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Efficiency of deep integration between a research university and an academic institute

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Abstract

I am analyzing the results of long-standing close cooperation between an academic institute and a national research university. I am making analysis based on sharing experience of our Samara National Research University and the Image Processing Systems Institute of the RAS. This integration has allowed us to enrich academic activities with up-to-date scientific results, to ensure the permanent inflow of young talents to science, to improve the efficiency of training highly-qualified professionals and the quality of research and development, and to jointly fulfill several large-scale projects and commercial contracts.

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Keywords: Institute of the Russian Academy of Sciences; National Research University; integration of fundamental science and higher education; training highly-qualified professionals; research activity; scientific school

Be one of each such props to,
eliminating the other from a burden,
one dream to go with one’s will…

Michelangelo Buonarroti

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Introduction

S.P. Korolyov Samara National Research University (shortly, Samara University; the first name – Kuibyshev Aviation Institute – KuAI) was founded in 1942 in the difficult for the country wartime. Several aviation enterprises were evacuated to Kuibyshev; they demanded engineers and engineering staff. Therefore, from the very beginning the Institute was closely connected with aviation enterprises. KuAI was the first institute in the Soviet Union where industrial branch research laboratories were created as a basis for solving research and development problems in the airspace industry. Industrial branch research laboratories played an important role in the development of this institution of higher learning as a research university. Another key milestone for the University was its close cooperation with the USSR Academy of Sciences (now the Russian Academy of Sciences). This interrelationship of scientific and educational activities has contributed to efficient industrial introduction of scientific and technological achievements and ensured the fundamental character of performed scientific studies and education. This paper is devoted to the 30 years' cooperation of Samara University with the Image Processing Systems Institute of the RAS (IPSI RAS) [1] established as part of one of KuAI's laboratories.

1. Establishing the SPECTR Scientific Educational Center

Partnership with academic institutes (A Department of Lebedev Physical Institute of the USSR Academy of Sciences (LPI RAS), Prokhorov General Physics Institute of the USSR Academy of Sciences (GPI RAS), Institute for Information Transmission Problems of the USSR Academy of Sciences (IITP, Kharkevich Institute), etc.) was characteristic of a research team headed by Prof. V.A. Soifer [2] still before the Department of Engineering Cybernetics was established at Kuibyshev Aviation Institute in 1982. Lecturers from the Department of Engineering Cybernetics began to actively interact with scientists from the Computer Center of the USSR Academy of Sciences (the research team headed by Academician Yu.I. Zhulavlev), and A Department of Lebedev Physical Institute of the USSR Academy of Sciences (headed by Academician A.M. Prokhorov). Due to this partnership, high-impact research results were obtained [3 – 10] and several new classes of optical elements (laser focusers [5 – 6], laser transverse-mode composition formers and analyzers [7 – 8], etc.) were proposed and studied. Creation of new optical elements was justified by research findings in the field of asymptotic calculations [9] and mathematical simulation [10] that resulted in building up a new research area named Computer Optics [11]. The obtained scientific results allowed the research team headed by V.A. Soifer to build up in 1986 the Kuibyshev Department of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences (CDB UI, Moscow) founded with support of its office chief, design manager of CDB UI, Professor Iosif Norairovich Sisakyan [12]. In 1988, the Kuibyshev Branch of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences was founded based on this department (since 1993 – Image Processing Systems Institute of the RAS (IPSI RAS); since 2016 – Image Processing Systems Institute of the RAS – Branch of the "Crystallographic and Photonics" Federal Research and Development Center of the Russian Academy of Sciences).

The SPECTR Scientific Educational Center (SEC) was founded in December 1988 by the joint order No. 167 of the Vice-President of the USSR Academy of Sciences, Academician E.P. Velikhov and the Deputy Minister of Higher and Secondary Vocational Education of the RSFSR O.M. Petrov based on the Kuibyshev Branch of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences (KB CDB UI) and Kuibyshev Aviation Institute. Prof. Dr. Sc (Engineering) V.A. Soifer was appointed a Director of the SPECTR SEC according to the joint order of Kuibyshev Aviation Institute and the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences. In 1990, V.A. Soifer became the President of KuAI keeping his status of the Director of KB CDB UI on a part-time basis. This type of one-man management and scientific and managerial talents of V.A. Soifer provided highly credible interaction between these research and educational institutions.

