Ministry of Education and Science of the Russian Federation

Interdisciplinary Research and Educational Strategic Academic Unit (StrAU) of SUSU (National Research University) «Smart Manufacturing»

Moscow, 2017

Contents

I. Executive Summary

The purpose of StrAU creation

To achieve scientific breakthroughs in digital technologies on a global scale by implementing technologies of the Industrial Internet of Things (IIoT) in leading companies of the Greater Urals and Russia.

Challenges	Description
Decline in traditional manufacturing industries	The traditional manufacturing industries, such as metals and machine building, are losing their competitive edge, and regions that are dependent on these industries may miss opportunities for development.
Data explosion	The ongoing data explosion requires efficient data collection, transfer and processing technologies to enable making informed decisions.
Cybersecurity	The implementation of the Industrial Internet of Things will significantly increase the threat of cyberattacks and the scale of its potential impact on mankind.
Environmental threat and climate change	The planet is under threat from irreversible climate change, requiring a reduction in negative environmental factors in tandem with greater resource and energy efficiency. The Greater Urals suffer from environmental degradation.

Focus areas

Priorities

1. Digital twins and model predictive control
2. Machine learning methods and extra-large data mining to solve industrial problems
3. Sensors for the IIoT
4. Information security in industrial systems

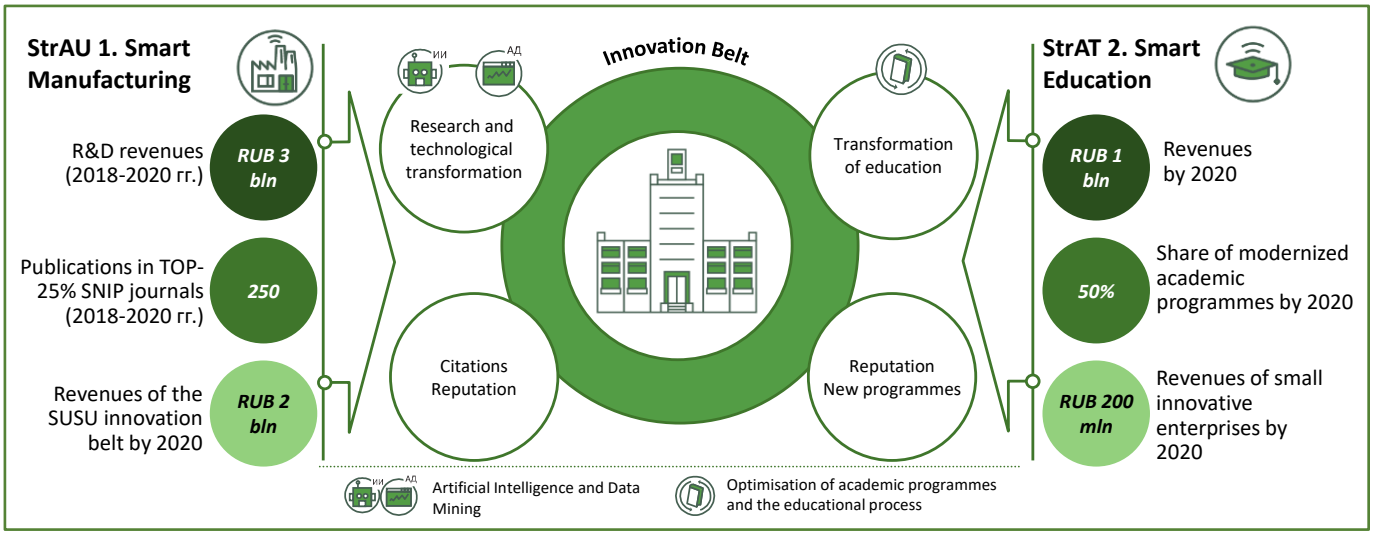
1. Effective and automated machine building based on cutting-edge digital technologies
2. Environmentally friendly and high-quality metals and mining industry with the lowest costs
3. The new economy of the Urals

StrAU's objectives

1. Increase R&D income through the implementation of large-scale comprehensive projects for industrial partners
2. Conduct fundamental and applied research to address global challenges linked to the development of the digital economy
3. Educate a new generation of highly-paid specialists capable of solving global challenges in digital technology fields
4. Popularise the Industrial Internet of Things through international conferences, research and best practice workshops

Results

- The volume of StrAU's R&D contracts exceeds **RUB 3 billion** in 2018-2020**.**
- The number of publications in the **top 25% of SNIP** journals indexed in the SCOPUS database reaches **250** in 2018-2020.
- **The USE score** for the StrAU's academic programmes increases to **80+** by 2020.
- Graduates' **salaries** show faster growth compared to the average rate across the region.
- SUSU climbs into the 300-350 bracket in QS' Computer Science subject ranking by 2020.



StrAU benefits from **SUSU's competitive advantages:**

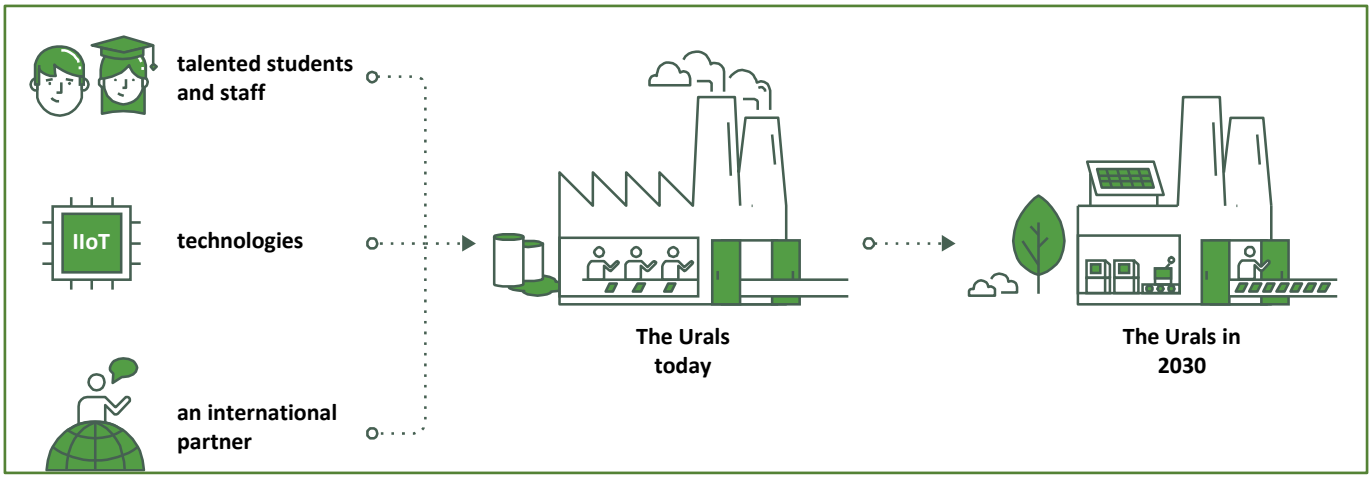
- **Experience in implementing large projects in priority research areas.** In 2014–2016, the volume of SUSU R&D contracts in the priority research areas of the StrAU performed for the Greater Urals' industries reached **RUB 1.05 billion.** A portfolio of large contracts worth RUB **875 million** in the priority research areas of the StrAU's has already been formed for 2018–2020.
- **Close ties with the manufacturing industry.** Key partners include the leading metals company **MMK** (Magnitogorsk Iron & Steel Works), the global industrial automation leader **Emerson Corporation** and the large automotive manufacturer **KAMAZ**.
- **Academic programmes designed to address the challenges that companies face.** Over 1,700 students are enrolled in programmes offered by StrAU in collaboration with industrial partners such as such as **Emerson** (USA), **Endress+Hauser (Switzerland) and Kaspersky Lab (Russia).**

The creation of the StrAU will contribute to the achievement of SUSU's strategic goals:

Research. The successful development of digital solutions for companies will improve non-budgetary income from R&D and will result in an increase in high quality publications in the fastest growing areas of research. The undertaking of comprehensive projects will contribute to improving communication and cooperation among SUSU's key departments.

Education. The implementation of academic programmes in popular fields in cooperation with leading academic and industrial partners in line with a project-based approach will attract the best foreign and Russian applicants, resulting in a higher average USE score.

Innovation and entrepreneurship. The successful implementation of large projects in collaboration with industry leaders will lead to the creation of joint R&D centres, while small innovative enterprises (SIE) will commercialise successful research in engineering and computer sciences. The StrAU will therefore contribute to the sustainable development of the Greater Urals and the creation of a favourable living environment in the region.



