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BRIEF REPORT ON A SCIENTIFIC MISSION TO THE UNITED STATES

- USSR -

by O. H. Ivakhnenko

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/Following is a translation of an article by O. H. Ivakhnenko in the Ukrainian-language periodical Avtomatyka (Automatic Control), Kiev, No. 1, 1960 pages 78-86/

Introduction

A delegation of scientists from the Soviet Union, made up of Professor O. M. Lietov, Doctor of Technical Sciences, O. M. Petrovs'kyi, Candidate of Technical Sciences (Institute of Automatic and Remote Control, Academy of Sciences of the USSR) and the author of this article Professor O. H. Ivakhnenko, Doctor of Technical Sciences Institute of Electrical Engineering, Academy of Sciences of the Ukrainian SSR), visited the United States of America where they remained from September 12 to 27, 1959.

The main purpose of this trip was to participate in the work of the Deliberative Committee of the Executive Council and General Assembly of the International Federation of Automatic Control (IFAC), to participate in the work of the 14th annual conference of the Instrument Society of America (ISA) and to visit the international exhibit of measuring instruments and automatic control organized in connection with this conference. (Note: Concerning the objectives of the IFAC and the next world congress of this international organization in Moscow, June 1960, see Avtomatyka, No. 3, 1958; No. 1, 1959).

We left Moscow by plane on September 12 and arrived in New York the same day where we were warmly met by members of the American national organization of the IFAC, Messrs. Jack Losier and Wm. Vannah, the editor of Control Engineering. The next day we flew to Chicago, Illinois; we stayed at the Edgewater Beach Hotel, where the meetings of the committees and the assembly were being held.

Meetings of the Deliberative Committee of the Executive Council of the IFAC

In the mornings and evenings of September 14 and 15 there meetings of the Deliberative Committee under the chairmanship of Professor D. Eckman (USA), head of the committee, and of the Executive Council under the chairmanship of Professor G. Chestnut (USA), president of the IFAC.

Among the delegates present were: Belgium - M. Einbinder; Czechoslovakia - M. Ulrich; Finland - Luoto; France - G. Loeb and Professor V. Broida; Hungary - S. Benedict and G. Bomosz; Italy - Professor G. Evangelisti, Professor A. Marino, G. Foddis, A. Lepesci, A. Ruberti; Israel - Dr. Lagav, Kreindler; Japan - Professor A. Nomote, Professor K. Kaneshige, G. Isobe, I. Inoue; Holland - Professor S. Verhagen; Norway - I. Hivald; Sweden - O. Dagle; Switzerland - Professor E. Gerike; Great Britain - Professor I. F. Coales; USA - Professor R. Oldenburger, G. Chestnut, J. Losier, N. B. Nichols, D. M. Boyd, Dr. Bergman, W. Vannah, Professor R. V. Johns, A. F. Sperry, Professor V. F. Stevens, Dr. D. G. Traxal, D. Hagen, R. M. Hutchinson, E. M. Grabbe, D. Johnston, D. Mosley; German Federal Republic - Dr. G. Ruppel.

The delegation of the Soviet Union was named above. There were no delegations from the Chinese People's Republic, Poland, Austria, Denmark or Turkey. China handed over its voting right to the Soviet delegation, Poland to Hungary, Austria to Switzerland and Turkey to the USA. It should be mentioned that the IFAC is the first international organization in which the Chinese People's Republic will in due time occupy its place.

At the meeting of the Deliberative Committee (made up of D. Eckman, G. Loeb, S. Benedict, T. Vamosz, A. Lepeschi, A. Ruberti, Lagav, E. Kreindler, K. Kaneshige, A. Nomoto, I. Inoue, T. Isobe, S. Verhagen, I. Hivald, O. Dagle, J. Losier, N. Nichols, D. Boyd and O. Petrovs'kyi) discussions were held on problems in the organization, content and approach of the work of a number of committees of the international organization of the IFAC, convoked to strengthen the exchange of information and coordinate the work of scientists on a world scale. It was considered practical to set up six committees:

Committee on the Theory of Automatic Control (Professor B. M. Petrov, USSR, Chairman)