The purpose of establishing the SPECTR SEC was the joint use of facilities and resources, including human resources, of KuAI and KB CDB UI in order to efficiently solve scientific and technical problems and to train specialists and highly qualified professionals – Candidates (PhDs) and Doctors (holders of an Advanced Doctorate) of Sciences. The first step in this cooperation was the purchase of an electronic lithographer BS-600 within a logistic support program of the USSR Academy of Sciences (manufactured by Tesla Brno, Czechoslovakia) valued at more than one million transferable rubles (i.e. at the then existing official exchange rate it was more than one million and

a half US dollars). Kuibyshev Aviation Institute provided some special-purpose facilities in order to place the electronic lithographer. The Deputy Director of KB CDB UI Yuriy Nikolaievich Boyarkin and the Vice-President of KuAI Oleg Alexandrovich Lapchuk contributed a lot to prepare facilities for the first in Samara region microelectronic equipment such as the electronic lithographer. Funded by the USSR Academy of Sciences, a joint group of specialists headed by the Head of KB CDB UI Laboratory Dr.Sc. (Physics and Mathematics) Mikhail Aronovich Golub and the Head of the Department of KuAI Dr.Sc. (Engineering) Petr Efimovich Molotov was directed to Czechoslovakia for a three-week training course to learn operating principles of the electronic lithographer. The group included the engineers from KuAI A.I. Eremenko and A.F. Fokin and the specialists from KB CDB UI – M.F. Bychkov, A.Yu. Miller and A.V. Mirzov. Alexander Fedorovich Fokin, who approved himself as a notable electronics engineer, played an important role in further performance and upgrade of the lithographer. Mikhail Fedorovich Bychkov and Alexander Ivanovich Eremenko proved themselves to be good specialists in logistic support of technological processes.

After beginning in 1991 financing the High Technologies State Research and Development Program, whose main contractor was Kuibyshev Aviation Institute, a plasma-chemical etcher, a magnetron sputtering set, clean rooms and other equipment were purchased at the expense of KuAI. Hence, the KuAI and KB CDB UI staff organized an integrated technological chain to create and study elements of Computer Optics [13]. A major contribution to the development of Computer Optics Technology [14 – 22] and equipment maintenance and repair was made by Professor Alexey Vasilievich Volkov [23].

Joint efforts of the KuAI and KB CDB UI scientists resulted in breakthrough outcomes in the field of Computer Optics and Digital Image Processing. The obtained results were globally recognized being proved by the fact that V.A. Soifer was proposed to become a guest editor of the peer-reviewed Journal “Optics and Lasers in Engineering.” As a result of this, in autumn 1991 a special issue of the Journal entitled “Computer Optics in the USSR” came out [24], which was basically compiled from the papers written by scientists from the SPECTR SEC [25 – 26]. Highly-cited papers of the SPECTR SEC employees also appeared in some other famous journals [27 – 30].

Due to opportunities provided by integration between KuAI and KB CDB UI, the first Doctorate theses of the SPECTR SEC scientists (1990 – M.A. Golub, 1992 – V.V. Kotlyar) were prepared and defended in the Thesis Committee of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences.

From the very beginning of its foundation, the SPECTR Scientific Educational Center observed democratic traditions typical for institutions of the USSR Academy of Sciences and for institutions of higher learning. An Academic Council of the Scientific Educational Center was established which held quarterly meetings and included the following members: KB CDB UI Deputy Director Yu.N. Boyarkin, Dean of the Faculty of System Engineering, Ph.D. in Engineering, Associate Professor S.M. Dubinina, heads of KB CDB UI laboratories Ph.D. in Engineering E.Yu. Arefiev, Ph.D. in Physics and Mathematics M.A. Golub, Ph.D. in Engineering A.G. Khramov, Director of the Branch of the Information Computer Center V.A. Gilev, Head of KuAI Research Laboratory 35 A.A. Bazarbaev, Associate Professor at the Department of Applied Mathematics, Ph.D. in Engineering, Associate Professor A.N. Kovartsev, Senior Scientific Researcher at the Department of Engineering Cybernetics, Ph.D. in Engineering, Associate Professor V.V. Sergeev, Associate Professor at the Department of Automated Control Systems, Ph.D. in Engineering, Associate Professor G.N. Tomnikov. The Council Chairman was Prof. Dr.Sc. (Engineering) V.A. Soifer and its Scientific Secretary was Ph.D. in Engineering N.L. Kazanskiy. The Council discussed all problems of research and educational activities of the Center and prepared all necessary solutions hereof.

Activities of the SPECTR Scientific Educational Center were also actively continued after reorganization of the Samara Branch of the Central Design Bureau of Unique Instrumentation of the Russian Academy of Sciences into the Image Processing Systems Institute (IPSI) and after renaming Kuibyshev Aviation Institute into S.P. Korolyov Samara State Aerospace University (SSAU). The results obtained in these yeas allowed the SPECTR SEC scientists to publish their papers in some peer-reviewed journals [31 – 38] and their monographs [39 – 40] in some highly reputed publishing companies in USA (CRC Press) and Great Britain (Taylor and Francis), as well as to defend their Doctorate theses in the SSAU Thesis Committee: V.V. Sergeyev (1993) and N.L. Kazanskiy (1996).