Transformation of the University. The StrAU will become a driver of change at SUSU, setting a high standard for research and academic programmes for the entire university due to the involvement of the best staff and the development of a new model of cooperation with leading academic and industrial partners.

Cutting-edge educational technologies. The StrAU «Smart Manufacturing» will work closely with the StrAU «Smart Education». Methods and technologies developed by the StrAU «Smart Education» will be used to support distance learning and academic programmes. The StrAU will also collaborate in research focusing on data mining and artificial intelligence. This will significantly improve the quality of education in the near future.

II. The StrAU passport

1. General information

1.1. List of departments that will be part of the StrAU

The StrAU will be institutionalised as the university's new academic unit that will involve in its activities the best staff from the following departments of SUSU.

Priority research areas	SUSU departments
 **Digital twins and model predictive control**	Department of Computational Mathematics and High-Performance Computing Department of Computer Modelling and Nanotechnologies
 **Machine learning methods and extra-large data mining to solve industrial problems**	Laboratory for Problem-Oriented Cloud Computing Environments (supervised by Andrey Chernykh of the CICESE Research Centre; h-index 12) Interdepartmental University Laboratory for Math Modelling and Computer Technologies
 **Sensors for the IIoT**	Laboratory for Self-Monitoring and Self-Validating Sensors and Systems (supervised by Henry Manus from the University of Oxford; h-index 12) Emerson PlantWeb Laboratory Endress+Hauser Laboratory Department of Information and Measurement Technology
 **Information security in industrial systems**	Kaspersky Lab's Information Security Research and Education Centre Department of Information Security

The StrAU will also actively cooperate with the following SUSU departments:

1. Supercomputer Modelling Laboratory: http://supercomputer.susu.ru/
2. Computer Engineering Centre: http://www.engineering.susu.ru, including the Laboratory of Digital Engineering Technologies established with **Siemens** in 2017.
3. Education Equipment and Technologies Institute.

1.2. StrAU leader

The proposed candidacy for leadership of the StrAU for 2018-2020 is **Radu Prodan**, h-index – 26, Associate Professor. Institute for Computer Science, University of Innsbruck, Austria.

1.3. Description of the StrAU' key educational programmes

Over 1,700 SUSU students study in the Smart Manufacturing StrAU: 1,446 undergraduates (bachelor's programmes) and 257 postgraduates (master's programmes). Many of SUSU's foreign students are StrAU enrollees.

All StrAU academic programmes will be updated to meet the principles of the SUSU 2018-2020 Roadmap: prioritising students' interests, enhancing the efficiency of the educational process, cultivating the university's social values, a focus on expected results and accessible education.

Current academic programmes:

№	Programme	Key Russian and foreign partners	Number of students
Master's programmes (in English)			
1.	Development of Database Management Systems	Lappeenranta University of Technology (Finland)	37
Master's degree programmes (in Russian)			
2.	Fundamental Informatics and Computing Sciences	The Russian Federal Nuclear Center - Zababakhin All-Russian Scientific Research Institute of Technical Physics, SKB-Kontur	100
3.	Infocommunication Technologies (ICT) and Electronic Meters	ChRP Polyot	39
4.	Instrument Engineering (in collaboration with Emerson Process Management)	Emerson Process Management	39
5.	Engineering Systems Management	Endress+Hauser	42
Bachelor's and specialist programmes (in Russian)			
6.	Fundamental Informatics and Computing Sciences	The Russian Federal Nuclear Center - Zababakhin All-Russian Scientific Research Institute of Technical Physics, SKB-Kontur	529
7.	Information Security in Industrial Enterprises	Kaspersky Lab	232

8.	Infocommunication Technologies (ICT) and Electronic Meters	ChRP Polyot	282
9.	Instrument Engineering (in collaboration with Emerson Process Management)	Emerson Process Management	156
10.	Engineering Systems Management	Endress+Hauser	247

All master's engineering programmes feature mandatory courses on supercomputer technologies for engineering purposes.

Of all the current educational opportunities, the following flagship StrAU programmes are worthy of special mention:

Industrial Automation and Instrument Engineering (bachelor's and master's programmes) is implemented on the basis of an in-house educational standard developed during our unique ten-year collaboration with **Emerson Process Management** (USA). The standard is based on the following guiding principles:

1. A focus on training to use measuring equipment and develop measuring systems.
2. A new professional competencies structure that draws from the expertise of leading Russian universities and modern industrial enterprises.
3. In-depth practical training supported by a cluster of laboratories, empowering learning and research activities through unique modern equipment.
4. Close collaboration with the Emerson Corporation, a global leader in industrial automation.

A significant number of graduates of the programme work as department heads for Emerson. Their **compensation is higher than the region's average salary by 150-200%**.

Development of Database Management Systems is one of the SUSU master's programmes focused on English-speaking students and implemented in collaboration with Finland's Lappeenranta University of Technology. Over 30 students successfully completed the programme in the past four years. Postgraduates in the master's programme who excel in their fields of study and speak English can study abroad at Lappeenranta University of Technology in their second year and major in one of the following areas:

1. **Software Engineering**.
2. **Intelligent Computing**, subspecialisation **Computer Vision.**

Students are required to defend their master's graduate thesis at both universities in English to receive diplomas from SUSU and Lappeenranta University of Technology.

Graduates of the programme work as senior developers and executives in foreign companies in Southeast Asia and countries of the Middle East, and also pursue PhD studies.

Engineering Systems Management (master's programme**)** benefits from the unique laboratory facilities of Endress+Hauser that helps students to learn and practice APCS commissioning using real equipment and sensors. Students have access to a distributed power management system on the university campus that is unique among Russian higher education institutions to work on their research projects.

A significant share of graduates work for the leading technology companies. Their **compensation exceeds the region's average salary twofold.**

SUSU works with other Russian and foreign partners in implementation of its academic programmes:

1. **SMS Group (Germany)** is a co-investor in the Laboratory for Mechanics, Laser Processing, and Digital Technology and is a strategic industrial partner. SMS Group provides internships to SUSU students and staff.
2. **Kaspersky Lab (Russia)** collaborates with SUSU in developing and implementing joint educational programmes, including major and supplementary educational programmes.
3. **National Engineering School of Saint-Étienne (France).**
4. **Internship partners** include Magnitogorsk Iron and Steel Works, Chelyabinsk Zinc Plant, the Russian Federal Nuclear Centre, SKB Kontur, Russian Railways and others.

SUSU graduates in the fields of computer sciences and engineering are highly competitive in the labour market in Russia and abroad, being co-founders of and working as leading specialists for global IT corporations, including Google (US), Rakuten (Japan), Huawei Technologies (China), SonarSource (Switzerland), Yandex (Russia) and Lyft (USA), in which Alexey Zakharov, a SUSU alumnus, heads Android development. A representative list of alumni of one of the departments of the StrAU can be found here: http://eecs.susu.ru/ru/alumni/.

1.4. Research, R&D and engineering projects: key focus areas

In 2014-2016, the total amount of concluded R&D contracts related to the StrAU key focus areas was **RUB 1.05bn,** while the total value of client-oriented R&D activities carried out by SUSU over the past three years in key industries exceeded **RUB 2.1bn**.

Focus area 1: Digital twins and model predictive control	RUB 368m 
Main project (1): «Development of model predictive control systems for technological processes».	

Key results: Cloud platform architecture for digital twins of industrial enterprises and a system of model predictive control that minimises natural gas consumption in the central power station of the Magnitogorsk Iron and Steel Works were designed. The positive economic effect of the solution for MMK is RUB 50m annually.

Project leader: Lev Kazarinov, Chair of the Department of Automated Control Systems, Doctor of Technical Sciences, Professor.

Key partners:

- Magnitogorsk Iron and Steel Works - key client.
- Peter the Great St Petersburg Polytechnic University - jointly designed academic programmes on automated control systems.

Project timeline: 2014-2016.

Client: Magnitogorsk Iron and Steel Works.

Examples of publications in the top 10% of SNIP journals over the past three years:

Title	Journal	Authors	SNIP
A methodology to design a 3D graphic editor for micro-modeling of fiber-reinforced composite parts	*Advances in Engineering Software*, Volume 90, 19 August 2015, Pages 76-82	Shchurova, C.I.	1.950
Mathematical model of plowing forces to account for flank wear using FME modelling for orthogonal cutting scheme	*International Journal of Advanced Manufacturing Technology*, Volume 89, Issue 9-12, 1 April 2017, Pages 3149-3159	Pimenov, D.Y., Guzeev, V.I.	1.548
Automatic system for intelligent support of continuous cast billet production control processes	*International Journal of Advanced Manufacturing Technology*, Volume 74, Issue 9-12, 7 October 2014, Pages 1407-1418	Logunova, O.S., Matsko, I.I., Posohov, I.A., Luk'ynov, S.I.	1.548

Focus area 2: Machine learning methods and extra-large data mining to solve industrial problems | RUB 365m

Main project (2): «Development of parallel extra-large data processing technologies using columns and data compression through cluster computing systems powered by multicore accelerators».