Committee on Bibliography (Professor Oppelt, German Federal Republic, chairman)

Committee on the Use of Automatic Control (Dr. Mosley, USA, chairman)

Committee on the Elements of Automatic Control (Professor Boromisz, Hungary, chairman)

Committee on Education (Professor Marino, Italy, chairman)

Committee on Terminology (Professor Gerike, Switzerland, chairman)

There was a detailed discussion of the work program for each committee with most interesting propositions being made. For example, in the Committee on Elements it was proposed that automatic control elements be exchanged between countries for purposes of comparison, testing and research. In the Committee on Education it was proposed that the teaching programs of institutes and colleges be exchanged, that missions be arranged for instructors and students for the purpose of mutual enrichment of instruction in automatic control with experience. No less important is the work of the Committee on Terminology. In connection with the rapid development of automatic control and cybernetics there is no uniform terminology not only between countries but within them, which leads to great confusion. For example, such terms are used to designate the two main principles of control:

Principal control principles	Ukrainian terms	English terms
1	kompaunduvannya	control by disturbances
	upravlinnya po zburennyakh	feedforward system
	pasyvnyy kontrol'	open loop system
	pryntsyp Ponsele	compound link
	rozimknute rehulyuvannya	computer control
	nereflektorna systema	inductive method
	rehulyuvannya kil'kosti	of control and so on
	kompensatsiynyy pryntsyp	control "by output"
	upravlinnya po vidkhylennyu	
	aktyvnyy kontrol'	feedback system
	pryntsyp Polzunova-Uata	closed circle system
	upravlinnya po rehul'ovaniy velychyni	
	pryntsyp zvorotnoho zv'yazku	opcon control
	zamknute rehulyuvannya	deductive method
	reflektorna system	of control and so on
	rehulyuvannya stanu	

We could cite many other examples which indicate the importance of establishing as standard a terminology as possible for automatic control. Considerable work in this field has been done in the Czechoslovakian Republic (work of A. Klimek).

It was decided to deal with those problems of the International Association of Computing Apparatus and the International Cybernetics Association for the Exchange of Experience.

At meetings of the Executive Council of the IFAC (composed of president G. Chestnut, 1st vice president O. M. Kietov, 2nd vice president V. Broida, treasurer E. Gerike, secretary G. Ruppel and

members F. Coales, D. Evangelisti, R. Oldenburger) there was a discussion of the principal problems in the activity of the IFAC for the last two years which have ensued since the First General Assembly of the IFAC (Paris, September 1957). These problems were also discussed at the Second General Assembly of the IFAC in Chicago.

Meetings of the Second General Assembly of the IFAC

Meetings of the Second General Assembly of the IFAC were held on September 16, 17 and 18. On September 16 the assembly heard and discussed: a report by President G. Chestnut (USA), a report by E. Gerike (Switzerland), a report by the head of the National Committee of the IFAC in the USSR Professor O. M. Lietov on preparations for the congress of the IFAC which will be held in Moscow in 1960 and certain other problems. The Assembly praised the activities of the president and secretary; the report of Professor O. M. Lietov was heard with particular attention. The National Committee of the IFAC in the USSR has done a lot of work in preparing for the congress. More than 400 scientific reports have been selected (almost 100 in the USSR), a work program has been drawn up for the congress, candidates for section chairmen have been put up, etc. After a detailed discussion of the speech the General Assembly expressed its thanks to the National Committee of the IFAC in the USSR for the preparatory work done and saluted the speaker with great applause.

On September 17 were the routine meetings of the General Assembly of the IFAC at which some amendments to the Constitution of the IFAC were discussed and adopted by open ballot. These amendments did not concern the essential organization of the IFAC. The new text of the constitution, as also its first variant, establishes that the objective of the International Federation of Automatic Control (IFAC) is the expansion of knowledge on automatic control, and organization and assistance in the coordination of research in these fields where international unity is needed. This expansion of knowledge on automatic control must be carried out: 1) by a constant exchange of information on automatic control between national organizations of the IFAC and between the IFAC and other international organizations, 2) by the organization of international scientific congresses, and 3) by other means, for example, by the publication of works, etc.