The critical joint activity of IPSI and SSAU is publication of the scientific Journal “Computer Optics.” The collection of research papers – Journal of Computer Optics – began to be published in 1987 at the initiative of Academician E. P. Velikhov, Academician A.M. Prokhorov and Professor I.N. Sisakyan as the information support

within the framework of the Comprehensive Program for Scientific and Technical Progress for CMEA member countries. Beginning from Issue 16 dedicated to the memory of Professor I.N. Sisakyan (1996), the Journal's edition was completely transferred to Samara. Further development and achievements of this periodical are largely defined by personal impact of the SPECTR SEC staff [41 – 42]. Beginning from 2007, the Journal of Computer Optics became a quarterly-issued annual scientific periodical (from the second half of 2015 it is issued six times a year) having been published jointly by SSAU and IPSI RAS. The Journal's Editorial Board involves five academicians (S.Yu. Zheltov, Yu.I. Zhuravlev, V.Ya. Panchenko, V.A. Soifer, I.A. Scherbakov), one Corresponding Member of the RAS (B.V. Krzhizhanovsky), six holders of an Advanced Doctorate (Doctors of Sciences) (N.L. Kazanskiy, V.V. Kotlyar, V.S. Pavelyev, V.V. Sergeev, S.N. Khonina, V.M. Chernov), scientists from Great Britain (Dr. Liam O'Faolain, University of St Andrews), Germany (Professor Rihard Kowarschik, Friedrich Schiller University of Jena), India (Professor Kehar Singh), China (Academician Jin Guofan, Tsinghua University, Beijing), USA (Dr. Olga Korotkova, University of Miami; Dr. Sc. (Physics and Mathematics) Sos Agaian, University of Texas, San Antonio) and Finland (Prof. Dr. Sc. (Engineering) Jari Turunen, University of Joensuu). The Journal's development strategy is defined by its Editor-in-Chief, Academician V. A. Soifer [43]; the important role in the Editorial Board's activity is played by the Executive Editor Ya.E. Takhtarov. A considerable achievement of the Journal of Computer Optics is that since 2012 the Journal has been reviewed and indexed in the Scopus and Compendex International Scientific Databases. In 2015, the Journal of Computer Optics was included in the 650 most popular, both in Russia and abroad, Russian scientific periodicals having been published on the Web of Science platform in the form of a separate, but fully integrated to Web of Science database of the Russian Science Citation Index (RSCI). According to 2015 results, the Journal of Computer Optics was included into the Scopus second high-profile quartile in all its chapters, and in 2016 it improved its ranking indices even more (https://www.scopus.com/sourceid/21100203110?origin=resultslist).

2. Involvement in the Integration Federal Target Program

In 1996, the SPECTR Scientific Educational Center became a part of the BASIS Research and Education Center (Basis REC) on the Fundamental Issues in Aerospace founded by Samara Research Center of the RAS (SRC RAS) and Samara State Aerospace University. Development of the Basis REC got a boost in 1997-2000 due to its involvement into the Federal Target Program "State Support to Integration of Higher Education and Fundamental Science in 1997-2000" (Integration FTP). A major role in preparation of a program application for participation in the Integration FTP was played by the President of SRC RAS, Academician Vladimir Pavlovich Shorin. The Federal Research University of High Technology (FRUHT) was founded in 2000 based on the Basis REC which involved for cooperation some leading academic and education institutions of the city of Samara. In 2001-2004, research and educational resources of FRUHT were developed a lot with support of the Integration FTP. Due to involvement in the Integration FTP, between 1997 and 2004 about 800 thousand US dollars was invested into the development of the SPECTR SEC as an integral part of the Basis REC and FRUHT. A network of science and education of Samara region was actively developed funded by the Integration Program; all FRUHT members were included into the singe network; computer facilities were purchased for high-performance computing systems; the first in Samara region computing clusters were created and successfully utilized. The High-Efficiency Information Processing Center was established in SRC RAS which involved in its operation the specialists from SSAU and IPSI RAS (Ph.D. in Engineering Vladimir Vasilievich Kravchuk, Ph.D. in Engineering Sergey Borisovich Popov, Dr.Sc. (Engineering) Vladimir Alexeevich Fursov).The Deputy President of SRC RAS, Dr.Sc. (Engineering) and the Head of SSAU's Research Department, Ph.D. in Engineering Sergey Konstantinovich Bochkarev contributed a lot to the development of these areas.

The significant focus area of the Integration FTP activities was the support of preparation and publication of monographs and textbooks. During this time period, the SPECTR SEC scientists being initiated and edited by V.A. Soifer prepared and published some fundamental multi-authored monographs on methods of Computer Optics and Digital Image Processing [44 – 45]. In 2003, the Publishing House "Fizmatlit" issued an additional, successfully disseminated edition of these monographs of three thousand copies each. The given editions were certified by the Ministry of Education of the Russian Federation as a textbook and a training manual for university-level students. The English and Chinese translations of these monographs [46 – 48] were published in famous foreign publishing companies such as John Wiley & Sons (USA), Tianjin Press (P.R. China). According to data of the Russian

Scientific Citation Index (e-library) as of end of January 2017, there are over one thousand references to the above mentioned monographs including their translated editions.

