

WEB-QUEST "CONTROL THEORY IN PERSONS": NOWADAYS AND FUTURE

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Abstract: In this paper the necessity of creating Web-quest "The History of Automatic Control Theory" is proved. Difficulties of using Internet-resource are described. General structure of the quest is given and selected chapter "The History of Linear Matrix Inequalities in Control Theory" is considered in details. This chapter devoted to scientists who have made significant contribution into development and application of linear matrix inequalities. The Web-pages of this chapter dedicated to such scientists as A.M. Lyapunov, V.A. Yakubovich, A.I. Lur'e, E.S. Pyatnitskii, V.M. Popov, G. Zames, J.C. Willems, S.P. Boyd and others. In conclusion the future works are discussed. *Copyright ©2005 IFAC*

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1. INTRODUCTION

Any significant achievements in science appear due to the efforts of many scientists. From the moral-ethical point of view studying of science history is extremely important.

This idea is not new. Great educator Jan Amos Komensky (Comenius) wrote about importance of the history of mechanical problems giving pleasure to human's intellect. He thought that main lessons should accompany by studying of history of great discoveries, permanently (Komensky, 1982).

On the other hand it is equally important to estimate the level of student's knowledge of science history.

For this purpose among the senior students of our university, majoring in applied mathematics and electrical engineering an anonymous questioning was held. The results were surprising for us. Many important historical perspectives in the field of control theory are unknown to our students. There are historical perspectives in periodicals such as IEEE Control Systems Magazine, GAMM Mitteilungen, and other magazines

and conference papers, but these publications are not available for all the students.

During three last centuries (with the advent of the first scientific journal in 1665) transfer of the scientific information was carried out mainly through scientific periodic journals and magazines (Kapitsa, 1987). Last decade all has considerably changed. Students don't often use books and magazines. They use Internet-sources frequently.

If we say, that there is no information about scientists in the World Wide Web, it won't be right. The Internet is used by millions of people. Nowadays it is numbered over three milliards of Web-pages in Internet and two millions pages are being added every day. The question is why Internet is of no use in our case?

2. MOTIVATIONS

Internet is introduced into all fields of our life and first of all it is used for education purposes It is well-known that Internet and the World Wide Web have

been created to give an opportunity to scientists of all over the World to fulfill joint work.

For the first time the idea of hypertext was stated by an outstanding American scientist Vannevar Bush, in 1945 in his article "As We May Think" (Bush, 1945; Herr *et al.*, 1999). And it is not accidentally that in October 1995 in the universities of the USA and Canada ceremonial conferences, devoted to the fifty-years of the publication of that work by Vannevar Bush in the magazine "The Atlantic Monthly" were held Fig. 1.

The article was dated 1945. At that time there were no personal computers and nets in the world. Electronic computers were presented only by single experimental models. Calculated technique of that time was electro-mechanical and analogous.

Vannevar Bush dreamed about *mechanized private file*. Nowadays Internet possesses considerable quantity of:

- *fast communication links;*
- *searching systems, among which are Yandex , Rambler , Google , Yahoo, etc;*
- *explorers (Internet Explorer, Netscape Navigator, etc);*
- *editors of the Web-pages*

As we can see, the plan was wonderful. We want to pay attention to such words as 'library', 'encyclopedia'. What do we have nowadays ?

There are serious objections concerning a *library* and an *encyclopedia*. Unfortunately, the library is reduced to periodicals. Mainly the materials of current years or, in a better case, of the last years are accessible for us.

The world 'encyclopedia' means scientific or popular-science inquiry publication, which contains a systematic code of knowledge. Usually we understand it as a collection of fundamental facts, information about outstanding scientists, who have made significant contribution to different fields of science.

Unfortunately we have periodicals in general. Let's take a look at the next example. An attempt to find on the Russian sites the portrait of a well-known, scientist in the field of control theory as R. Kalman hasn't led to a desirable result. At the same time if you try to search the surname of your postgraduate student, the information about his publications will surely be found.

As for foreign Internet links, we will probably find works of contemporaries with the reference to the publishing of this author there, but not the information about him.

Transliteration is a very big problem. It appeared many years ago in libraries. Now creators of searching programs try to solve it. Transliteration makes successful search for information very problematic. Very

often necessary information exists, but a surname or a name may be written differently in different languages. For example, see Fig. 2.

Transliteration is one of the reasons for duplication and distribution of information in the Internet.