On September 18 there were elections for the new staff of the Executive Committee of the IFAC. In accordance with the proposal of the British delegation, Professor O. M. Lietov, head of the National Committee of the IFAC for the USSR, was unanimously elected president of the IFAC for the next term (2 years). Professor S. Benedict (Hungary) was elected 2nd vice president.

Geneva (Switzerland) was selected as the site for the next General Assembly of the IFAC which will be held in 1963.

On September 19 the first meeting of the new staff of the Executive Committee of the IFAC was held.

In addition to official meetings the delegates to the IFAC took part in a number of meetings and receptions between September 14 and 19.

On September 15 a large number of the delegates were invited to a reception which the American scientist R. Oldenburger gave in honor of the Soviet delegation.

On September 16 a reception was given by Professor Richard Johns, outstanding scientists and representative of American business firms in the field of automation.

On September 17 a trip was arranged to the suburban home of the American scientist D. Boyd where an original picnic (barbecue) had been prepared. There we saw the private home laboratory of this scientist in which young men from a neighboring school (ages 15 - 17) are enthusiastically assembling a rather complicated digital computer using transistors, a magnetic memory device, and other modern means of automatic control according to plans worked out by D. Boyd and his students. These separate instruments are mounted on 6 x 12 cm textolite panels with a printed circuit for uniting the elements. The panels are assembled into blocks of 10 - 20 units and are used for the automatic control of model trains, model airplanes, etc.

In this same laboratory they built a discrete computer for controling an automobile which helped its author win a race through a complicated locality around a lake. The computer helped to determine the most advantageous speed at each site of the route by which the automobile would be first at the finish line and this assured the victory of its designer.

On September 18 there was a banquet in celebration of the election of the new Presidium of the IFAC and the new staff of the Executive Committee.

All these meetings made it possible to establish many personal contacts and aquaintances between the scientists of the different countries.

The Swedish delegate said that one of the purposes of his trip to the USA was to try to find there scientists of Swedish origin and urge them to return to the fatherland. During the last years

firms and colleges in the USA have attracted a great number of European scientists who have been working in the field of automation.

On September 19 the meetings and sessions of the IFAC came to a close and some of the delegates departed but a majority of them took part in a conference of the Instrument Society of America which was held September 20-25, also in Chicago, but in a different place (Morrison Hotel and Palmer House). The Soviet delegation moved to the latter hotel on September 19.

14th Conference of the Instrument Society of America

The Instrument Society of America is a voluntary organization which aims basically at collecting information in the field of instrument making and automatic control. With this purpose the society holds conferences, symposiums, organizes courses for supplementary instruction, lecture cycles and discussions, arranges exhibits and issues a number of publications. For instance, in 1960 there will be 12 conferences and symposiums of national scope (for details, see ISA Journal, Sept. 1959, Vol VI, No. 9). In addition, during the year there will be held almost a thousand meetings of local chapters of the society. There are 94 such chapters located throughout the United States and Canada.

The society publishes its own journal, popular pamphlets on automation and translates into English in their entirety the Russian journals Izmeritel'naya tekhnika /Measuring Instruments/, Pribory i tekhnika eksperimenta /Experimental Apparatus and Equipment/, Avtomatika i telemekhanika /Automatic and Remote Control/, and Zavodskaya laboratoriya /The Plant Laboratory/. These translations in printed form are available for subscription in the United States and Canada for $6,00 a number.

It should be pointed out that in the United States, as distinct from our own country, there is no defined boundary between instrument making and automatic control. Our Society of Instrument Making hardly ever deals with problems in automatic control.

The 14th conference of the society opened on September 20 with a reception given by G. S. Frost, 1959 president of the society, for all delegates to the conference and the exhibit, which was approximately 30,000 persons.

