Education for high-tech chemical industries: TSU experience

Kurzina I.A., Ananko S.Yu.

Национальный
исследовательский
Томский
государственный
университет

Национальный исследовательский
Томский государственный университет

TSU is the leader of the program for increasing the competitiveness of leading Russian universities "5-100".

- is one of the five best classical universities in the country and the five best universities in the Russian Federation according to the QS rating of the BRICS countries
- more than 15 thousand students, 14 faculties and 6 institutes, 66 - world-class laboratories, Shared Use Centers, Engineering Centers, including IHTC.
- there are more than 100 high-tech companies in the belt of enterprises - partners of TSU
- Bolshoi Tomsk University annually graduates about 300 chemists (about 1000 people are trained).
- QS "Chemistry" 300-400, QS Chem. Eng.200-250.

TSU rating

Рейтинг	2020г место университета / общее кол-во мест	2019г место университета / общее кол-во мест
QS World University Rankings	250/801+	268/801+
THE World University Rankings	501-600 / 1001+	501-600 / 1001+
THE Most International Universities	103 / 170	-
Academic Ranking of World Universities (ARWU)	801-900 / 1000	801-900 / 1000
Round University Rankings	139 / 829	178 / 820
RUR Reputation Rankings		236 / 797
Webometrics: Ranking Web of Universities	659 / 11999	717 / 11997
U-Multirank		
SCImago Institutions Rankings - Higher Education	488 / 684	503 / 681
QS Best Student Cities		73 / 120
U.S. News Best Global Universities		509 / 1500

ACTUAL EDUCATION

Tomsk State University implements training at all levels of higher education: bachelor's degree, specialty, master's degree, postgraduate studies.

The average USE score in 2019 is 80.78.

The core of the undergraduate program is a system of interrelated disciplines and modules, a foundation on which general professional competencies are built.

<u>Principles of Master's Degree:</u>
interdisciplinarity
double diplomas
double diplomas
mobility and activity
targeted preparation (enterprise inquiries)
individual plan

Context for all universities in the world

Industrial (technological) revolution. Critical rethinking by universities of their values, missions and academic (research, educational, cultural, management) practices, taking into account digitalization, robotization, global environmental and social risks and the current pandemic.

UNIVERSITY 3.0

open university, which actively cooperates with industrial companies and foreign universities - partners

TSU -3.0

Professor of the University of Delft (Netherlands) Johan Wissema: “Education should be aimed at teaching the student to solve practical problems, and not just at the transfer of knowledge

UNIVERSITY 2.0

like Humboldt University – a combination of research, teaching and the idea of free teaching (Jaspers K. Die Idee der Universitaet).

TSU – 2.0

Typical type for universities of the Soviet and post-Soviet period of training researchers and teachers of higher education

OOP in the chemical profile of training at TSU

QS WORLD UNIVERSITY RANKINGS

Chemistry 450–500
Chem.Eng. 251–300

Resources:
Faculty of Chemistry (5 departments, 56 teaching staff)
Chemical Center (6 research laboratories, 62 HP)
Engineering Chemical Technology Center (36 engineers and technologists)

The main programs for the preparation of CPD:

- "Chemistry" (04.03.01, "Chemistry"), the beginning of preparation since 1998;
- "Fundamental and Applied Chemistry" (04.05.01, "Fundamental and Applied Chemistry"), the beginning of preparation from 1932;
- "Fundamental and Applied Chemistry of Substances and Materials" (04.04.01, "Chemistry"), the beginning of preparation since 1998;
- "Translational Chemical and Biomedical Technologies" (04.04.01, "Chemistry"), the beginning of preparation in 2016

Competitive factor - strong background in fundamental and applied chemistry.

Currently, this is not enough for employers - high-tech companies in the chemical industry.

The main problem is the inconsistency of graduates with the professional requirements of high-tech industries (lack of digital competencies, design thinking, adaptability to knowledge in other areas, soft skills).
Companies solve the problem of “finishing up” in different ways: through corporate training centers, targeted EP and PC in universities, internships.

The challenge of OOP transformation is to maintain a strong core and introduce new elements that meet the requirements of modern technologies.