Key results: Parallel algorithms for tracking similar sub-sequences in a super-large time-series for cluster supercomputer systems that use Intel multicore CPUs surpassing similar existing systems were developed.

Project leader: Leonid B. Sokolinsky, Doctor of Science in Physics and Mathematics, Professor.

Key partners:

- Heidelberg University Institute for Computer Science (Germany) – joint research into parallel algorithms of smart extra-large data mining.
- RSC Technologies (leading Russian and CIS developer and integrator of HPC solutions) – commercialisation of research by installing software to run parallel algorithms of smart extra-large data mining on computing clusters supplied to data centres in Russia and abroad.

Project timeline: 2014-2016.

Client: The Russian Foundation for Fundamental Research.

Main project (3): «Development of a digital mock-up model and establishment of high-tech manufacturing of a next-generation energy-efficient transmissions for trucks and buses».

Key results: Researchers developed a method of digital engineering of drive axle for trucks and buses, including engineering solutions tested during the early design stages with the help of digital models, development and verification of smart models of drive axles.

Project leader: Andrei Keller, Doctor of Engineering, Professor.
Key partners:

- KAMAZ - key client.
- Supercomputer Modelling Laboratory - provides resources for the computer modelling of technological processes.

Project timeline: 2014-2016.
Client: KAMAZ.

Examples of publications in the top 10% of SNIP journals over the past three years:

Title	Journal	Authors	SNIP
Neural network approach for automatic image analysis of cutting edge wear	*Mechanical Systems and Signal Processing*, Volume 88, 1 May 2017, Pages 100-110	Mikołajczyk, T., Nowicki, K., Kłodowski, A., Pimenov, D.Y.	3.023
Model of the Newtonian cosmology: Symmetries, invariant and partially invariant solutions	*Communications in Nonlinear Science and Numerical Simulation*, Volume 39, October 01, 2016, Pages 248-251	Klebanov, I., Startsun, O., Ivanov, S.	1.574
Minimisation of turning time for high-strength steel with a given surface roughness using the Edgeworth–Pareto optimization method	*International Journal of Advanced Manufacturing Technology*, 1 July 2017, Pages 1-18	Abbas, A.T., Pimenov, D.Y., Erdakov, I.N., Mikolajczyk, T., El Danaf, E.A., Taha, M.A.	1.548

Focus area 3: Sensors for the IIoT — RUB 298m

Main project (4): «Development of smart meters and control methods for system self-monitoring».

Key results: researchers developed self-controlling pressure sensors and signal parameter assessment algorithms that enable super-resolution; self-diagnosing and metrological self-monitoring sensors were designed.

Project leader: Alexander Shestakov, Doctor of Technical Sciences, Professor.
Key partners:

- Oxford University – joint research into flow measurement.

- Mendeleev All-Russian Institute for Metrology – collaborated on developing methods of metrological self-monitoring.
- Emerson Corporation – developed a test bed to carry out research on digital industrial distributed systems, self-monitoring pressure sensors and sensor calibration efficiency.

Project timeline: 2014-2016
Client: The Emerson Corporation and the Russian Foundation for Fundamental Research.

Based on the results of the project, an article '*Wireless acceleration sensor of moving elements for condition monitoring of mechanisms*' was published in the Q1 SNIP journal **Measurement Science and Technology Impact Factor** with an impact factor of **1.492** in **2017**.

Main project (5): «Development of an energy-efficient, real-time geo-information system to optimise control of a municipal entity's heating and water supply».

Key results: An algorithm was designed for the multiparameter analysis of technological heating processes, including the possibility to predict and optimise energy consumption and streamline heating flow management in heating supply networks to save up to 25% of the heating energy.

Project leader: Alexander Dyakonov, Doctor of Technical Sciences, Professor.
Key partners:

- Russian instrument engineering company Control Systems, who also happened to be the client.

Project timeline: 2014-2016.
Client: Control Systems.

Examples of publications in the top 10% of SNIP journals over the past three years:

Title	Journal	Authors	SNIP
Giant faraday rotation of high-order plasmonic modes in graphene-covered nanowires	*Nano Letters*, Volume 16, Issue 7, 13 July 2016, Pages 4391-4395	Kuzmin, D.A., Bychkov, I.V., Shavrov, V.G., Temnov, V.V.	2.584
Detection of structural changes through principal component analysis and multivariate statistical inference	*Structural Health Monitoring*, Volume 15, Issue 2, 1 March 2016, Pages 127-142	Pozo, F., Arruga, I., Mujica, L.E., Ruiz, M., Podivilova, E.	1.641
Joint effect of polarization and the propagation path of a light beam on its intrinsic structure	*Optics Express*, Volume 24, Issue 17, 22 August 2016, Pages 19157-19166	Abdulkareem, S., Kundikova, N.	1.589

1.5. Current list of external StrAU beneficiaries

The Smart Manufacturing StrAU will radically transform the university by developing competencies needed to become a world-class research university. A large number of diverse stakeholders will benefit from activities of the StrAU as a result of its development, including the leading international and Russian industrial enterprises, R&D centres, universities, the Chelyabinsk region and the city of Chelyabinsk, and local communitries.

The current partnership with **Emerson** (USA), which operates in the Greater Urals as a result of the acquisition of Metran, a former local instrument engineering company, is a perfect example of the Smart Manufacturing StrAU's beneficial impact. Emerson is already involved in SUSU educational programmes that are built on project-oriented educational approaches, and new joint bachelor's and master's programmes will be implemented as part of the StrAU. Moreover, Emerson commissions research in the StrAU's major areas of study. SUSU completed a distributed virtual test bed project for Emerson. Emerson is also a key employer for graduates of some of the academic programmes of the StrAU.

An excellent example of the advantages of StrAU development for external organisations is the model demonstrated during a project on additive technologies implemented together with the **SMS Group** and **the National Engineering School of Saint-Etienne** in **2016-2017**, with whom SUSU established a joint laboratory. The project featured research, educational and innovative components. A leading international scientist, along with major industrial and academic partners, carried out the project, which provided an innovative solution for MMK located in the Greater Urals. PhD and master's students of SUSU went to study at ENISE with support of the Erasmus+ program in 2016-2017.

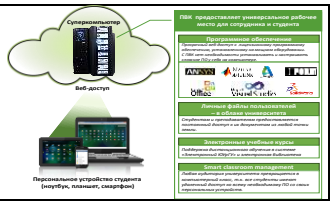
Oxford University (UK) – joint research on algorithms for self-diagnostic sensors of pressure, temperature, vibration. Oxford and SUSU are developing a versatile digital transmitter that uses the Prism algorithm originally designed at Oxford University under the leadership of Manus Henry, head of the SUSU Laboratory for Self-Monitoring and Self-Validating Sensors and Systems.

SUSU cooperates with **Kaspersky Lab** on research into information security in industrial systems and benefits from its expertise in the joint master's programmes on Network Security, Information Security in Open Systems, Protection of Information in the Internet, Computer Virology and Modelling of Information Resistance to Information Security Threats.

Magnitogorsk Iron and Steel Works – commercialization of SUSU research (application of algorithms developed at the university for the smart analysis of data from equipment condition sensors to predict industrial equipment failures, preventive maintenance planning) and R&D involvement (collection and provision of realistic datasets for computing exercises).