In charge of this reception was Albert Sperry, the head of the Chicago chapter of the society. There were some 60 meetings in the halls of the Morrison Hotel and the Palmer House at which approximately 190 reports, lectures and papers were given and discussed. The topics of the papers were new trends in the development of instrument making and automatic control. For instance,

54 papers (30% of the total)were devoted to computing apparatus and their use. On the other hand we should point out that all the papers were of a popular and not a scientific nature. There were no reports on mathematical research apparatus and profound theoretical problems were only mentioned. The speakers limited themselves to indicating structural diagrams while the greatest importance was given not to the equipment but to technological policy. There were particularly long discussions of problems in reliability, cost, economic aspects, organization of production, operational data, etc. Reports at conferences of our technical societies, as we can see, are of an analogous nature.

On September 21 there were meetings on the use of automatic control with the following subsections: 1) Survey lectures, 2) Chemistry and petroleum, 3) Power engineering, 4) Food industry, 5) General problems.

At the same time a section was working under the banner of "World progress in instrument making." Here survey reports were given on the status of automatic control in industry, in military science, in the consuent of space and on the "status of automatic control in Europe and England" (by "Europe" was meant only the western part of the continent).

On the same day a series of lectures was given by leading scientists among which we should mention the lecture by Professor D. Eckman on the "Future of Control Machines". The speaker pointed out the principal structural diagrams of automatic computers, taking into account feedback and exciting circuits. The possibility of utilizing computers for control depends on the properties of the object. For example a control machine can be used comparatively simply to regulate street traffic while certain chemical reactions take place so rapidly that they cannot be placed under control.

A discussion was also held on the topic "Prospects for control machines". The organization of the discussion was very interesting. The organizers prepared five talks in the form of brief reports lasting 10 minutes each. In the interval between reports a "moderator", i.e. the head of the discussion, endeavored in every way to enliven the discussion, frequently directly calling on one of those present to speak on the problem at hand. The entire discussion was quite lively and lasted for 2½ hours but, unfortunately, it was for some reason limited to a discussion of systems of a closed type (with feedback).

On September 22 the greatest attention was attracted by the so-called "International section" where only foreign scientists spoke. In the morning the French scientist J. Loev reported on new methods for measuring microscopic distances; the Swedish scientist O. Dagle

on a new inductive transducer for measuring moments on the shaft of a motor; the Japanese scientist T. Isobe spoke on gas consumption meters.

At the evening sessions papers were read by two Germans: by G. Kronmüller (on a new compensator diagram for measuring small angles of rotation) and E. Lehrer (on the dynamic properties of gas analyzers) as well as my paper on the topic "Basic problems in the general theory of the combined applications of cybernetic automatic control systems." The essence of this paper may be learned from articles under the same title published in Avtomatyka, Nos. 3-4, 1958, Nos. 1-2, 1959 and in the Polish journal Archiwum automatici i telemechaniki, Vol. IV, No. 1, 1959.

The paper aroused a number of questions and a discussion which lasted long beyond the allotted time (50 minutes). Great interest and understanding of the importance of the principle of combined control was evidenced by the American scientists G. Chestnut, D. Eckman, I. Lefkowitz, K. Amatnek, and others.

During the course of the discussion the idea came up that although conditions of invariance have been known in the USA since 1951 (work of G. Moore), they have still not been related to the practice of feedforward systems which developed independently of them. Engineer B. Pidhaynyy reported that he had applied in servo systems the insertion of the first and second derivative [?] from a control signal (obtained by means of gyro apparatus) as early as 1951. Until recently the theory of systems with feedforward links and even more the general theory of combined systems has not been fundamentally developed by any one in the USA. In this problem scientists of the USSR have clear precedence.

The term "cybernetic system" aroused a number of comments since the word "cybernetics" in the USA relates only to biological, economic and social systems and not to automatic control.

In touching on this problem one American scientist commented that in his opinion the socialist system with a planned economy is like a control system with stable open circuits while the capitalist is like a system with feedback capable of instability (oscillations). The combined system, in his opinion, would be the most excellent. In addition to the 11-year period of fluctuations in the capitalist economy he detected also a 4-year period. (Note: American Professor Otto G. M. Smith constructed an electronic analogue machine which models the economic processes in a capitalist society. The machine supported the conclusions of Marxist-Leninist theory on the general crisis of capitalism (Cf. O.F.M. Smith and H. F. Erdley, "An Electronic Analogue for an Economic System" in Electrical Engineering, IRE Conference Paper, Seattle, Washington, June 1951; Publs. in Electrical

Engineering, Vol. 71, No. 4, April 1952, pp. 362-366; Proceedings of the IRE, October 1953, pp. 1514-1519; Reprinted by California Engineer, November 1953, and Krokodil, No. 3, 1959))

In my conclusion I counseled him only to think seriously about these problems.