CASE

Network additional education from modules that form the necessary competencies

Национальный исследовательский Томский государственный университет

ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

ТУСУР | TUSUR UNIVERSITY

СИБУР

1.5 year

TPU: Polyolefin Technology
Processing of polymeric materials
Processes and apparatus of chemical tech /
modeling, etc.
TSU: Catalysis in oil refining
Gas chromatographic analysis of raw materials,
TUSUR: Internet of Things
Cisco Networking Academy courses,

- technological processes
- safety culture
- digital competencies
- economic literacy

The target audience:
3-4 year undergraduate students
students of 3-5 courses specialty
1-2 year graduate students

Working profession (4-5 rank)

Protection of "on-line" industrial cases with the consulting support of SIBUR experts during the COVID19 pandemic

Internship at the enterprise under the guidance of a mentor

Scheme of the training cycle at the request of the enterprises of the SIBUR group

1 этап

Targeted student training program

Срок обучения: 0,5 – 1,5 года

The target audience:
3-4 year undergraduate students
students of 3-5 courses specialty
1-2 year graduate students

ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Национальный исследовательский Томский государственный университет

ТУСУР | TUSUR UNIVERSITY
Томский государственный университет систем управления и радиоэлектроники

Theoretical modules from universities

TPU: Polyolefin Technology
Processing of polymeric materials
Processes and apparatus of chemical tech / modeling, etc.
TSU: Catalysis in oil refining
Gas chromatographic analysis of raw materials, etc.
TUSUR: Internet of Things
Cisco Networking Academy courses, etc.

Internship at the enterprise under the guidance of a mentor

2 этап

1 Master's program (in conjunction with a foreign partner university)

Срок обучения: 2 года

Invited target audience: graduates of specialized areas of preparation for bachelor's degree

Вариант #1 Химический инжиниринг

ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

POLITECNICO MILANO

1 год
- ❑ Modern research methods
- ❑ Advanced theoretical training in chemical technology
- ❑ Tech English
- ❑ Project management
- ❑ Internship at the enterprises of the SIBUR group

2 год
- ❑ Choice of specialization
- ❑ Module in a foreign university on chem. technologies / mat. modeling and business processes
- ❑ Internship at a foreign enterprise
- ❑ Protection of the project according to the task of the enterprise

Вариант #2 Промышленный инжиниринг

Национальный исследовательский Томский государственный университет

Chimie Paris ParisTech | PSL

1 год
- ❑ Modern research methods
- ❑ Advanced theoretical training in analytical and digital chemistry
- ❑ Science English
- ❑ Innovation management
- ❑ Internship at NIOST

2 год
- ❑ Choice of specialization
- ❑ Module in a foreign university on industrial analytical chemistry and process control
- ❑ Internship at a foreign enterprise
- ❑ Protection of a project for innovative products

2 Chemical engineering professional retraining program

Срок обучения: 1 год

Invited target audience: employees of SIBUR Group enterprises

ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

POLITECNICO MILANO

Сириус Образовательный центр

1 год
- ❑ Advanced theoretical training in chemical technology
- ❑ Tech English / Project Management
- ❑ Module in a foreign university on chem. those./
- ❑ mat. modeling and business processes
- ❑ Protection of the project according to the task of the enterprise

CASE

Open educational cross-disciplinary modules

Module: "Mathematical modeling of technological processes in the ASPEN software environment"

Target audience: personnel of industrial companies, masters and graduate students

Main sections
1 . ASPEN HYSYS
2. ASPEN EDR
3. Pinch Analysis

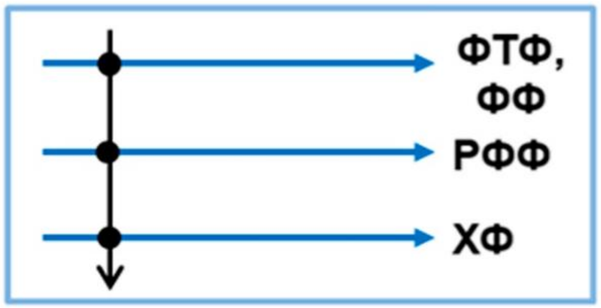
Module: "Quantum" (quantum disciplines, quantum computing)