Priority areas	Beneficiaries
 **Digital twins and model predictive control**	Rostec KAMAZ Chelyabinsk Zink Plant Uralvagonzavod Chelyabinsk Pipe-Rolling Plant VSMPO-Avisma EVRAZ
 **Machine learning methods and extra-large data mining to solve industrial problems**	Heidelberg University Institute of Informatics (Germany) Rostelecom Roskosmos Rosatom Rosneft Ensenada R&D and Higher Education Centre (Mexico) ZAO RSK Technologies UEC-Perm Engines
 **Sensors for the IIoT**	Endress+Hauser (Switzerland) Mendeleev National R&D Institute of Metrology Penza State University Volgodonsk Engineering Institute of the National Nuclear Research University MEPhI
 **Staff and postgraduate exchange programmes, development of joint bachelor's and master's programmes and dual PhD programmes**	Endress+Hauser (Switzerland) Rostock University (Germany) Central Lancashire University (UK) Aalborg University (Denmark) Lappeenranta University of Technology (Finland) Jordan University (Jordan) St Petersburg Polytechnic University Ural Federal University
 **Development of innovation and entrepreneurship**	Government of the Chelyabinsk Region Administration of the City of Chelyabinsk SUSU innovation belt: • GalSen • Ural Engineering Centre • Regional Engineering Centre of Additive and Laser Technologies

1.6. StrAU infrastructure

<table>
<tr><th>№</th><th>Name</th><th>Cost</th></tr>
<tr><td>1</td><td>Supercomputer Modelling Laboratory computational resources  </td><td>RUB 450 million</td></tr>
<tr><td colspan="3">The Supercomputer Modelling Laboratory is equipped with modern supercomputers:
The Tornado SUSU, with a peak capacity reaching 473.6 teraflops
The SKIF Aurora, with a peak capacity reaching 117 teraflops
The SKIF Ural, with a peak capacity reaching 16 teraflops
Over the past three years, SUSU supercomputer capacity has powered over 150 research projects resulting in over 100 publications ranked by Scopus and Web of Science.</td></tr>
<tr><td>2</td><td>Emerson PlantWeb laboratory  </td><td>RUB 29 million</td></tr>
<tr><td colspan="3">This laboratory is based on Emerson equipment. Emerson is a US-based global leader in manufacturing automation equipment. The lab uses DeltaV 12.0, a scalable engineering management system based on PlantWeb architecture. This system features Asset Management Solutions, a programme that enables the calibration, configuration and diagnostics of field equipment. DeltaV 12.0 may be applied for manufacturing automation purposes.</td></tr>
<tr><td>3</td><td>Endress+Hauser APCS Laboratory  </td><td>RUB 20 million</td></tr>
<tr><td colspan="3">This laboratory features a network of operator stations and a complex rig for learning and laboratory purposes. Working on their projects, young researchers have access to a distributed power management system on the university campus that is unique among Russian institutions of higher education. The distinctive feature of this distributed power management system is that it is designed as an open energy supply system that can channel energy surplus to external city grids.</td></tr>
<tr><td>4</td><td>Personal Virtual Computer (http://pvc.susu.ru)  </td><td>RUB 20 million</td></tr>
<tr><td colspan="3">Based on the SKIF Ural supercomputer, SUSU operates a unique personal virtual computer that provides remote access to laboratory facilities and specialised licenced software, and to the university’s educational portals for students and professors. The PVC enables a wide range of modern concurrent software solutions: ANSYS (CFX, Mechanical, EM), Fluent, Maxwell, ТЕСИС FlowVision, OpenFOAM, LS-DYNA, SFTC DEFORM, SolidWorks, MATLAB, etc.</td></tr>
</table>

2. StrAU academic development plans

2.1. Modernisation of academic programmes

The StrAU will accept and develop proposals to create new bachelor's, master's and PhD programmes in the fields of IT, computer sciences, mathematics, project and IT management, and it will also modernize and expand the existing programmes. The ultimate goal is the **international accreditation of all StrAU programmes,** including the English-taught master's programmes in accordance with the requirements of the European Quality Assurance Network for Informatics Education (EQANIE) in the Accreditation Agency Specialised in Accrediting Degree Programmes in Engineering (ASIIN).

ACADEMIC PROGRAMMES TO BE IMPLEMENTED

№	Programme	Target employers	Number of students in 2020*
Master's programmes (in English and Russian)			
1.	High-load computational systems (in collaboration with Intel)	Google, Yandex, LuxSoft, SKB Kontur	60
2.	Data Mining and Methods of Artificial Intelligence (in collaboration with NVidia)	Yandex, Google, Rostelecom	80
3.	Control Systems for Smart Industry (in collaboration with NVidia)	Siemens, SMS group, Emerson, Endress+Hauzer	50
4.	Industrial Sensors and Internet of Things (in collaboration with Emerson)	Emerson, General Electric	50
Master's programmes (in Russian)			
1.	Cybersecurity of high-load and industrial systems (in collaboration with Kaspersky Lab)	Rostelecom, Kaspersky Lab	50
Bachelor's programmes (in English and Russian)			
1.	Software Engineering of Cloud Systems	Yandex, LuxSoft	150
2.	Internet of Things: Sensors and Networks	Elmetro, Emerson	120
3.	Cyberphysical systems	KAMAZ	120

4.	Industrial Control Systems	Emerson	100
		Всего:	**780**
** The studies of at least half of these students will study on a contract basis.*			

Some of the most promising new academic programmes in StrAU should be mentioned:

Cybersecurity of high-load and industrial systems. The multidiscplinary Information Security Research and Education Centre (REC) created by SUSU with Kaspersky Lab will be widely used to train master's students in this field. The joint REC has already implemented a number of academic programmes using Kaspersky Lab's security analysis software, which is based on the heuristics for the comprehensive analysis of high-load systems. The presence of specialised laboratories at SUSU allows the university to train master's students in analysing the protection of automated production process control systems. In addition, the use of Kaspersky Lab's global expertise and cutting-edge cybersecurity technologies raises the level of training of industrial systems information security specialists to global standards.

Control Systems for Smart Industry (in collaboration with the SMS Group): As part of this programme, master's students will learn the fundamentals of the structure of a cyber-physical system, in which the system components detect and interact with each other using various signals. The students will use the SMS Group's software package for their studies, which will enable them to model digital production, carry out virtual commissioning and virtually control the system.

Industrial sensor-based systems and the IoT (in collaboration with Emerson): As part of this programme, Emerson provides its PlantWeb lab hardware, which enables the simulation of power metering and regulation systems and, afterwards, modelling production based on the analysis of data collected from actual sensors. This enables the implementation of educational projects to address problems like creating digital twins of actual equipment, the technological process and the enterprise as a whole. The future intention is to use the production of digital twins for trainings in intelligent production controls, in which all changes are made in the digital twin.

SUSU and PwC will jointly create a research and education centre to actively promote the Industrial Internet of Things (IIoT) and cooperate in education. Partnering with PwC will allow StrAU students to participate in case competitions, attend lectures of leading experts, undertake internships at PwC offices and engage in consulting projects on the IIoT.

As part of the plans for StrAU development, new educational technologies will be introduced in relevant courses in accordance with the **new tutorial paradigm**:

1. The **application of mixed-learning principles based on the Smart Education StrAU's platform and methodologies,** which will significantly improve the educational process' quality and flexibility.
2. Academic programmes will be built **according to the StrAU Industrial Council's recommendations. The academic process will be** managed in close cooperation with partner

companies, including through the **engagement of companies' leading specialists to teach in at least 50% of courses and** the use of partners' industrial facilities.

3. **The implementation of a team-based approach to bachelor's and master's programmes,** which will help students develop independent thinking skills and new approaches to solving R&D and business problems. Students will do **internships at the facilities of leading academic and industrial partners in Russia and abroad.**
4. **The development of soft skills and entrepreneurial competencies.** Each StrAU programme will integrate entrepreneurial and soft-skill development modules so that each graduate has the necessary skills to work efficiently in teams and be innovative during their careers.
5. All StrAU students will have **intensive language training** with mandatory international certification (IELTS).

2.2. Measures aimed at development of faculty members and research staff

1. **The supervisors of academic programmes** and faculty members **will be selected from international candidates on a competitive basis, which will ensure the best teaching of various disciplines by the best teachers using their proprietary methodologies.**
2. Faculty members will be encouraged to develop and use MOOCs in their teaching and to continue their own lifelong learning. In particular, with the support of the Smart Education StrAU, faculty members will **develop communication skills** through special courses and trainings and **learn how to effectively use modern learning management systems (LMS).**
3. Faculty members will go on short-term secondments to leading Russian and international universities to learn new teaching methods. The StrAU faculty **will study English** and have mandatory international certification exams at the end of the course.
4. **A regular feedback system** will be in use based on student surveys at the end of each course, as well as feedback from colleagues and external experts on each academic module. For feedback purposes, the students will have full access to all course materials.
5. StrAU will **invite guest lecturers from top Russian and international universities to** lead individual modules of academic programmes. The StrAU **will invite specialists from the corporate sector to teach** to make SUSU academic programmes more practice-oriented.