Discussions on the paper and the related problems actually continued the next day. From all these conversations I was able to determine that much of what we believe has been done only in our country has also been realized by the Americans.

For example, the problem of extremal regulation of the efficiency of a steam boiler by correcting the ration of $\frac{\text{air}}{\text{fuel}}$ was solved in the USA at approximately the same time as in our country and in the same scope (as yet one or two test installations). /See Note/. As distinct from our pattern, as a primary measuring element it uses an oxymeter which operates on a magnetic principle. (Note: Cf. Avtomatyke, No. 2, 1959).

Test fluctuations in extremal regulators (of the step-type or with modulation) with a low sensitivity of the measuring element lead to excessive smoking of the furnace. Therefore American scientists (in particular, Professor Lefkowitz) came to the conclusion of the necessity for eliminating test fluctuations by observing the ordinary operation of the boiler unit with evidence of noises (second category disturbances). In our work we came to the same conclusion. (Note: Cf. Avtomatyka, No. 3, 1959).

A more identical course of scientific thought may be followed in the working out of such a problem as the solution of the application of the method of successive approximations. A cyberntic regulator, as an supplement to an ordinary system, may in turn have a cybernetic regulator of second approximation, and the last, a cybernetic regulator of third approximation, etc. /See note 1/. Let's point out that the necessity for creating cybernetic regulators of second approximation has been confirmed by the necessities of practice. /See note 2/. The idea of successive approximations as we have seen was developed independently both in the Soviet Union and in the USA and it will be the main topic of a paper by Professors Eckman and Lefkowitz at the next congress of the IFAC in Moscow in 1960. (Note 1: Cf. Avtomyka, Nos. 1 and 4, 1959) (Note 2: Avtomatyka, No. 4, 1959).

Finally, a mathematical apparatus, analogous to our "relay" correlation functions, has been made in America by scientist Queens. All these works have not been published.

The existence of common conclusions and the peculiar "parallelism"

in the work of Soviet and American scientists confirms once again the idea of the basic usefulness of contacts for the exchange of experience between scientists of these countries in order to accelerate technical progress.

In addition to the "International section," on September 22 the following sections were in operation: "Apparatus in the paper industry and for measuring pulp", Apparatus for studying automobiles" with discussions on the topics "Problems of personnel for the operation of automatic control", "standards of accuracy for Apparatus", "Items on control: 1) in the steel industry, 2) in the operation of wind tunnels and in testing machinery, 3) in process automation, 4) in power production."

September 23 the International Section continued its sessions at which the English scientist P. Sutherby spoke on a specific computer for collecting data for production control. The French scientist R. Blain reported on a hydraulic control system. The Czechoslovak representative M. Ulrich made a report on the topic "Electric generator of random functions for investigating automatic control systems."

In addition the sections of aeronautics and rocket construction, process automation in chemistry and petroleum refining, economics and management, atomic instrument manufacture, physical and mechanical measurements, two sections of the chemical society and, finally a section on the use of control machines for production automation were meeting.

In the last section the most interesting was the report by Engineer R. VanNice and D. Barta on "The use of automatic optimizing control for slow processes." The speech was devoted to a brief description of the principle of action and the properties of an optimizing regulator developed by the Westinghouse firm and known under the name of Opcon. This work was awarded the prize of the American Association of Progress for 1958.

Opcon is an optimizing regulator of the step type with an original "strategy" for finding the extremum. Opcon can be used for objects where it is required to select the values of two regulated effects M_1 and M_2 in order to achieve the extremum of one index of quality F. We know of three practical applications of Opcon:

1) for equalizing a.c. measuring bridges; here Φ is voltage at the bridge output, M_1 and M_2 capacitance and resistance;

2) for the process of dehydrogenation of ethylbenzene;

3) for distillation columns of petroleum refineries (for details on the last two uses see the supplement to the

report). (Note: Some information on Opcon can be obtained in the Westinghouse Engineer, March 1959 and Control Engineering, February 1959, No. 2, Automation Progress, August 1959, Ekspress-informatsiya (Automatic Control series), No. 26, 1959.)