Results of the following researchers from the SPECTR SEC which were included into Doctorate theses materials have formed the basis for these and some other monographs: A.A. Kalentiev (1998), V.A. Fursov (1999), V.M. Chernov (1999), L.L. Doskolovich [49] (2001), A.Yu. Privalov (2001), S.N. Khonina [50] (2001) and A.V. Volkov (2002). Due to successful development of the Department of Engineering Cybernetics of SSAU, the time was ripe for its structuring and in 2001 the Department of Geoinformatics (now the Department of Geoinformatics and Information Security) headed by Prof. Dr.Sc. (Engineering) V.V. Sergeev was split therefrom. Later on, the Department of Engineering Cybernetics was separated into two more new departments: the Department of Supercomputers and General Informatics (Head of the Department – Prof. Dr.Sc. (Engineering) V.A. Fursov) and the Department of Nanoengineering (Dr.Sc. (Physics and Mathematics), Associate Professor V.S. Pavelyev). We are currently working on separating one more department, i.e. the Department of Photonics and Optoinformation Technology, from the Department of Engineering Cybernetics (Prof. Dr.Sc. (Physics and Mathemathics) S.N. Khonina).

One of the first organizational arrangements of the SPECTR SEC, which involved the joint efforts of the staff of KB CDB UI ASUSSR and KuAI, was preparation and conduct of the 4th Meeting on Computer Optics in Togliatti on February 19-24, 1990. The 5th International Workshop on Digital Image Processing and Computer Graphics "Image Processing and Computer Optics" chaired by Academician Nikolay Alexandrovich Kuznetsov was held in Samara on August 23-26, 1994 through joint efforts of SSAU and IPSI RAS involving the Institute for Information Transmission Problems of the USSR Academy of Sciences (IITP, Kharkevich Institute) and the Institute for Information Processing of the Austrian Academy of Sciences. An important direction of the Integration FTP was the support of arranging the largest scientific conferences both on the problems of integration and on up-to-date sectors of the development of science and technology. The following events may be referred to the first arrangements covered: the First Conference "Integration Status and Perspectives between Fundamental Science and Higher Education" (September 21-24, 1998, SSAU, Samara Research Center of the RAS, Saratov State University, Fig. 1) and the All-Russia Conference with international participation "Integration of Science and High Education in Russia" (September 14-17, 2001, Samara).

Fig. 1. At the sectional meeting of the First Conference on Integration (1998) – Academician N.A. Plate and the Deputy Director of Lebedev Physical Institute of the RAS, Professor V.N. Ochkin.

The largest international conferences arranged by SSAU and IPSI RAS with the support of the Integration FTP on the subjects of the SPECTR SEC activities were as follows: International Symposium "Information Optics. Fundamentals of Science and Technologies" (Moscow, August 27-30, 1997; Chairman of the Program Committee – Academician Andrey Leonovich Mikaelyan); the 5th International Conference "Pattern Recognition and Image Analysis: New Information Technologies (PRIA-5-2000)» (Samara, October 16-22, 2000; Chairman of the Program Committee – Academician Yuri Ivanovich Zhuravlev); the International Conference "Mathematical Modeling – 2001" (MM – 2001) (Samara, June 13-16, 2001; Chairman of the Program Committee – Academician Alexander Andreevich Samarskii – Fig. 2) and some other.

Fig. 2. Academicians A.A. Samarskii and Yu.I. Zhuravlev in the Presidium of the International Conference “MM-2001”.

Thus, the Integration FTP supported the efforts of research teams of SSAU and academic institutions on their joint studies that ensured a wide range of large-scale fundamental and applied problems on key-priority directions of the development of science and technology having been solved. Participation in the Integration FTP offered financial and organizational opportunities to create more sophisticated models of educational and research centers and a system of ongoing education in order to train highly skilled specialists. The experience in research and educational activities acquired in this period became a basis for involvement of Samara University into a large-scale project implemented within the framework of the Russian-American Basic Research and Higher Education (BRHE) Program. The projects of this Program were funded by the American Civil Research and Development Foundation (50 %) and by the Ministry of Education and Science of the Russian Federation (25 %). A winner university had to provide co-financing of the project in the quantity of remaining 25 %.

The first failed attempt to get involved into the Russian-American Basic Research and Higher Education (BRHE) Program was made in 2001. The project proposal prepared by researchers from the SPECTR Scientific Educational Center was shortlisted in the third competition, but it wasn’t supported by representatives of the American Civil Research and Development Foundation (CRDF) and the RF Ministry of Education. Upon arriving in Samara, the Commission remained dissatisfied by the subject of the project and the way it was presented. V. A. Soifer organized preparation to the next competition, one of the important components of which was to study the experience of Moscow Institute of Physics and Technology (MIPT) which was among the competition winners in 2001. Consultations with the MIPT Vice-rector (now – Academician) Eduard Evgenievich Son proved to be useful. An important factor was a guarantee provided by the Government of Samara region on the project’s co-financing at the amount of 2.5 million rubles per year. Hence, SSAU won a big three-year grant to fulfill the Research & Education Center for Mathematical Principles of Diffractive Optics and Image Processing Project. Thus, collective achievements of the SPECTR SEC got international funding which wouldn’t be possible without expertise and widely progressing development provided due to participation in the Integration FTP.