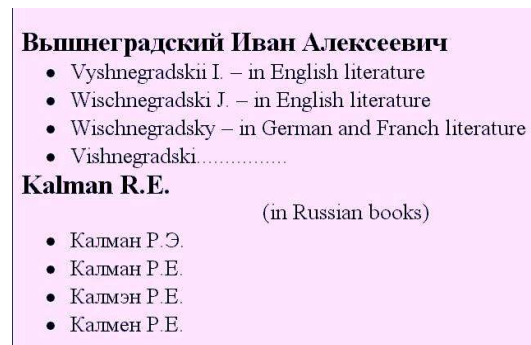


Fig. 2. Transliteration

3. REQUIREMENTS

It is necessary to create a WEB-quest, which would permit to have minimum of necessary information in one Web-site and using hyperlinks for organising connection with the existing sites. Therefore it has been decided to create WEB-quest devoted to the history of appearance of the automatic control theory.

The hypertext technology must be put in a basis. Using the hyperlinks allows to save time when searching for necessary materials. This textbook can be called a Web-quest as on it pages there is a great amount of hyper references on the pages of other sites in the World Wide Web. Due to using HTML, the files are compact, occupy small space. It allows transferring them from a computer to a computer easily (Pakshina, 2002).

This quest must to contain many photos, circuits and figures on Web-pages. At usual lectures it would be inconvenient to organize display of these materials and it would demand more lecture time.

Each Web-page must contain a full list of both literary and Internet-resources used for its creation.

Each Internet-link must be active.

Very positively student's reaction must be for this material.

4. THE GENERAL STRUCTURE OF QUEST

4.1 The founders

At present the quest consists of four chapters. "Founders of the Automatic Control Theory in Russia" are devoted to such known scientists as I.A. Vyshnegradsky, A.M. Lyapunov, I.N. Voznesensky A.A. Andronov and M.A. Aizerman.

As We May Think

by Vannevar Bush

"...Consider a future device for individual use, which is a sort of **mechanized private file and library**. It needs a name, and, to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory.

It consists of a desk, and while it can presumably be operated from a distance, it is primarily the piece of furniture at which he works. On the top are slanting translucent screens, on which material can be projected for convenient reading. There is a keyboard, and sets of buttons and levers. Otherwise it looks like an ordinary desk. Wholly new forms of **encyclopedias** will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified..."

Fig. 1. Bush's article

Number	Chapter's name	Demonstration		
		Conference	Country	Date
1.	"Founders of the Automatic Control Theory in Russia"	6 th IFAC Symposium ADVANCE IN CONTROL EDUCATION (ACE'03)	Finland	June, 2003
2.	"Founders of the Automatic Control Theory in Europe"			
3.	"The History of Optimal Control"	6 th International Conference CONTROL OF POWER SYSTEMS '04	Slovak Republic	June, 2004
		Second IFAC Workshop INTERNET BASED CONTROL EDUCATION (IBCE'04)	France	September, 2004
4.	"The History of Linear Matrix Inequalities in Control Theory"	9 th International Conference SYSTEM ANALYSIS AND CONTROL (in Russian)	Ukraine	July, 2004
		16 th IFAC World Congress	Czech Republic	July, 2005
5.	"The Founders of Filtering Theory"	IV International Conference SYSTEM IDENTIFICATION AND CONTROL PROBLEMS (SICPRO '05) (in Russian)	Russia	January, 2005
6.	"The Chronicle of IFAC's Congress"	?	?	?