3. R&D development plans

3.1. List of R&D priorities/relevant StrAU engineering projects

StrAU research areas are focused on creating efficient and automated engineering techniques supported by the latest digital technologies as well as eco-friendly and cost-effective metallurgy, thus contributing to the new economy of the Urals. Within these research areas, SUSU will implement complex interdisciplinary projects in cooperation with leading global companies to embed IIoT solutions that are customised to the client's needs. An emerging consortium of our major partners with expertise in various industries (Siemens, SMS Group, Emerson [industrial automation], Kaspersky Lab [cyber-security] and PwC [advisory services in the field of operating efficiency and business model development]) will help achieve these goals.

Overall, the planned project portfolio for 2018-2020 amounts to **RUB 2.7m. The portfolio** will expand through targeted measures aimed at promoting collaboration in priority industries from the SUSU Roadmap, including implementing roadmaps to establish business partnerships and industrial councils.

Focus area 1: Digital twins and model predictive control	RUB 500 mln 

Main project (1): To create an industrial cloud platform to maintain digital twins; developing and implementing a multifactor optimisable system of regulation of automated steam boiler and turbine generators in the central power station of the Magnitogorsk Iron and Steel Works; and developing methods for planning flow application and algorithms to carry out engineering analyses in distributed computing environments.

Client and leading partner: Magnitogorsk Iron and Steel Works

Core deliverables: To implement model predictive control for engineering processes based on predictions of the condition of the equipment that are obtained from digital twins. For computer modelling, this cloud platform will use developed algorithms for cloud resource planning to factor for uncertainty.

Focus area research results: Cumulative number of publications in the top 25% according to Scopus and/or Web of Science in 2018-2020 - 50.

Connection to education: Research results will be included in Control Systems for Smart Industry (English-language master's programme) and Cyber-Physical Systems (bachelor's programme).

Academic partners:

1) Ensenada Centre for Scientific Research and Higher Education (Mexico) – joint research in cloud resource planning.
2) University of Texas (USA) – cooperation in creating computer models for physical equipment (the "digital twins").

Industrial partners:

3) Emerson Corporation (USA) – joint R&D projects to design cloud-based solutions for digital manufacturing.
4) Magnitogorsk Iron and Steel Works (Russia) – commercialisation of SUSU research (creating digital twins for industrial equipment to predict the condition of certain equipment)

Focus area 2: Machine learning methods and extra-large data mining to solve industrial problems	RUB 910 mln 

Main project (2): To create a digital platform for the Future Factory to design and develop globally competitive cargo vehicles for **KAMAZ** based on the multicriteria optimisation of subsystems through highly adequate digital models.

Client and leading partner: KAMAZ

Core deliverables:

1. To develop a platform ensuring end-to-end digital design and multicriteria optimisation in a single KAMAZ-SUSU environment for best-in-class cargo vehicle systems, assembly blocks and units.

2. Following the model of an energy-efficient, premium-class MST KAMAZ (waste collection truck), methodologies for the multicriteria optimisation of truck systems at the design stage were developed to create an engineering concept beyond the chief engineer's comprehension and reduce the amount of subsequent field testing (simulation-based design).
3. A virtual test site was created for cargo vehicle systems, assembly blocks and units based on the cloud platform for digital twins.

Focus area research results: Cumulative number of publications in the top 25% according to Scopus and/or Web of Science in 2018-2020 - 50.

Connection to education: Research results will be included in Data Analytics and Artificial Intelligence Methodologies (English-language master's programme) and Cyber-Physical Systems (bachelor's programme).

Academic partners:

1) Heidelberg University Institute for Computer Science (Germany) – joint research in parallel algorithms for smart extra-large data mining.
2) Lappeenranta University of Technology (Finland) – joint research in parallel algorithms of image analysis and pattern recognition.
3) Database R&D Team of the Institute for System Programming of the Russian Academy of Sciences (led by S.D. Kuznetsov).
4) St Petersburg State University Data Analytics R&D team (led by B.A. Novikov).

Industrial partners:

5) Intel Corporation – joint academic programmes in parallel programming of algorithms for data analytics.
6) RSC Technologies – commercialisation of research (installing software to run parallel algorithms for smart extra-large data mining in computing clusters supplied to data centres in Russia and abroad).

Leading researchers:

1. Professor A. Andreyak, leader of the Parallel and Distributed Systems R&D team from Heidelberg University Institute for Computer Science (H-index - 15).
2. Florian Skopik, Senior Scientist in the ICT Security Research Team at the Austrian Institute of Technology (H-index - 13).
3. Professor Paulo Simões, PhD, University of Coimbra (Portugal), Centre for Informatics and Systems (CISUC), Computer Communications (Networks), Computer Security and Reliability (H-index – 8).
4. Martin McGinnity, Pro Vice-Chancellor and Head of College School, College of Science and Technology, Nottingham Trent University (UK) (H-index - 22).

Focus area 3: Sensors for the IIoT | RUB 900 mln

Main project (3): To design a Coriolis flow meter that measures multiphase flows and receives data through IIoT sensor networks based on supercomputer modelling, neural networks and digital twins. This device will ensure highly accurate max flux values when measuring the volume and mass criteria for a compound gas-liquid mixture.

Focus area research results: Cumulative number of publications in the top 25% according to Scopus and/or Web of Science in 2018-2020 - 50.

Connection to education: Preparing bachelor's and master's students within the StrAU framework in the IoT: Sensors and Networks programme and the Industrial Sensors and Internet of Things programme.

Partners:

1. ROSATOM Corporation (Luch Research and Development Institute, Hydropress Research and Industrial Association, Research and Development Institute of Automatics and Electrical Engineering), OAO Teplopribor – developing hardware and software for thermal converter monitoring.
2. Emerson Corporation – joint R&D on flow meter development.
3. ELMETRO – industrial partner.
4. Oxford University – joint research on signal processing, measuring equipment and self-diagnostics.

Main project (4): To develop and organise a cyber-physical system based on long-distance wireless sensor networks for monitoring, collecting and storing condition sensor data from an enterprise's power systems and utilities.

Core deliverables: To develop a cloud platform to detect hidden data trends and anomalies produced by sensor networks in the IIoT. This cloud platform will enable interaction between sensors and equipment to create digital twins of power systems, efficiency projections and work planning, and to take prompt measures to improve equipment operations.

Focus area research results: Number of publications in the top 25% according to Scopus and/or Web of Science in 2018-2020 (cumulatively) - 50.

Connection to education: The research results will be included in Control Systems for Smart Industry (English-language master's programme) and Cyber-Physical Systems (bachelor's programme).

Focus area 4: Information security in industrial systems	RUB 400 mln 

Main project (5): To develop a complex cyber-security system for corporate automated process control systems (APCS) using algorithms based on machine learning and specific heuristic methods for anomaly detection in industrial processes.

Core deliverables: To implement software that analyses corporate APCS based on benchmark data protection models and that detects anomalies and assesses APCS security levels against technology-related risks and regulatory requirements.

Focus area research results: Cumulative number of publications in the top 25% according to Scopus and/or Web of Science in 2018-2020 - 50.

Connection to education: Research results will be included in Information Security for Industrial Enterprises (bachelor's programme) and Cyber-security for High-Load and Industrial Systems (English-language master's programme), and they will be used in professional development programmes for industry leaders' personnel.

Partners:

1. Russian Federal Agency for Technical and Export Control (FATEC) – contracted to develop certified information security tools of a new standard.
2. Kaspersky Lab – uses patented heuristics for comprehensive system security analyses.
3. Austrian Institute of Technology – joint research in cyber-physical risk management.
4. Emerson Corporation – joint research on security risk analysis for Ovation APCS.

Leading researchers:

1) Professor Helge Janicke, Professor in Computer Science, Head of the School of Computer Science and Informatics, Head of the Cyber-Technology Institute (CTI), De Montfort University (UK) (H-index - 7).
2) Florian Skopik, Senior Scientist in the ICT Security Research Team at the Austrian Institute of Technology, (H-index – 13).
3) Professor Paulo Simões, PhD, University of Coimbra (Portugal), Centre for Informatics and Systems (CISUC), Computer Communications (Networks), Computer Security and Reliability (H-index – 8).
4) Franck Leprévost, Professor of Computer Sciences at the University of Luxembourg, expert in cryptography and algorithmic theory of numbers (H-index - 4).