3. Participation in the Russian-American Basic Research and Higher Education Program

Participation of SSAU in the Russian-American Basic Research and Higher Education (BRHE) Program, the CRDF grant REC-SA-014-02, has become a turning point in development and improvement of the University’s competitiveness. Creation of the Research and Education Center (REC 014) (the 14th in Russia) “Research & Education Center for Mathematical Principles of Diffractive Optics and Image Processing” within the framework of this Program was a prototype of the structure with a completely new level of organization of research and education.

REC 014 was founded in Samara State Aerospace University (SSAU) in October 2002. REC 014 included the following departments: Department of Engineering Cybernetics, Department of Geoinformatics, Research Laboratory 35 and Physical-Mathematical School of SSAU. The Project applicants were as follows: Image Processing Systems Institute of the RAS (IPSI RAS) (laboratories of Diffractive Optics, Mathematical Methods of

Image Processing, Laser Measurements, and Experimental Design Bureau "Microtechnology") and Samara Research Center of the RAS (Center for High-Efficiency Information Processing). The main subdivision of Samara Aerospace University being in charge of the Project administration was the Institute for Computer Research.

The following structures were formed in REC 014 for the Project administration: Council of REC 014, Expert Board of REC 014 and Project Directorate. The Council of REC 014 determined a development strategy of REC 014. The Council was headed by the Project Academic Advisor V.A. Soifer. The Council included: Director of REC E.V. Shakhmatov, Head for Scientific Component V.V. Kotlyar, Head for Educational Component V.V. Sergeev, Head for Foreign Affairs Component N.L. Kazanskiy, responsible executive for youth outreach (Academic Secretary of the REC Council) A.Yu. Privalov, and Project Coordinator V.A. Fursov.

The Expert Board selected participants of REC 014 on a competitive basis. Not only members of REC 014, but also representatives of other departments and subdivisions of the University worked in the Expert Board. The Chairman of the Expert Board was Dr. Sc. (Engineering) A.Yu. Privalov (Department of Engineering Cybernetics, SSAU), the secretary was Ph.D. in Engineering M.A. Chicheva (Department of Geoinformatics, SSAU). The following experts got into the Expert Board of REC: Ph.D. in Engineering N.I. Glumov (Samara-Informsputnik Open Joint Stock Company), Dr. Sc. (Physics and Mathematics) L.L. Doskolovich (IPSI RAS), Dr. Sc. (Physics and Mathematics) I.P. Zavershinskiy (Department of Physics, SSAU), Ph.D. in Engineering N.Yu. Ilyasova (Department of Engineering Cybernetics), Dr. Sc. (Physics and Mathematics) N.E. Molevich (Department of Physics, SSAU), Dr. Sc. (Physics and Mathematics) S.N. Khonina (IPSI RAS).

The Directorate provided operational administration of the Project being based on decisions of the Council of REC 014 and the Expert Board of REC 014. The experience in REC 014 Project management was extremely useful. Main features of this management structure were efficiently used thereafter when preparing tender applications and in implementation of the University Development Program in its new capacity (as the National Research University) and when forming Strategic Academic Units (StrAUs).

One of the first steps of REC 014 was the development of close cooperation with the following Russian academic institutions:

- Computational Center of the RAS and Research Board of the RAS on the Cybernetics Systemic Problem (Moscow), Academician Yu.I. Zhuravlev, Corresponding Member of the RAS (now Academician) K.V. Rudakov, Prof. Dr.Sc. (Physics and Mathematics) V.V. Ryazanov;
- Prokhorov General Physics Institute of the RAS (Moscow), Academician E.M. Dianov, Corresponding Member of the RAS (now Academician) V.I. Konov, Academician I.A. Shcherbakov;
- Kotel'nikov Institute of Radio-Engineering and Electronics of the RAS (Moscow) and the Division of Open Systems of the Council of the RAS, Academician Yu.V. Gulyaev, Academician A.S. Bugaev, Academician N.A. Kuznetsov, Corresponding Member of the RAS S.A. Nikitov, Prof. Dr.Sc. (Engineering) A.Ya. Oleinikov;
- Institute of Laser and Information Technologies of the RAS (Shatura, Moscow region), Academician V.Ya. Panchenko;
- Institute of Automation and Electrometry, Siberian Branch of the RAS (Novosibirsk), Prof. Dr.Sc. (Engineering) V.S. Kirichuk, Dr. Sc. (Engineering) V.P. Koronkevich, Dr. Sc. (Engineeringh) A.G. Poleshchuk, Prof. Dr.Sc. (Engineering) O.I. Potaturkin;
- and many others.

Employees from some academic institutions have being participated in the work of REC 014 as advisers and lecturers since its first days.