Fig. 3. The structure of quest

FOUNDERS OF LINEAR MATRIX INEQUALITIES

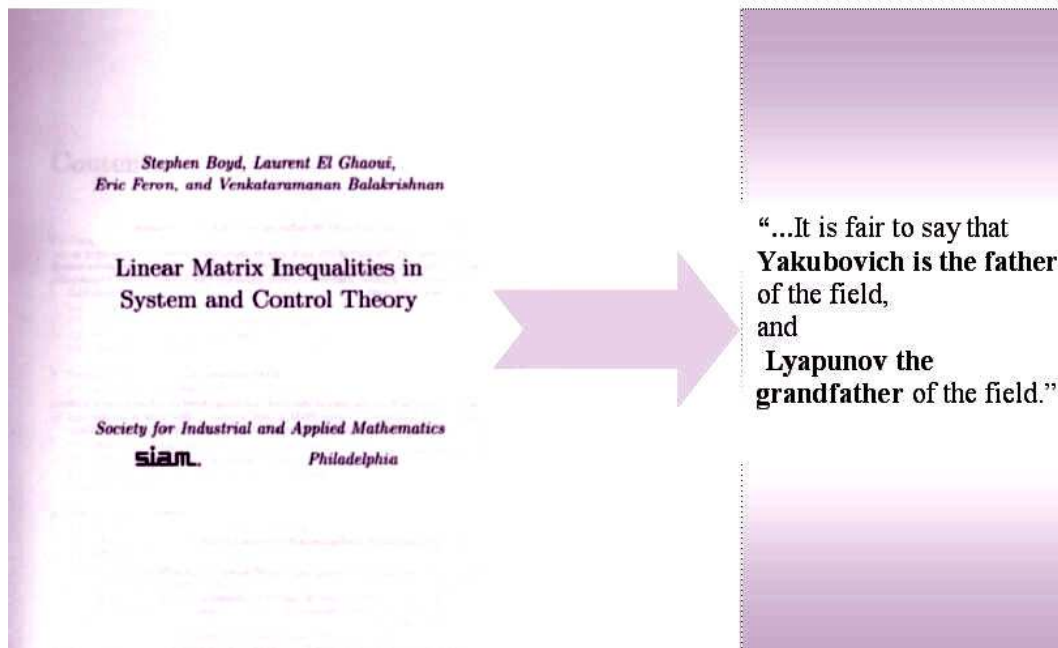


Fig. 4. Founders.

Date	Events	Authors
1892	First LMI appears.	Lyapunov A.M.
1940's	Application of Lyapunov's methods to real control engineering problems.	Lur'e A. I.
		Postnikov V.N.
Early 1960's	PR lemma gives graphical techniques for solving another family of LMI.	Yakubovich V.A.
		Popov V.M.
		Kalman R.E.
		Tsytkin Ya.Z.
Late 1960's	Observation that the same family of LMIs can be solved by solving an algebraic Riccati equation (ARE).	Zames G.
		Sandberg I.V.
1971	LMIs in Positive real lemma can be solved by solving certain ARE	Willems J.C.
Late 1970's - early 1980's	Recognition that many LMI can be solving by computer via convex programming.	Horisberg H.P.
		Bélanger P.R.
		Pyatnitskii E.S.
		Skorodinskii V.I.
		Kamenetskii V.A.
Late 1980's	Development of interior-point algorithms for LMIs.	Karmarkar N.
		Nesterov Yu.E.
1994 r.	LMI's are common method analysis and synthesis.	Nemirovskii A.S.
		Boyd S.P.

Fig. 5. Main events.

The second chapter is called "Founders of the Automatic Control Theory in Europe " in which the life and works of greatest foreign scientists of the first size (D.K. Maxwell, A. Stodola, A. Hurwitz, and E. Routh) is described (Pakshina, 2003).

The third chapter is "The History of Optimal Control". It devoted to well known scientists such as J. Bernoulli, L.S. Pontryagin, R. Bellman, B.T. Polyak and others (Pakshina, 2004; Pakshina and Mechtaev, 2004).

The material of these chapters was presented on different conferences, see Fig. 3.

The fourth chapter is "The History of Linear Matrix Inequalities in Control Theory". The choose of these chapters was not arbitrary. This time is not the best for development of science, education and engineering in our country and the selected material gives significant moral support for students because high evaluation of role of Russian scientists by international community. In the next section the fourth chapter will be considered in more details.

5. THE HISTORY OF LINER MATRIX INEQUALITIES IN CONTROL THEORY

In 1994 Stephen Boyd, Laurent El Ghaoui, Eric Feron and Venkataramanan Balakrishnan have issued the monograph "Linear Matrix Inrqualities in System and Control Theory" (Boyd *et al.*, 1994*b*). Now this book by opinion of many scientists can be evaluated as classic one. The authors selected two prominent figure in this field: Yakubovich and Lyapunov, see Fig. 4.

Rather a detailed list of scientist, who have submitted huge contribution to the development of the direction , is given in the book. There are 18 names on this list and 10 of them belong to our countrymen. The history of LMI can be divided into several stages and can be shown as the following table (Fig. 5) (Boyd *et al.*, 1994*b*; Boyd *et al.*, 1994*a*; Hurak, 2001; Polyak and Scherbakov, 2002). The line reflecting the contribution of Stephen Boyd is added to the table.