3.2. Measures aimed at development of faculty members and research staff

Leading scientists who are expected to join activities of the StrAU:

Photo	Name, surname	Position	Research Interests
	Rajkumar Buyya, **h-index 74**	Professor, Director of the Cloud Computing and Distributed Systems (CLOUDS) Laboratory, University of Melbourne, Australia	• Internet of things • Cloud computing • Distributed computing
	Radu Prodan, **h-index 26**	Associate Professor, Institute for Computer Science, University of Innsbruck, Austria	• Parallel and distributed systems • Cloud computing • High-performance scientific computing
	Sergey Andreev, **h-index 18**	Senior Researcher, Tampere University of Technology, Finland	• Wireless and heterogeneous networking • Machine-to-machine applications • Energy efficiency
	Paulo Leitão, **h-index 18**	Professor of Electrical Engineering, Polytechnic Institute of Bragança, Portugal	• Intelligent and reconfigurable systems • Cyber-physical systems • Factory automation, multi-agent and self-organized systems

	Günther Schuh, **h-index 16**	Prof. Dr.-Ing., Division Director, Fraunhofer Institute for Production Technology IPT, Aachen, Germany	• Production management • Factory planning, production planning issues • Innovation management
	Birgit Vogel-Heuser, **h-index 16**	Prof. Dr.-Ing., Institute of Automation and Information Systems, Technische Universitat Munchen, Germany	• Modeling of distributed embedded systems in automation control • Human Machine Interaction in process engineering
	Florian Skopik, **h-index 11**	Senior Research Scientist, Center for Digital Safety and Security, AIT Austrian Institute of Technology	• Critical infrastructure protection • Smart grid security • National cyber security and defence
	Goran Putnik, **h-index 10**	Professor, Escola de Engenharia da Universidade do Minho, Portugal	• Software, Manufacturing and Industrial Engineering • Computational Intelligence • Cognitive Science and Artificial Thinking
	Thomas Bauernhansl **h-index 7**	Professor, Director Fraunhofer Institute for Manufacturing Engineering and Automation, University Stuttgart	• Industry 4.0 • Digital production • Plant economics and manufacturing technology
	Reiner Anderl, **h-index 7**	Professor of Computer Integrated Design, former Dean of the Mechanical Engineering Department, Technische Universitat Darmstadt	• Virtual product creation and computer-aided design • Collaborative and distributed product development • Knowledge-based product development

Actions aimed at research and teaching staff development:

1. The faculty members in the StrAU will be **selected from international candidates on a competitive basis** while the most distinguished SUSU staff will be selected based on the results of their previous work in line with KPIs.
2. **StrAU will invite talented postdocs** to teach and carry out research at SUSU.
3. **Long-term secondments for postgraduates and young researchers** in leading international universities and large enterprises, along with **participation in prestigious international conferences**, will become an essential staff development tool.
4. **The StrAU faculty will study English** and take mandatory international certification exams.
5. **The StrAU research staff will study project management, communication and entrepreneurship skills**, and they will get access to funding to develop business ideas on the basis of SUSU research.

4. StrAU performance metrics

4.1. List of academic, research and technological areas considered most important by StrAU for ensuring the high competitiveness of the university in the next three to five years

By 2020, StrAU will have **ensured the high competitiveness** in the following research areas:

1. **Digital twins and model predictive control:** industrial cloud platforms to support digital twins with multicriteria optimisation systems, and methods and algorithms of flow application planning to carry out engineering analyses in distributed computing environments.
2. **Machine learning methods and extra-large data mining to solve industrial problems:** digital platforms beyond a human engineer's intuition based on the multicriteria optimisation of subsystems via highly adequate digital models.
3. **Sensors for the IIoT:** IoT cyber-physical systems based on long-distance networks of wireless sensors.
4. **Information security in industrial systems:** cyber-security for corporate automated management systems using algorithms based on machine learning for anomaly detection in industrial processes.

By 2020, the StrAU will have implemented the following **high-demand academic programmes** related to the IIoT using cutting-edge technologies and teaching methodologies:

- **Industrial Sensors and Internet of Things** (English-language master's programme in collaboration with the Emerson Corporation)
- **Cyber-security for High-Load and Industrial Systems (master's programme** in collaboration with Kaspersky Lab)
- **Data Mining and Methods of Artificial Intelligence** (English-language master's programme in collaboration with NVidia Corporation)
- **High-Load Computational Systems** (English-language master's programme in collaboration with the Intel Corporation)

The StrAU will also actively develop English-taught bachelor's programmes in popular fields.

4.2. The impact of StrAU on actions and indicators of SUSU's approved roadmap

The StrAU will play a key role in implementing the university's transformational changes. In particular, the StrAU will be involved in implementing the strategic initiatives 1, 2, 3, 4, 6 and 8:

Research:

– New laboratories will open and bring in world-class scientists and researchers in disruptive IT, as well as foreign postdocs to carry out research and educational activities.

– The StrAU staff will participate in developing smart data mining methodologies to shape learning patterns for SUSU students.

Education:

– Obtaining international accreditation for key academic programmes by 2020.

– Starting in 2018, all programmes within the StrAU will be problem- and project-oriented.

– Starting in 2018, all StrAU students will be studying in advanced English courses and passing a mandatory IELTS examination.

– All StrAU academic programmes will be developed to coincide with the general trend to minimise in-class hours and introduce tutors by 2020.

– In 2018, MOOCs for high-potential areas will be developed and introduced. By 2020, the leading learning platforms will have 10 MOOCs for key StrAU educational areas.

– By 2020, 100% of the StrAU faculty will be using new teaching technologies.

– Starting in 2018, all programmes within StrAU will be LMS-enabled. StrAU faculty will be involved in implementing LMS and training other staff to use it efficiently.

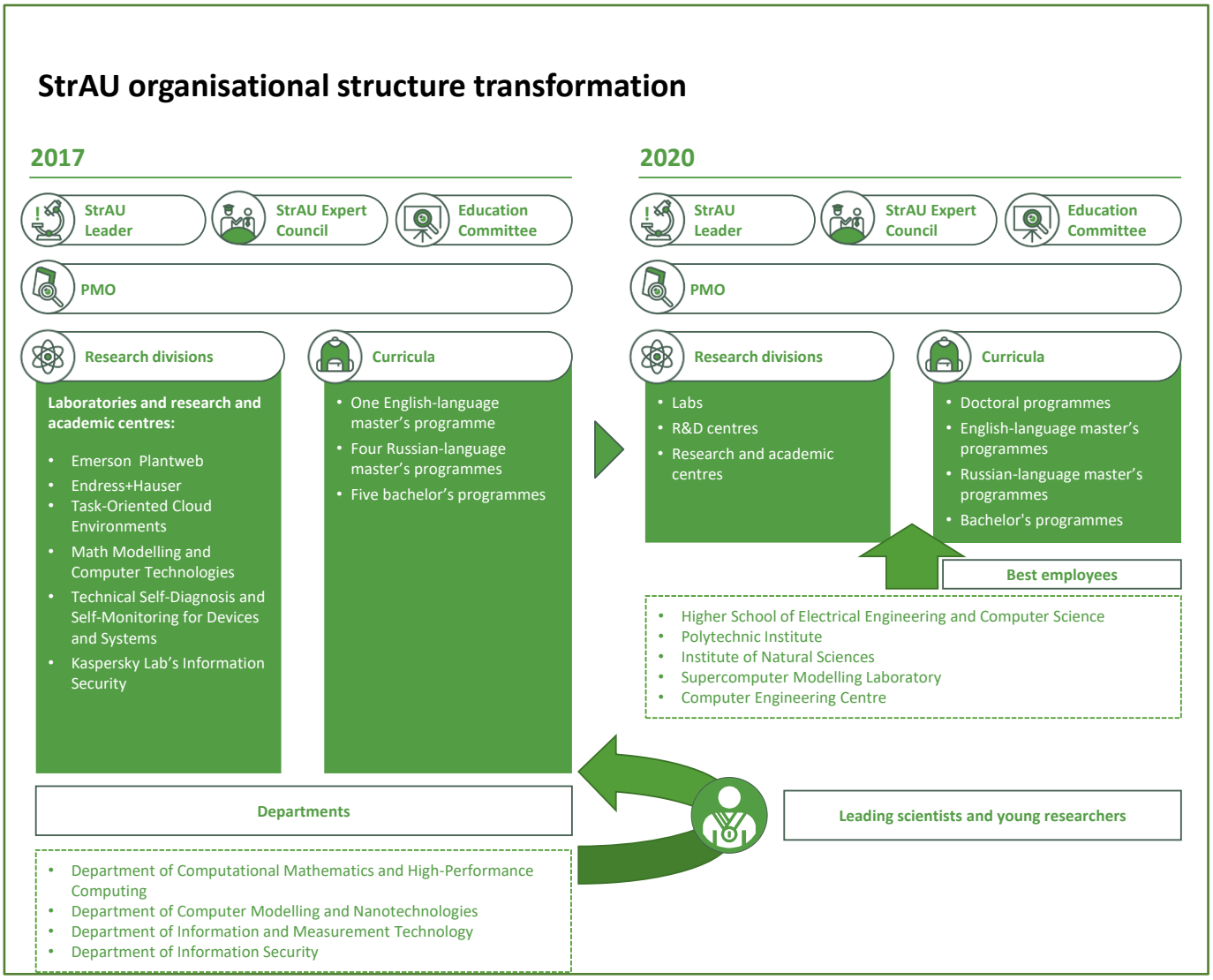
5. StrAU structure and governance system

5.1 Organisational structure at the StrAU inception and key changes in the structure and composition of the StrAU over a five-year period of time

The Smart Manufacturing StrAU will be set up as a new institutional unit cooperating with different university schools and departments, as well as with the Smart Education StrAU to carry out research and academic programmes. This new unit will engage world-class researchers, the best SUSU staff and members of the management team.