The "strategy" of seeking the extremum is explained in Fig. 1. Opcon is a system with a variable size of stage of change in the regulated effects. Let's assume that the initial state of a system corresponded to point A_0. In order to seek the extremum Opcon, after being turned on, works in sequence several "large" steps M_1 and M_2 which correspond to points of the square $A_1A_2A_3..A_7$. The values of ψ which correspond to these points are recalled and the greatest are selected from them. Let's assume for example that these values correspond to point A_7. The logic circuit after this determines the values of M_1 and M_2 which correspond to A_7. Further Opcon repeats the selection of the largest value but already with a much smaller stage in the change of M_1 and M_2. The process is repeated until the system achieves the extremum.

The first model of Opcon operated on electromagnetic relays, the second on relays and electron potentiometers, the third entirely on transistors. /See note/. In the first models the size of the stage of regulated influences was changed three times, in the later ones only one (large and small stage). After being switched on the system always starts working from the large stage and then shifts (and remains) on the small one. In the case of using Opcon to regulate the process of ethylbenzene dehydrogenation the search for the extremum lasts approximately one hour (see supplement). (Note: Elements of transistor systems similar to those used in Opcon are described, for example, in Feingerate technik, No. 7, July 1959, p. 306, and in the Westinghouse journal mentioned above.)

Works on the theory and technology of extremal regulation in the USA are being done in almost all research centers in the country.

At the Massachusetts Institute of Technology work in this area is being done by S. Draper, L. Lining, Goodman, Painter and others.

Scientists Eckman, Lefkowitz and Reswick are working at the Case Institute in Cleveland.

These problems are also being treated at the Polytechnic Institute of Brooklyn, at the Space Technologic Laboratory (scientists Aseltine, Mancini, Sarture and others), at the Dystrom Company (Ch. Taylor, VanNice), as the Ascania firm (Ziebolz), in Ohio (Cosgrief, Emerling and others), Honeywell Company (Shack), Westinghouse (Van Nuys, Bart, Rituk, Cownes, Archer and others), General Electric and many other institutes and

companies.

In addition to the three practical problems mentioned above which can be solved by Opcon there is that of the extremal regulation of a boiler; these studies are also directed to working out extremal regulators for aviation. The general impression is created that despite large prospects for the future, at this time almost the only concrete practical result of the great amount of laboratory work in the USA in the field of extremal regulation is Opcon of Westinghouse and its uses mentioned above.

In the USA a great deal of work is being done on compiling detailed surveys of the status of this problem. One such survey was made by scientists Aseltine, Mancini and Sarture. /See note/. Mathias is also no preparing a basic survey (R. A. Mathias, Electrical Engineering Department, Carnegie Inst. of Technology, Pittsburgh, 13, Pa.) (Note: See IRE Transactions on Automation Control, December 1958).

September 24, the last work day of the conference. This day saw activities of sections on measurements, transducers, electronic instruments, regulation systems with feedback, instruments used in photography, discussions were held on the topic "How the Instrument Society of America can prepare for increasing requirements in the quality of instruction." A cycle of popular lectures was given with consideration given to equipment and control machines.

Exhibit of Instrument Manufacture and Automatic Control

Simultaneous with the conference was the annual exhibit of instruments and automatic equipment which lasted from September 21 to 25 and was visited by all the 30,000 delegates to the conference. The exhibit was held at some distance from the center of Chicago in an unattractive but large amphitheater. All exhibitors displayed on a single floor of this structure which occupies an area of apppoximately 200 x 400 meters. The enormous hall was skillfully decorated with colored cloth, paper, ads, brilliantly illuminated by special lights and neon lamps. The entire hall was occupied by 16 rows of exhibits from more than 400 firms, including not only American but British, German and Japanese firms. The displays of the firms showed new systems, equipment, units and parts developed in 1958 with a brief explanation of the use of the exhibits and also, and this is the main purpose, with a designation of the address of the firm from which the given item can be bought. Prices for automatic control equipment are high. For example, the price of a universal transistor digital computer is 200 - 300 thousand dollars (including installation in operation).