The BRHE Program management paid special attention to international scientific co-operation (Fig. 3). Using new opportunities, the staff of REC 014 established new contacts and developed those ones available before. The most effective international cooperation was established with scientists from the following scientific and educational institutions:

- Friedrich Schiller University of Jena (Germany), Professor Rihard Kowarschik;
- Beijing Institute of Technology (China), Academician Zhou Liwei;
- Laser Center Hannover (Germany), Professor B.N. Chichkov;
- Research Center of FIAT (Orbassano, Italy), Dr. Piero Perlo;
- University of Joensuu (Joensuu, Finland), Professor of the Finnish Academy of Sciences Jari Turunen;

- Texas Tech University (Lubbock, TX, USA), Professor Michael Sobolevskiy;
- Abeam Technologies (Castro Valley, CA, USA), Dr. Sergey Babin;
- NetCracker Technology (Waltham, MA, USA), Vice-president M.A. Feinberg;
- University of St Andrews (Great Britain), Dr. Liam O'Faolain;
- and many others.

Fig. 3. Vice-President of the International Commission for Optics (ICO), Academician Jin Guofan (Tsinghua University, Beijing) is lecturing on Binary Optics and Optics of Free Forms for scientists and students of REC 014.

The international and inter-Russian scientific cooperation supported by the BRHE administration facilitated to actively motivate the scientists from REC to publish their results in the best worldwide renowned periodicals [51 – 65], to identify up-to-date research subjects such as formation of nanostructured magnetooptic elements, distributed computer vision systems, methods of analysis of nanoscale images. Some of these key important results were published in the Journal "Computer Optics" [66 – 72]. The use of obtained scientific results in the educational process was facilitated by their synthesis in the form of monographs and reviews [73 – 78].

REC 014 paid careful attention to involvement of young people in research and development activities. Any student could participate in the Project after having passed through a competitive selection procedure. The decision on putting postgraduates and students into the list of performers was made by the REC 014 Expert Council based on their applications. The total amount of individual financial support to young researchers in REC 014 was over 15 % from the average annual grant volume. Totally from 10 to 15 grants were annually allocated for young researchers in REC 014. More than 50 young researchers from REC 014 were participated in grants implementation. Among them were 35 % of young scientists (postgraduates and holders of an Advanced Doctorate) and 65 % of students.

Special care was paid in REC 014 to the work with schoolchildren (Head of this direction – Professor V.S. Aslanov). Based on REC 014 using the funds of the Ministry of Education and Science of the Russian Federation and CRDF, two classes for intensive training on Mathematics, Physics and Computer Studies were organized in the Physical-Mathematical School (PMS) of Samara Aerospace University. Enrollment of schoolchildren to PMS was performed based on their competition scores. Over 250 schoolchildren from Samara took part in the competition.

Development of REC 014 had a significant impact on the educational process and scientific studies at the University. This was considerably facilitated with the fact that by beginning of the Project implementation a high integration level between fundamental studies and higher education had already been achieved under the Integration Federal Target Program that enabled to extend its three-year financing for other three years, whereas for some small projects (such as minigrants or support to young Ph.D. Candidates (Candidates of Science)) financing of REC under the BRHE Program pursued until 2008, and some minigrants were funded by BRHE until 2010.

In a little over six years of the Project implementation (from October 1, 2002 to December 31, 2008), the main results of activities of REC 014 "Mathematical Foundation of Diffractive Optics and Image Processing" were as follows:

- 653 research papers published including 225 papers with the involvement of students and 185 papers prepared by young scientists (most of the articles indexed in SCOPUS and WOS databases);
- 386 reports prepared and made at international conferences including 221 ones with the involvement of students;

- 95 textbooks and study guides and 6 monographs prepared and issued;
- 9 Summer Schools and conferences of different levels held;
- 18 Ph.D. theses and 7 Doctoral theses defended.

The great majority of young Project participants (young researchers, postgraduates and students) having defended their Ph.D. and Doctoral theses with financial support from REC 014 has kept their work at the University or IPSI RAS. Many of them are currently the leaders in scientific and educational activities, have high indices of their publication activities and are in charge of some priority activities of the University and IPSI RAS. The first Pro-rector - Vice-rector for Science and Innovations of Samara University, Dr.Sc. (Engineering) Andrey Bronislavovich Prokofiev and IPSI RAS Deputy Director for Science and Innovations Dr.Sc. (Physics and Mathematics) Roman Vasilievich Skidanov may be considered as an example of researchers having won three-year BRHE scholarships to support research and development of young Ph.D. Candidates.

Thus, REC 014 “Mathematical Foundation of Diffractive Optics and Image Processing” was a basis for forming human resources of the University and IPSI RAS. We have successfully managed in avoiding negative implications of the outflow of young talents from the University during the 1990s. Groups of young researchers and lecturers who currently contribute a lot to the development and improving competitiveness of the University have been formed in the course of the Project implementation.

Experience of participation in the Integration FTP and the BRHE Program had a positive impact on high quality of SSAU’s applications for its involvement in the largest competitions initiated by the Ministry of Education and Science of the Russian Federation – Innovative Education Programs (2006) and on gaining a National Research University status (2009), and our previously obtained competences and expertise allowed us not only to take the lead as competition winners, but also to admirably fulfill all annual goals of the development programs [79].