StrAU will have a two-tier management structure:

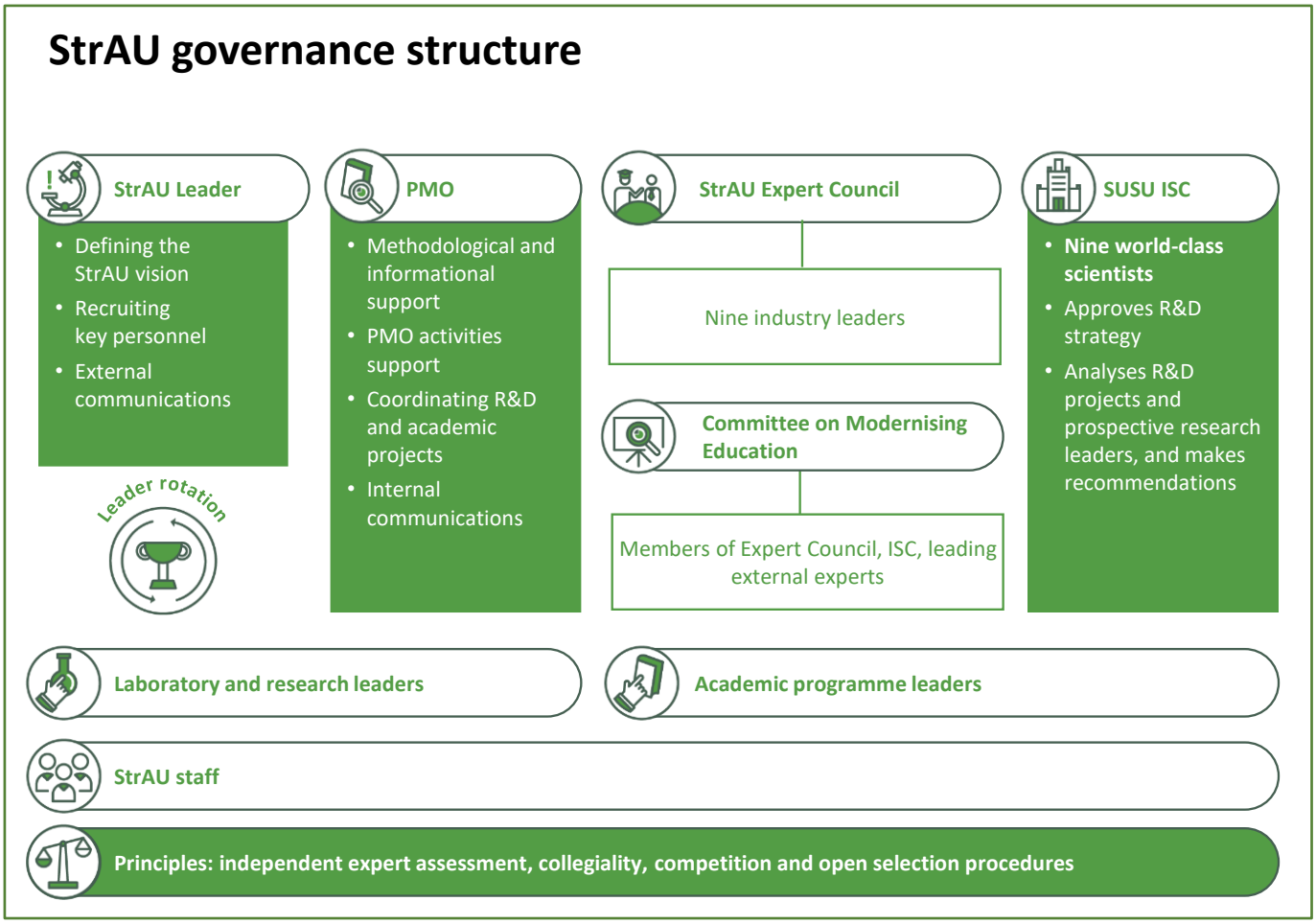
- The SUSU International Academic Advisory Council, StrAU Expert Council and StrAU Committee on Modernising Education.
- The StrAU Leader and the StrAU Project Management Office (PMO).



5.2. The StrAU governance structure

All decisions will be made based on the expertise of the three **StrAU advisory bodies**:

- The SUSU **International Academic Advisory Council** (IAAC) makes decisions on strategic aspects of StrAU development, provides recommendations on financial support to large research projects from the Project 5-100 budget and approves the StrAU's research strategy.
- The **StrAU Expert Council** is a collegial body formed from leading companies working in priority industries of the Greater Urals, global IT technology and engineering leaders, and leading R&D institutes and globally renowned researchers. The council consists of nine people and it reviews detailed plans for developing applied research. The council also approves competition procedures, scholarships and grants for research in the interests of business.
- **The StrAU Committee on Modernising Education** is a collegial body of seven experts, including representatives of the IAAC, representatives of the StrAU Expert Council and leading education experts. The committee provides recommendations on academic programmes and their modernisation, reviewing compliance with competency standards and market demand.



Candidates to the StrAU Expert Council:

№	Name, Surname	Position	Photo
1	Irek Gumerov	Deputy Director General, KAMAZ	
2	Johan Vanderplaetse	President for Russia and the CIS, Schneider Electric	
3	Nikolay Mester	Corporate Projects Development Director	

4	Pavel Shilyaev	CEO, Magnitogorsk Iron and Steel Works	
5	Pino Tese	Executive Vice President, SMS Group	
6	Slawomir Suchomski	Vice President, Europe, Emerson Process Management	
7	Tim Clough	Partner & Technology Development Leader, PwC Russia	

StrAU executive bodies:

- The **StrAU Leader** is a visionary and leading researcher who develops and presents the StrAU research and education development strategy, including the programme for attracting researchers and implementing large research projects, and also supervises the StrAU's strategic development. The StrAU Leader is appointed for three years from a pool of leading global researchers. The appointee for the position is not allowed to hold the office for more than two consecutive terms.
- The **StrAU PMO** provides methodological and information support, coordinates academic and research projects and manages internal communications. The StrAU PMO controls the implementation of strategies, decisions and projects approved by the StrAU collegial bodies and StrAU Leader that may require bringing in external specialists and resources.

Candidates for the **Expert Council** can be nominated by the Rector or by members of the IAAC for SUSU's Project 5-100 programme. The IAAC makes the decision to put the nominated candidate on the StrAU's Expert Council by a simple majority vote.

5.3. StrAU autonomy

StrAU are autonomous and independent in terms of budgeting and funding. The university provides budget for implementing academic programmes and research projects, and also additional funding that is allocated based on the IAAC's recommendations. The decisions to create new laboratories, research and education centres, and to appoint leading scientists to the StrAU are made on recommendations of the IAAC

following the competition procedures. The StrAU will independently raise grants and financing from business by cooperating with the leading global corporations.

The StrAU has powers to expand or reduce its research teams, launch or discontinue academic programmes, organise competition procedures to recruit employees (except leading scientists). Internal administrative functions (accounting, HR and legal departments) for all StrAU are centralised at the university level. Programme managers are granted broad powers of autonomy within the approved parameters of research projects or academic programmes. When necessary, decisions are made by the Academic Board and Supervisory Board within their powers as granted by the SUSU Charter.

As the StrAU structure evolves, the StrAU will become more autonomous financially and administratively, as well as in other ways.