Module: "Molecular biology "(molecular modeling, synthetic biology)

Modules as part of key disciplines and practices allow students of different directions and levels of training to quickly master basic knowledge and digital tools for their practical application

Place of the cross-module among the main educational programs

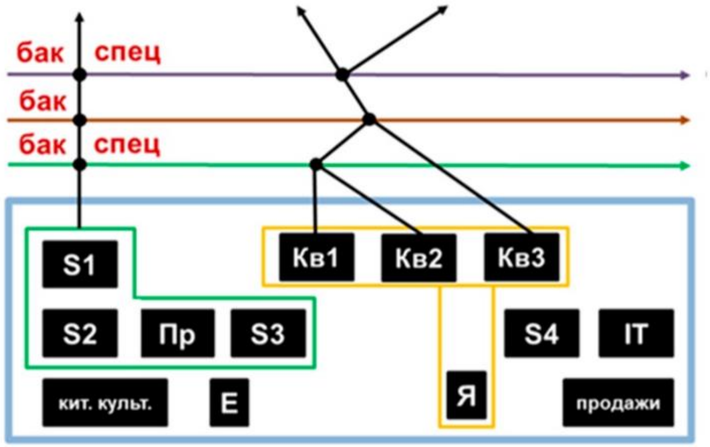
external listeners



Crossmodule

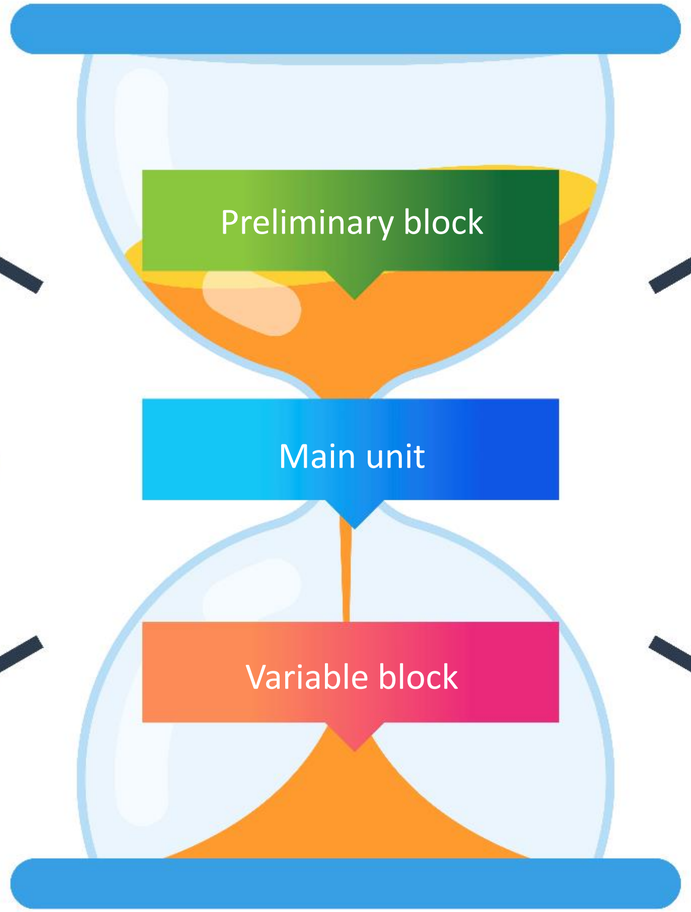
SM&T

partner sites



- Chemist with digital adaptation
- Bioengineer
- Chemist with complex competencies
- Genetic engineer
- Modeling Specialist
- ...

INPUT:
developed concept of



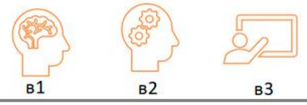
EXIT:
realized by

All to choose from consistent TSU courses (k1, k2 ....)

Independent training at MOOCs from the list of proposed, with presentation certificate

Entry Requirements Needed

Provides in-depth training at the world level in the basic courses of KDOM. TSU teachers or invited specialists, incl. foreign with high qualifications, accredited reputation



On the basis of the main course, KDOM makes it possible to deepen knowledge in different areas of activity (academic courses, applied, technology, application, etc.). All elective courses.