A survey of the exhibition makes it possible to draw some general conclusions. First we should point out the great progress in germanium

and silicon triodes and diodes (transistors); there were no electron tubes at the exhibit; magnetic amplifiers are also rarely employed. Transistors have a power of up to 1 kilowatt (in laboratory samples). The greatest novelties at the exhibition were special measuring instruments (gas consumption and capacity, mass spectrometry, etc.) and control apparatus of a specific type.

One of the best developed and rapidly growing companies which is producing transistor control devices and servo systems of a specific type is the Thompson, Ramo, Woolridge Company, founded only two years ago. At the exhibition the firm demonstrated the RW-300 universal controller for production automation /See note/. The machine includes converters of continuous values into digital, an input device, a control program composer, an output device and servomotors. Printed circuits and transistors (in relay systems) assure performance reliability. Photographs were also shown of a celebration of the turning on (March 12, 1959) of a machine for controlling a large polymerization installation in Texas with a production capacity of 1800 barrels per day (286,200 liters per day). The productivity of the installation following automation increased 8-10%. In this application the control machine obtains information from 110 transducers; 34 values are recorded, 16 flows, temperatures and pressures are controlled. It is reported that this machine is being used in the production of vinyl chloride and for petroleum refineries. (Note: See Ekspress-informatsiya, series VT, No. 6, 1958; No. 8, 1958 and Yu. I. In'kov's book Elektronnyye vychislitel'nyye mashiny /Electronic computers/, 1958, p. 32).

Digital control machines for the automation of chemical plants are being offered by the Hagen Company. Its machines are boldly called "cybernetic". The same firm is producing analog machines with magnetic amplifiers which assure reliability.

Transistors are being used not only in digital but in analog computers (Electronic Associates, New Jersey).

The firm of Genesis showed installations for ultrashort-wave radio lines which serve for the control and remote control of gas pipelines. The same firm is offering transistor control machines for petroleum refining and the chemical industry.

Control machines for production automation have also been shown by the Beckman firm of California. This firm, strengthened by its particularly great practical research, is proposing the introduction of step-by-step automation of production in existing production areas.

Great attention is being paid to the development of automatic control elements.

The Feranti firm showed magnetostriction delay lines with a time from 5 to 500 microseconds at a frequency of up to 1 million cycles. The firms Computer Control Company (California) and National Cash Register Company (California) have offered new bars for miniature magnetic memeory devices. Computer Control Company also demonstrated standard cores for computers (with a printed circuit and transistors). Very promising new computers - differential analyzers (digital in means of action but analog in usage) - were presented by the same firm.

Automatic potentiometers operating on transistor amplifiers were shown by the Japanese Toshiba firm. The Leatron firm showed a new low-power a.c. tracking system with powdered magnetic clutches (for changing the speed and direction of rotation). New gyroscopes (RG-100 with an accuracy of 0.1%) were shown by Fairchild (New York). D.c. amplifiers in which zero drift is achieved by vibrators were shown by Airrax (Massachusetts).

Honeywell showed a 40-signal recording device operating on a single magnetic tape. Kin Tel Reserves (San Diego) offered d.c. digital voltmeters with an accuracy of 0.01 - 1 digital units.

An electrostatic function generation for different production devices was shown by Research Incorporated (Minnesota).

Miniature servomotors, combined with a taxogenerator into a single machine, were shown by National Pneumatic Company.

Two firms (Airrax and Electroprodax Laboratories) offered electric tachometers with inductive transducers which are installed near any gear wheel. The electric stage motors (with a speed of up to 120 cycles) have been developed only for low powers (of the order of 100 volts). With greater power, hydraulic step-type engines are used. (Note: At the Electric Engineering Institute of the Ukrainian Academy of Sciences powerful step-type motors of up to 150 cycles have been developed. Cf. Avtomatyka, No. 1, 4, 1959).