Close integration helped the SPECTR SEC to win in 2014 a large competition of the Russian Science Foundation (RSF) aimed at setting up new research laboratories by joining efforts of universities and scientific institutions. As a result, in 2014 the Innovative Earth’s Remote Sensing Technologies Research Laboratory was founded in SSAU. To staff a new laboratory with academic personnel, 19 postdoctoral research fellows from IPSI including four holders of an Advanced Doctorate (Doctors of Sciences) took their primary employments at SSAU. Co-financing of the Laboratory from the budget of Samara region has contributed to getting promising results in the field of creating superlight lenses, designing image-forming hyperspectrometers, hyperspectral information processing and development of methods for video data flow computing [80 – 91]. In this regard, the SPECTR SEC staff has won five more RSF grants having provided significant financing of five research teams.

4. Several quantitative indices

In Fig. 4 we have presented a graph describing the dynamics of publications of the SPECTR SEC staff. The major growth of the publications is in the current five years. This growth is provided by the University’s Publication Activity Support Program, as well as by implementation of the Russian Science Foundation projects. Thus, the number of publications in peer-reviewed journals increases [91 – 101]. In particular, in 2016 the SPECTR SEC staff published 98 and 45 papers in journals indexed in the Scopus and Web of Sciences international databases, respectively.

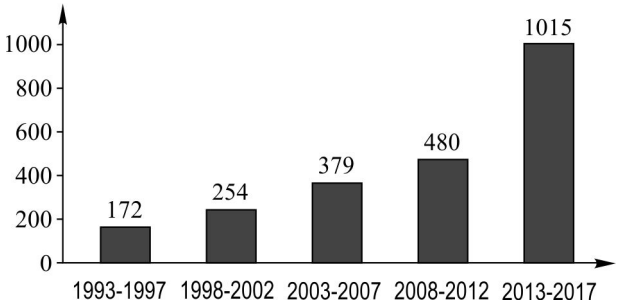

Fig. 4. The dynamics of publications of the SPECTR SEC staff.

The publication activity and a high level of scientific results have contributed to increasing personal bibliometric indices of the SPECTR SEC staff both in the Russian Science Citation Index (RSCI) and in international databases (see Table 1). It is particularly important that not only eminent scientists such as V.A. Soifer, V.V. Kotlyar, S.N. Khonina, L.L. Doskolovich, but also young scientists of thirty – A.A. Kovalev, E.A. Bezus and D.A. Bykov have been included in the best-scientist list.

Table 1. Bibliometric indices of leading scientists from the SPECTR SEC (RSCI and Scopus).

	Name	Publications		References		Hirsch index	
		RSCI	Scopus	RSCI	Scopus	RSCI	Scopus
1	Soifer V.A.	525	229	6722	2704	38	29
2	Khonina S.N.	494	300	4753	2655	32	27
3	Kotlyar V.V.	482	280	4193	2147	31	25
4	Kazanskiy N.L.	402	178	4778	2165	36	29
5	Doskolovich L.L.	303	179	3365	1847	29	25
6	Pavelyev V.S.	200	90	1413	425	14	11
7	Skidanov R.V.	190	104	1847	700	19	14
8	Kovalev A.A.	164	103	1010	645	17	15
9	Kharitonov S.I.	140	52	1526	572	19	14
10	Karpeev S.V.	131	67	764	447	14	13
11	Bykov D.A.	68	52	641	558	15	14
12	Bezus E.A.	64	48	565	465	14	13
13	Volotovsky S.G.	62	38	731	412	16	13
14	Serafimovich P.G.	61	43	440	320	12	10
15	Stafeev S.S.	58	50	308	230	10	9
16	Moiseev M.A.	57	44	333	277	9	9
17	Morozov A.A.	33	52	199	232	8	9

Achievements of the SPECTR SEC staff in scientific and educational activities have been awarded with the following different federal, regional and international prizes and awards:

- 1992 – Russian Federation State Prize in Science and Engineering – V.A. Soifer together with other scientists from Samara University (V.A. Barvinok, V.I. Bogdanovich, P.A. Bordakov, V.I. Mordasov, A.G. Tsidulko, V.P. Shorin), I.N. Sisakyan and some production specialists;
- 1993 – First Prize of the German Informatics Society for the best research in the field of Image Processing and Pattern Recognition – V.A. Soifer and S.N. Khonina;
- 1995 – Order of Honor (V.A. Soifer);
- 1998 through 2017 – regional prizes in Science and Engineering – N.L. Kazanskiy, V.V. Kotlyar, V.V. Sergeev (1998); V.M. Chernov (1999); V.A. Soifer, V.A. Fursov, V.V. Kravchuk (2001); N.I. Glumov, N.Yu. Ilyasova, A.G. Khramov (2003); A.V. Volkov (2007); S.V. Karpeev (2008); L.L. Doskolovich (2009); S.N. Khonina (2010); R.V. Skidanov (2011); V.V. Myasnikov (2012); S.I. Kharitonov (2013); S.B. Popov (2014); A.A. Kovalev (2015); D.L. Golovashkin and E.A. Shchepakina (2016);
- 1999 –Honored Science Worker of the Russian Federation (V.A. Soifer);
- 1999 – Medal to the Order of Merit for the Fatherland, 2nd grade (Kazanskiy N.L.);
- 2000 – V.A. Soifer was elected as a Corresponding Member of the Russian Academy of Science for the Department of Information Technology and Computer Systems of the RAS;
- 2004 – State Prize of the Russian Federation for young scientists in the field of science and technology (D.L. Golovashkin and V.S. Pavelyev);