6. StrAU development calendar

	Description	Deliverables	Deadline		
			2018	2019	2020
1.	**Organisational changes**				
1.1.	Ensure the regular operation of the SUSU International Scientific Council	Regular operation of SUSU International Scientific Council ensured	December	December	December
1.2.	Restructure and modernise university divisions to enhance efficiency	SUSU divisions restructured	January-December	January-December	January-December
1.3.	Ensure regular PMO operation, including StrAU implementation	Regular PMO operation ensured	December	December	December
1.4.	Conduct information campaigns on StrAU operations in general and also about each individual StrAU	StrAU information campaigns conducted	January-December	January-December	January-December
1.5.	Develop faculty incentives and development systems for the StrAU	Incentive and development systems set up	January-December	January-December	January-December
	Forming and developing StrAU	**Smart Manufacturing StrAU 1** **StrAU 1 objectives:** Achieve global-scale scientific breakthroughs in digital technologies by implementing the Industrial Internet of Things at leading companies in the Greater Urals and Russia. **StrAU 1 tasks:** ○ Increase R&D income by implementing large-scale comprehensive projects for industrial partners ○ Conduct fundamental and applied research to address global challenges resulting from the development of the digital economy ○ Train a new generation of highly-paid specialists capable of solving global challenges in the field of digital technologies ○ Popularise the Industrial Internet of Things through international conferences and research-to-practise workshops **QS Computer Science ranking after establishment and development of StrAU 1 is complete:** ○ 2020 - 300-350			
2.	**Changes and results in educational activities**				
2.1.	Use student enrolment pattern analysis to eliminate low-demand programmes	Programmes restructured	December	December	December

	Description	Deliverables	Deadline		
			2018	2019	2020
2.2.	Implement and develop new recruiting and engagement systems for talented applicants from Russian and foreign universities	Recruitment efficiency enhanced	January-December	January-December	January-December
2.3.	Ensure the modernisation of academic programmes to introduce a task-oriented and project-oriented approach to learning	Task-oriented and project-oriented learning approach introduced	January-December	January-December	January-December
2.4.	Develop the university's system for recruiting international PhD students, especially through the creation of a system of grants for talented applicants	International PhD student recruitment system established	January-December	January-December	January-December
2.5.	Develop an academic mobility system among leading Russian and foreign universities for students, PhD students and talented faculty	Academic mobility for the university's students ensured	January-December	January-December	January-December
2.6.	Establish new academic programmes (including English-language programmes) partnering with leading R&D institutions and high-tech companies	New academic programmes in cooperation with Russian and foreign partners established	January-December	January-December	January-December
2.7.	Add business skills modules to academic programmes	New business skills modules in the university's various academic programmes established	September	September	September
2.8.	Ensure the optimisation of educational processes to decrease the amount of in-class activities	Number of in-class activities drops	September	September	September
3.	**Changes and results in R&D activities**				
3.1.	Engage leading world-class scientists and researchers in key development areas	Top Russian and foreign researchers brought in	January-December	January-December	January-December
3.2.	Develop and maintain laboratories to conduct research in key StrAU areas including fundamental research	Lab development and maintenance ensured	January-December	January-December	January-December
3.3.	Develop a system to recruit and hire junior academic staff and develop a competitive process for the selection of applicants	Junior academic staff engagement and development system established	January-December	January-December	January-December
3.4.	Improve the system for motivating academic staff and PhD students to publish articles in leading academic journals	System for motivating academic staff and PhD students to publish articles established	January-December	January-December	January-December
3.5.	Develop a subsidy system to support academic staff, PhD students and students in their fundamental research activities	Subsidy system for academic staff, PhD students and students established	December	December	December

	Description	Deliverables	Deadline		
			2018	2019	2020
4.	**General changes and results, incl. at university level**				
4.1.	Restructure business processes, including the implementation of a CRM system and automated workflow	Workflow automation ensured	December	December	December
4.2.	Develop a recruiting system for new staff and build a talent pool	Talent pool of highly talented individuals formed	December	December	December
4.3.	Modernise the multilingual infrastructure for scientific, academic and extracurricular activities	Bilingual infrastructure in place	January-December	January-December	January-December
4.4.	Ensure the university's development in the global academic community, i.e. by including the university's journals in the Scopus and Web of Science databases	Inclusion of the university's journals in the Scopus and Web of Science databases ensured	December	December	December

Appendix 1.

Table 1. Performance Indicators of the StrAU

№	Indicator	Fact	Plan			
		2016	2017	2018	2019	2020
1.	StrAU acting subject rank in ARWU, THE, QS subject rankings (according to university's roadmap)					
1a	Rank in QS «Computer Science» subject ranking				351-400	301-350
1b	Rank in QS «Mechanical, Aeronautical & Manufacturing Engineering» subject ranking			201-300	201-300	201-300
2.	Number of articles in the Web of Science per StrAU academician/researcher	3,0	4,0	4,5	4,5	4,5
3.	Number of articles in the Scopus per StrAU academician/researcher	6,0	7,0	7,0	7,0	7,0
4.	Average citation index per StrAU researcher/academician measured by the total count of articles included in the Web of Science database	3,8	4,7	5,7	7,4	10,3
5.	Average citation index per StrAU researcher/academician measured by the total count of articles included in the Scopus database	7,0	8,0	10,0	12,0	16,0
6.	Proportion of foreign professors, academicians and researchers in the total headcount of researchers and academicians in StrAU, including Russian nationals holding a PhD from foreign universities	9%	10%	12%	15%	20%
7.	Proportion of foreign students enrolled in the main educational programs of the University's StrAU (including students from the CIS countries)	7%	10%	11%	12%	15%
8.	An average USE (Unified State Examinations) score of full-time students enrolled at the University with their tuition to be paid out of the federal budget under bachelor and specialist degree StrAU programs	72	78	80	82	85
9.	Proportion of revenues from non-budget sources in the structure of the StrAU revenues	36%	40%	44%	47%	50%

Table 2. Quantitative characteristics of StrAU's development

№	Indicator	Fact	Plan			
		2016	2017	2018	2019	2020
1.	Number of StrAU educational programs with international accreditation, units	0	1	1	2	2
2.	Number of StrAU foreign language education programs	1	2	3	4	4
3.	Number of StrAU double-diploma education programs	1	2	2	3	3
4.	Share of StrAU main educational programs students, who are involved in research projects, in total number of StrAU students	10%	20%	30%	40%	60%
5.	Share of StrAU main educational programs students in total number of university's students	4%	5%	6%	8%	10%
5a	The same for bachelor programs	3%	4%	5%	6%	8%
5b	The same for master programs	11%	11%	11%	11%	12%
5c	The same for post-graduate programs	13%	12%	15%	17%	25%
6.	Share of StrAU faculty staff, who have made publications in Scopus or Web of Science database, in total number of StrAU faculty staff	80%	82%	83%	85%	90%
7.	Share of StrAU staff in total number of educational organization staff	5%	5%	8%	10%	13%
8.	Number of intellectual activity;s results (IAR), have created by StrAU staff	23	25	27	29	31
9.	Average SNIP of journals, indexed in the Scopus database, which published articles of the SAE NEP in the reporting year	0,75	0,8	0,9	1,0	1,2

Table 3. Financial model of the strategic academic unit

	Fact*	Plan			
	2016	2017	2016	2017	2016
TOTAL INCOME:	**451**	**645**	**1 027**	**1 702**	**2 344**
1. Budgetary sources	**107**	**222**	**441**	**544**	**659**
1.1. Subsidy for state assignment	107	222	291	394	509
1.2. Subsidy for R&D activity state assignment					
1.3. Other subsidies and budgetary sources			150	150	150
2. Non-budgetary sources	**344**	**423**	**587**	**1 158**	**1 685**
2.1. Income from commercial education activity (tertiary education, pre-university courses, second degree and additional education, distance learning and other)		45	90	135	180
2.2. Income from R&D activity (scientific researches, consulting and analytic activities, including grants from RSF, RSCI and others)	344	378	497	1 023	1 505
2.3. Income from intellectual activity results using					
3. Other income					
TOTAL EXPENDITURES:	**446**	**644**	**1 020**	**1 704**	**2 343**
1. Expenditures on some elements of governance sector	**103**	**266**	**524**	**681**	**838**
1.1. Wage expenditures	103	226	350	474	598
1.2. Expenditures for equipment and row materials		30	53	77	100
1.3. Other operation expenditures	-	10	20	30	40
1.4. Capital investments			100	100	100
2. Expenditures on StrAU research projects funding	**344**	**378**	**497**	**1 023**	**1 505**
Direction 1: Digital twins and model predictive control	123	135	83	170	250
Direction 2: Machine learning methods and extra-large data mining to solve industrial problems	122	134	150	309	455
Direction 3: Sensors for the Industrial Internet of Things	99	109	149	306	450
Direction 4: Information security in industrial systems	-	-	66	136	200
Other			50	102	150
3. Other expenses					
DEFICIT / PROFICIENCY	**4**	**0**	**7**	**-2**	**1**

*model calculation in StrAU prerequisites