In this brief survey we have limited ourselves to those exhibits which seemed the most interesting to us.

We should also mention the apparatus called Fosdick, developed by the National Bureau of Standards, which photoelectrically converts a hand-written text into figures of a binary code. At the exhibition there was also a demonstration of an apparatus which converts a code on punch cards or tapes back into a manuscript or sketch. A further goal in this direction is the creation of control apparatus which converts what is written directly into finished parts without human participation in the process.

Computing machines (not intended for automation) were poorly

represented at the exhibition and by second-rate firms (National Cash Register, Dialog, California). The principal American companies (IBM, Remington, Burroughs, Datamatic) did not exhibit their products.

We were also surprised that Westinghouse, known in automation thanks to the development and introduction of the extremal regulator Opcon, was likewise not represented at the exhibition.

Systems for the program control of machine tools were not shown at the exhibition. Only particular elements were shown (for example, step-type motors).

A survey of the exhibition and talks with representatives of the firms create the general idea that despite the great amount of work done total automation of production is proceeding slowly in the USA. One of the basic negative factors of a technical nature against control machines is their low reliability and high cost which can be quite successfully eliminated by using transistors, printed circuits, magnetic elements, automatic protection from damage, etc. On the other hand, in the words of a representative of Thompson, Ramo, Woolridge Company "within only ten years or approximately that all modern refineries and chemical producers will be completely automated through control machiners."

In our country, the Soviet Union, thanks to the advantages of the socialist system of government, we will reach the same in a much shorter period, during the realization of the seven-year plan for the development of the national economy of the USSR.

Visit to a Plant with a High Level of Automation

Delegates to the conference of the ISA were given the opportunity to visit four plants with a very high level of automation.

September 22: Clark Oil Company petroleum refinery in Blue Island. There delegates were shown two alkylating installations which are controlled by special regulators.

September 23: steel mill in Chicago.

September 24: a) corn processing plant of the Corn Product Company; b) atomic reactor at the Argonne National Laboratory.

September 22 and 23 I was busy at the conference with my report. On tickets for visiting the atomic center was the note: Only for citizens of the United States. So I visited only the corn processing plant. The tour lasted 6 hours.

This plant is the largest establishment of its type. It occupies

an area of 375 acres (150 hectares) and includes 90 buildings.

The plant uses close to 105,000 bushels of corn (3780 cubic meters), the production of which requires more than 1750 acres (700 hectares). In addition, the plant uses daily 25 carloads of coal, 20 million pounds (900,000 kilograms) of steam, 8,640,000 kilowatt hours of electricity, 3 million gallons (13,500,000 liters) of potable water and 25,000,000 gallons (112,000,000 liters) of river water. Each grain of corn is separated into particles (germ, starch, etc.) and is processed by steam and chemicals. The plant produces more than 300 items: flour, sugar, molasses, syrup, starch, jam, oil (table, salad, cooking, etc.), marmelade, dextrin, etc. Automatic control prevails both in the main processing shops as well as in those for filling, labeling and packing bottles and cans. In the main shops are only one or two attendants. On the walls were signs: "This shop had its last shutdown..." with a date from two to three weeks before. In the packing rooms were a number of nonautomated operations. For example, the loading of boxes with finished products into cars has not been automated. Control of the operation of the main shops in the plant is concentrated in a main control board like those which we are accustomed to seeing in electric power plants. The thermal power station which provides steam and electric power for the plant is extremely clean, despite the fact that it operates on powdered coal. The boilers of the entire boiler room are controlled by a single person from a central panel. There were no people near the boilers.

A very good impression was made by the plant control laboratory which was equipped with the most modern instruments for production control.

The plant operates around the clock on a three-shift basis. There are close to 900 persons (not including those engaged in the construction of new shops) in each shift in the main shops, at the electric power plant, in transportation and in auxiliary divisions; for such a large establishment this cannot be considered a great number of employees.

Our participation in the conference and visits to the exhibition and plants were very interesting. It is essential to expand our scientific contacts and our cooperation with scientists; this is basic to general progress, mutual understanding and the cause of peace.

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