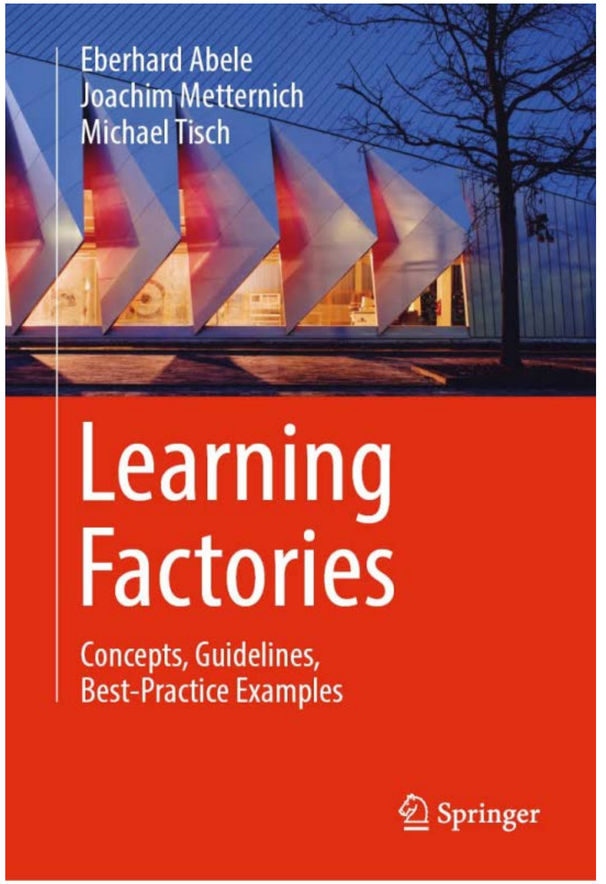
	Level competencies	**Duration**	**Proof of education**
	elementary	up to 108 h.	PDA certificate or document
	in-depth	up to 216 h.	PDA certificate or document
	applied	up to 36 h.	PDA certificate or document

Mastering the main course is required

CASE

Learning Factory

The Learning Factory is a practice-oriented modular training format aimed at training personnel for engineering and industrial practice, which is an element of the educational and scientific infrastructure of TSU that stimulates the introduction of advanced technologies in the chemical industry.



The experimental industrial site "KatTech" is a training and production platform within an existing production facility with a deployed flexible modular design that imitates the structure of production of catalysts and sorbents, allocated under a special agreement between partners (TSU, ICHTC, SIBUR / NIOST).

The platform includes equipment and tools, software, auxiliary materials, transformable workplaces.
The platform can be reconfigured for technological processes and allows you to create new industrial products, technological and information solutions.

The platform is an infrastructural element of the Learning Factory and can be integrated into network educational programs with the participation of TSU aimed at training personnel for modern chemical production 4.0.

The main typology of training "Learning Factory"

Dimensions	Features
Purpose	teaching and/or training and/or research
Process	authentic + multi stage + technical and organizational
Setting	changeable + real or virtual*
Product	physical or service**
Didactics	concept based + formal and informal learning + own actions of trainees + on-site or remote learning***
Operating Model	sustainable plan allows the ongoing operation (desired)

Key characteristics of learning factories /E. Abele et al. / CIRP Annals - Manufacturing Technology 66 (2017) 803–826.

Partnership

A new paradigm for interdisciplinary training for high-tech industries

Industrial partners

- Flexible educational cross-modules
- Involvement of partners in the formation of the educational professional environment of universities from the first year
- Network learning formats
- Learning factory

TSU + Big University

- Systemic and facilitated technology transfer to the university environment
- Access to industry experts and the Big University partner network
- Additional infrastructure sites (LF) for training, experimental work and project implementation
- LF in Lab contract research and production at Fab in Lab experimental sites

250 qualified personnel annual

graduation chemical engineers with knowledge of English specialists with interdisciplinary and practical training

specialists trained for specific high-tech industries

Thank you very much for your attention!