

## In Memory of Teacher and Friend

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Alexey Grigorievich Ivakhnenko was born on March 30, 1913. He was outstanding scientist and remarkable person. Alexey Grigorievich Ivakhnenko set up his scientific school, brought up hundreds of candidates and tens of doctors of sciences. His personal merits before science are great and were acknowledged worldwide. Alexey Grigorievich was the first to write a domestic monograph on technical cybernetics which was repeatedly released abroad, had tens of other books published. These books dealt with results of his research in the field of control theory, mathematical modeling and informatics.



Without making an attempt to describe in frames of this essay everything made by him we will consider only his contribution to the invariance theory of control systems whose history features a lot of grave events. We will remind a reader that by the term “invariance theory of control systems” is meant the method of control synthesis of a dynamical system which ensures the independence (invariance) of a controlled coordinate from disturbances acting upon this system.

In the 50s of the last century at the Institute of Electrical Engineering of AS of Ukraine A.G. Ivakhnenko successfully carried out a large cycle of theoretical and practical investigations which convincingly demonstrated the efficiency of application of compensating connections which allowed one to prove in practice the possibility of attaining the invariance effect, speaking more precisely, quasi-invariance in industrial samples of control systems due to velocity of an asynchronous motors. The value of this result consisted in the fact that at that time it was one of few examples of invariant theory ideas implemented “in iron” and which was in great demand among its supporters.

The start was made by the paper of G.V. Shchipanov "Theory and methods of constructing automatic regulators" (Automatics and Telemechanics, 1939, No. 1) which stated the problem of such control synthesis (in terms of that time "regulator") which would ensure the invariance of a controlled coordinate of a controlled object.

Supporters of clear ideology of "scientific communism" reacted on this paper rather unexpectedly. On May 16, 1941 the main article "Science and Industry" of newspaper "Pravda" subjected research institutes to severe criticism. In particular, it said that these institutes are "completely isolated from needs of national economy, some of them sank in routine and stagnation with nests of pseudo-science. The Institute of Automatics and Telemechanics of Academy of Sciences of USSR is the example of it. For a long time this Institute was obsessed with pseudo-scientific absurd theory in the field of automatics and regulation...". In this connection soon there was set up a special commission of Presidium of Academy of Sciences of USSR aimed at discussing and estimating G.V. Shchipanov's work.

In 1941 No. 2 issue of the journal "Automatics and Telemechanics" published the conclusions drawn by this commission and later the journal "Bolshevik" (1941, issue No. 9) published the article titled "Pseudo-scientific works of Institute of Automatics and Telemechanics of Academy of Sciences of USSR". One of conclusions of this article declared: "Pseudo-scientific activity of Institute of Automatics and Telemechanics in the field of regulation theory bears a tremendous damage to our country. This activity disorients engineers-practitioners, prevents the development of the regulation theory and discredits the soviet science and the highest scientific body of the country — Academy of Sciences of USSR. It is high time to set the limit of such activity of Institute of Automatics and Telemechanics. It led to Academician V.S. Kulebakin being dismissed from the position of Director of the Institute and the laboratory of G.V. Shchipanov went into liquidation.

The case could have been going on, but soon the war broke out and there was no time left for fighting with the "pseudo-science".

In the history of after war development of the invariance theory of control systems the fate granted Kiev a special role. Of the entire series of meetings on the invariance theory the first meeting that played the decisive role in the further course of events in this field was held in Kiev in 1958.

When choosing the place for the meeting holding of importance was the fact that Kiev was far away from a residence of the most committed supporters of "ideological clearness of the Soviet science" who kept on viewing the invariance theory as the one isolated from the real science. Although the scales of this seminar were rather modest and there were given only 10–15 reports, but it very much affected events occurred afterwards. Based on the decision taken at the meeting, on behalf of Academician-secretary of Department of technical sciences of AS of USSR Academician V.S. Kulebyakin there occurred the application to the Presidium of Academy of Sciences of USSR with a request to set up a commission on reconsideration of decision taken by the pre-war commission of Presidium of AS of USSR regarding the work of Professor G.V. Shchipanov. Soon Presidium of AS of USSR recognized the decision of its former commission to be erroneous and it was cancelled. This promoted the restoration of generous name of G.V. Shchipanov and simultaneously removed "taboo" from the invariance theory of control systems.