5.1 The structure of chapter

It is give a historical view of Linear Matrix Inequalities in control and system theory. There are Web-pages devoted to main discoveries on the LMIs since 1892 till nowadays in the chapter (Boyd *et al.*, 1994*b*; Boyd *et al.*, 1994*a*; Hurak, 2001; Polyak and Scherbakov, 2002). It is considered that Lur'e and Postnikov were the first to apply Lyapunov's methods to practical control engineering problems.

In the chapter the special attention is given to E.S. Pyatnitskii (Fig. 6) and his collaborators V. A. Kamenetskii and V. I. Skorodinskii. They were first to formu-

late the search for a Lyapunov function as a convex optimization problem.

The term "Linear Matrix Inequality" was coined by J. C. Willems and is widely used now.

There are several Web-pages dedicated to Stephen Boyd (Fig. 7). He considers LMIs as general method of linear systems analysis and synthesis. This scientist plays an important role in development of LMI.



Fig. 6. E.S. Pyatnitskii.



Fig. 7. S.P. Boyd in International Student Olympiad on Automatic Control in Saint Petersburg, Russia

Besides, the contribution of Russian scientists into development and application of linear matrix inequalities is great.

At present this chapter contains information about 15 scientists.

5.2 The test

At the end of each chapter there is a test block with control questions on the learnt material (Fig. 8). In these questions the big attention is paid to connections between scientists, continuity of discoveries. Though the Web-pages contain a lot of the interesting information concerning life and works of scientists, first of all test questions are about their contribution to the automatic control theory (Fig. 9). The choice from the base in test is at random.

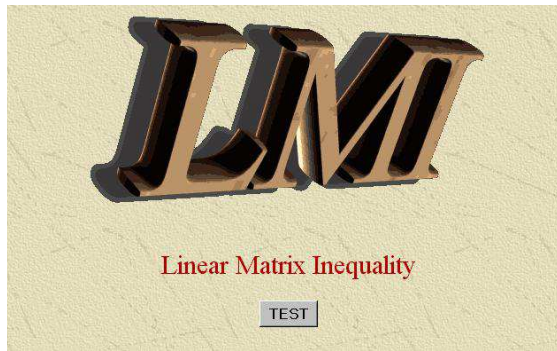


Fig. 8. Title of test

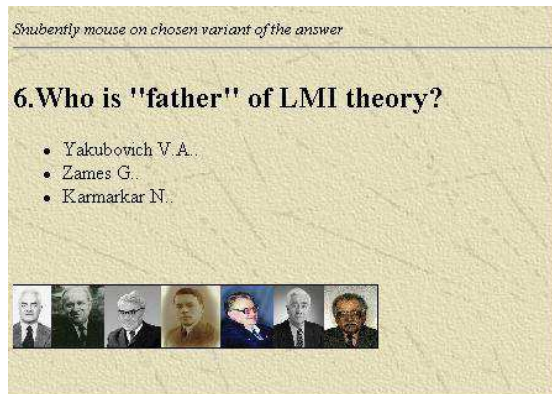


Fig. 9. Example of the question

6. FUTURE WORKS

In the nearest future we have a plan to expand chapter "The History of Linear Matrix Inequalities in Control Theory" with Web-pages about life and activity of such scientist as I.V.Sandberg, H.P.Horisberg, P.R.Belanger and N. Karmarkar.

Besides, we are working with chapter "The Founders of Filtering Theory". The Web-pages of this chapter will be dedicated to such scientists as N.Wiener, R.E.Kalman, A.N. Kolmogorov, V.S.Pugachev, R.L. Stratonovich and R.S. Bucy.

Now we start for creation of the chapter "The Chronicle of the IFAC Congresses". This is big and important project because fifty IFAC Anniversary and we hope that IFAC secretariat and all the control community help us in process of information gathering and selection to realize this project successfully.

7. CONCLUSION

Though an initial problem was creation of a electronic closed textbook for students of Arzamas branch of Nizhny Novgorod State Technical University in Russia, a prospect problem is creation of a Web-quest both in Russian, and in the English languages.

The quest can be recommended to the senior students and post-graduate students both for lecture and for independent studying. Besides it is intended to help

teachers as a source of popular information about control theory and about founders of this science.

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