- 2004 – Order of Merit for the Fatherland, 4th grade (V.A. Soifer);
- 2007 through 2017 – prizes of the Governor of Samara region for technological breakthroughs – V.A. Soifer (2007), V.V. Kotlyar (2013), S.N. Khonina (2015), N.L. Kazanskiy (2016), L.L. Doskolovich and V.V. Sergeev (2017);
- 2008 – Russian Federation Government Award for technological breakthroughs (V.A. Soifer);
- 2008 – Honored Worker of Higher Education of the Russian Federation (V.A. Fursov);
- 2010 – Order of Merit for the Fatherland, 3rd grade (V.A. Soifer);
- 2010 – Russian Federation Government Award in Education (V.A. Soifer together with Academician V.P. Shorin and lecturers from other universities);
- 2011 – Medal and Award of the Russian Academy of Sciences for young scientists following the 2010 competition results (V.A. Kolpakov);
- 2012 – Gold Medal of the World Salon of Inventions in Geneva (Switzerland) – A.G. Khramov jointly with scientists from Samara State Medical University;
- 2014 – Medals of the Russian Academy of Sciences with Awards for young scientists following the 2013 competition results (D.A. Bykov and A.V. Gavrilov);
- 2014 – Scopus Award Russia from Elsevier Publishing House in nomination of Contribution to the Development of Science – V.A. Soifer (jointly with the Russian Foundation for Basic Research);
- 2014 – Honored Science Worker of Samara Region (N.L. Kazanskiy);
- 2015 – Medals of the Russian Academy of Sciences with Awards for university students following the 2014 competition results (E.V. Byzov and S.V. Kravchenko);
- 2015 – Order of Honour of the European Academy of Natural Sciences (Hannover) “For Large Contribution to Research and Development” (V.A. Soifer);
- 2015 – L.L. Doskolovich was elected a Professor of the RAS for the Department of Nanotechnologies and Information Technologies of the RAS;
- 2016 – Scopus Award Russia from Elsevier Publishing House in nomination of Contribution to the Development of Science – N.L. Kazanskiy (jointly with the Ministry of Education and Science of the Russian Federation);
- 2016 – V.A. Soifer was elected a Full Member of the Academy of Sciences of the Russian Federation in the Department of Nanotechnologies and Information Technologies of the RAS;
- 2017 – Honored Science Worker of Samara Region (V.V. Kotlyar).

5. Conclusion

Successful experience with academic institutions explains well all current decisions and achievements of the management team of Samara University on creating a modern university as a shared research and education center based on long-term and close cooperation with advanced high-technology companies.

The value of the University’s integration experience is determined by the fact that during 30 years the University has:

- developed an efficient democratic mechanism of educational and research process administration based on undivided authority;
- provided access for the University’s lecturers, students and postgraduates to participate in academic activities and research programs;
- solved partially a problem of selecting full-time positions for young researchers including those ones required to handle unique research equipment;
- provided opportunities to retain young talents through involving them into research and development activities on grants, state programs and commercial contracts;
- strengthened a fundamental component of research and development that resulted in enhancing publication activity and increasing representation level of obtained results;
- increased considerably a number of Doctors of Physics and Mathematics and formed a network of respective Thesis Boards based thereupon;
- carried out opportunity for joint involvement of the University’s administration and academic staff in large projects not only related to the support of integration processes (the Integration FTP, BRHE, the Cadre FTP), but

also being executed under Federal Target Scientific-and-Technological and Defense Programs, within the framework of competitions on the Decree of the Russian Federation Government No. 218 (support of research and development for the purpose of organization of high-tech manufacturing), the Russian Science Foundation, the Advanced Research Foundation, and in performing large commercial contracts.

All of these factors together have produced a synergy effect having contributed to implementation of the SSAU's Innovative Educational Program "Development of a Center of Excellence and Training of World-class Specialists in Aerospace and Geoinformation Technologies" (2006-2007) and the National Research University Development Program (2009-2018).

SSAU's achievements in fulfilling the above mentioned programs have resulted in increasing the University's influence both in Russia and abroad and allowed SSAU in 2013 to join the first rank of competition winners under the Russian Academic Excellence Project (Program 5-100). The efforts of the administration and staff of the University enabled it to improve its worldwide reputation for the last three years and to promote itself through world university rankings [102].

It should be particularly emphasized that cooperation of the University with academic institutions has significantly influenced both on the University's development and on the development of scientific research in institutions of the Russian Academy of Sciences. Participation of the RAS scientists in the University's educational activities was the main mechanism for attraction talented University's graduates to work in academic institutions. This contributed to renewal of the scientific staff and, ultimately, to improvement of the quality and intensity of fundamental scientific research. Perhaps this is one of the exceptional examples when positive feedback contributes to sustainable development.

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