The next important event in the history of the invariance theory development was the meeting on the invariance theory of control systems and its application held in Kiev in 1962 but now it was All-Union one. By its scale the second All-Union meeting essentially exceeded the previous one. Its 200 participants were representatives of scientific, design-production bodies and high educational institutions from Moscow, Leningrad, Kiev, Sverdlovsk, Minsk, Baku, Kharkov and some other cities. All together more than 50 reports were given at this meeting.

The second meeting featured a wide presentation of works describing the results of applications of the invariance theory ideas to solving the control problems in aviation, energetics, transport and some other fields of country's economy. This had to be taken into account. The basic results of the held second meeting can be formulated as follows: there had been proved and convincingly demonstrated the efficiency of the basic result of the invariance theory — the development of the method of structural and parametric synthesis of controllers which under meeting certain conditions will ensure the invariance effect. Definition of these conditions was formulated by Academician B.N. Petrov in the form of his known "two-channel principle" admitting the visual physical interpretation, namely: to obtain the invariance effect there has to be two (or more) identical in their dynamical characteristics channels of disturbance propagation, thereby the compensation of its effect on a controlled object is attained.

Unfortunately, in this period of euphoria and passion for possibilities to improve the operation performance of control systems designed by using the recommendations on the invariance theory there remained almost unnoticed the fact that the invariant control systems are the systems not coarse by Andronov with all implications followed. As known, the invariance effect can be attained only under fulfillment of strict equality between corresponding differential operators or transfer functions composed of both mathematical models of an object and operators of the controlled object. In this case on default it was set that a designer of control system is precisely familiar with a mathematical model of an object. At that time even the thought that between an object model and an object itself there could be some differences was perceived as heterodoxy. With availability of inevitable parametric uncertainty in a description of a controlled object one can deal only with quasi-invariance effect. However, it was inappropriate to speak openly about such profane thoughts. Everybody tended to an ideal which was unattainable in real conditions: the absolute invariance.

After the second meeting in Kiev in 1962 over several years a series of All-Union meetings was held. So for a while Kiev turned in a sort of Mecca for supporters of this scientific direction.

The contribution of Alexey Grigorievich Ivakhnenko in formation and development of the invariance theory of control systems was tremendous and cannot be overestimated.

In the middle of the 60s of the last century Alexey Grigorievich unexpectedly for his pupils and colleagues made a sharp turn in his scientific career. He released a paper on a group method of data handling which marked the start of a new period in his creative work. After this publication A.G. Ivakhnenko left his field of research and almost completely focused on creation, formation and development of new scientific trend which in the course of time was called "inductive modeling". His basic tool was the group method of data handling (GMDH) which was original, seemed simple but was amazingly effective at solving applied problems and thereby made its author famous in scientific circles worldwide. By their structure GMDH algorithms represent the implementation of inductive principle "from a particular case to a general one: from simple particular models via a hierarchical complication one constructs a certain more general model which optimally reflects the level of information value of data sampling.

Alexey Grigorievich was generously gifted by nature with different talents: he was not only a talented researcher but also a brilliant teacher. Above it has already been said about his outstanding contribution to training a scientific staff. Nowadays many his pupils head departments at the institutes of NAS of Ukraine and departments at universities, are in charge of faculties.

Alexey Grigorievich was very sociable person, trusty to people in his surrounding and was payed back with a sincere respect. I am grateful to my fate that I learnt a lot from Alexey Grigorievich and had a possibility to keep in close touch with him for a long period of time.