it, although in actual usage they appear equivalent. If a term is used in a search, documents

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indexed by terms one and two levels broader than the given term are also candidates for retrieval. "And" logic is used with the match on roles satisfied if any term-role in the search matches a term-role in the document.

The system is interesting in that a multi-list file structure is used and unusual in that the file is maintained on magnetic tape. (Disks are unknown on Soviet computers and the MINSK-2 has no drum storage). The multi-list file structure can be thought of as sets of documents threaded together by strings running through common descriptors, one string per descriptor. The document surrogates are put on magnetic tape in order of accession with the newer documents near the beginning of the tape. For each descriptor a "head of list" element identifies the descriptor and points to the location on tape of the first (most recent) document indexed by the descriptor, which contains a pointer to the next document indexed by that descriptor, etc., until an "end of string" indicator appears.

Performing a search corresponds to finding the documents common to all the strings (descriptors) of the search. It appears that all strings are followed during the search rather than following the shortest one and checking each document on it for the occurrence of the other descriptors.

Experiments made with and without roles produced the following results:

	<u>With Roles</u>	<u>Without Roles</u>
Noise	3 percent	35 percent
Losses	14 percent	5 percent

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c. Comments

The system served two purposes; it enabled the medical people to try out computer aided searching and it enabled the information systems people to try out the multi-list file structure. The second objective was not completely met since a random access storage device was not available. (The same thing can be said of attempts to evaluate inverted file structures using other than random access storage.)

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SECTION III

FACILITIES AND PERSONNEL

The following list relates authors with facilities. In one case the project was a joint effort of two organizations, d) and e) and there was no specific affiliation indicated for either of the authors.

<u>FACILITIES</u>	<u>PERSONNEL</u>
a) Central Bureau of Scientific and Technical Information and Patent Certification of the All-Union Scientific Research Institute of Radiation Technology (TsbNTI of the VNIIRT) (1,9)	V. L. Greysukh N. M. Mikheyeva A. I. Nadtochiy V. I. Gostev G. S. Chuba V. F. Kalinin V. A. Voronin N. S. Denisenko
b) Scientific Research Institute of Economic Studies on Radio Electronics (NIIEIR) (3,7)	S. A. Gorokhov V. K. Vakhobov A. A. Mikhaylov L. M. Yesilevskaya T. S. Kutayev
c) All-Union Institute of Scientific and Technical Information (VINITI)	V. S. Chernyavskiy L. M. Frid
d) Chair of Computer Engineering of Moscow Energetics Institute (4)	A. I. Kitov* S. K. Kerimov*
e) Laboratory of Mathematical Simulation of the Cardiovascular Surgery Institute, Academy of Medical Sciences, U.S.S.R. (4)	
f) Leningrad State Institute of Culture in the name of N. K. Krupskoy (8)	A. V. Sokolov D. I. Byumenau R. F. Grinin A. M. Sorkin

* May be associated with either facility d or e.

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SECTION IV

COMPUTERS AND PERIPHERALS

Four Soviet computers were used in systems reviewed in this report. They were the URAL-2, URAL-4, MINSK-2, and MINSK-22. Input media for these machines are typically paper tape and punched cards. Output is on paper tape, punched cards, and printers. At the time of these reports the availability of an alphanumeric printer was exceptional; most installations having only a numeric printer which printed one machine word per line. Secondary storage consists of magnetic tape and also, in the case of the URAL machines, a magnetic drum.

It appears that the hardware and software limitations of these machines has somewhat hampered the development of computerized information systems, mainly because of the resulting machine dependence of the systems. With the availability of better hardware, which seems to be indicated in the newer, URAL-11 and BESM-6 computers, and improved software, the information system designers should be able to develop systems designed for the user instead of the equipment.

Table I gives some of the characteristics of the machines mentioned above.

TABLE I
 CHARACTERISTICS OF SOVIET COMPUTERS AVAILABLE TO INFORMATION SYSTEM DESIGNERS

Computer	Operations per sec.	Word Size in Bits	Memory (Words)			Alphanumeric Printer	Reference
			Core	Drum	Tape		
MINSK-2	6,000	36	4,096	--	40,000	no	1
MINSK-22	6,000	36	8,192	--	1,600,000	300 lpm	1
URAL-2	6,000	40	2,048	8,192	--	no	1
URAL-4	6,000	40	2,048	80,000	5,000,000	300 lpm	1
URAL-11	50,000	24	4,000 - 16,000	98,000 - 399,000	1,000,000 - 8,000,000	yes	1
BESM-6	500,000	50	32,000	32,000 per drum	1,000,000 per tape	Two 600 lpm	13

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SECTION V

CONCLUSIONS

1. Reviewed Systems

Many of the Soviet computer aided information systems appear crude at first glance because of hardware and software limitations (e.g. punching descriptor codes in row binary). In spite of this they are comparable to early U. S. systems in the areas of language control and depth of indexing.

2. Current and Projected Systems

Based on the state-of-the-art of information retrieval systems in the U.S.S.R., as determined from the available literature, and the history of such systems in the U. S. the following conclusions result. The systems implemented now (1969) and in the near future (1970-1971) will have essentially the same type of language structure; that is, manually assigned index terms (descriptors) normalized in some way to prevent problems due to matching variations of the same word. The file structure used 90 percent of the time will be the fully inverted structure with the index put on random storage (magnetic drums) whenever possible. More use will be made of computerized thesauri and automatic posting of document numbers to broader forms of index terms. Big advances in usability will be made due to faster and more convenient input and output though the systems will still be run in the batch mode of operation.

3. Limitations

The main near-term limitations are in the areas of remote access to computerized systems and mass storage devices. Unless the Soviets expend

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considerably more effort on mass storage and remote communications, their systems will become input/output bound and capacity limited just as they are now. Long-term limitations may arise if thorough studies are not made of proposed systems. The available literature doesn't indicate anything more than a cursory systems analysis before implementation.

4. Related Fields

Other areas of information technology are critical to the successful development of nationwide information retrieval systems. In particular, areas such as automatic indexing, character recognition, and microimaging are being studied and developed in the U.S.S.R.

5. Priorities

The emphasis on increased utilization of information retrieval systems in the area of science and technology directed by the Communist Party and the Government is evident. However information retrieval systems are also being developed in the areas of law and education and will no doubt appear in other state controlled functions. Emphasis seems to be on developing practical working systems, with not too much rigorous testing or analysis.

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<p>ABSTRACT</p> <p>This report reviews computerized information systems in the U.S.S.R. Systems documented in (translated) Soviet reports are examined on a case by case basis to determine significant characteristics. The few well documented systems are similar to earlier systems in the U. S. Developers of computerized information systems in the U.S.S.R. are hampered by inadequate hardware and software. Emphasis is being placed on practical solutions of information problems.</p> <p>This report was prepared under DIA Task T68-05-02.</p>					