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University 4.0: What Type of Thinking is Coming? (Part II)

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Abstract. The study is framed by the concepts of 1) "university – cognitive institute" and 2) "generations of university". Within different generations, the types of thinking (mindsets) that were generated and used in universities are considered (in pre-industrial society – scholastic, in industrial society – research, in post-industrial society – entrepreneurial). To characterize the mindset, a methodological scheme "object – manner – intention" is used:
Thinking at the University 1.0: object – Divine order, its metaphysical foundations; manner – positing mental entities, constructing reasoning; intention – understanding authoritative texts and creating a consistent doctrine (a common field of meanings).
Thinking in University 2.0: object – Nature (objects, processes, laws); manner – building models, creating ideal objects, mental experimentation, hypothesizing; intention – creating theories (ontologies of nature), setting tasks for observations and experiments, creating foundations for production technologies and projects (industrial civilization).
Thinking in University 3.0: object – Activity (subjects, actions, technologies, environments, opportunities); manner – analyzing possibilities based on multi-subject models, planning of innovations; focusing on entrepreneurial schemes that configure the participants, creating the basis for new social and production practices.
Thinking in University 4.0: object – The world of thinking and practices (subjects, principles, norms, foundations and boundaries of various thoughts and practices); manner – methodological reflection, positing and transforming the foundations of thoughts and practices; focusing on projects and technologies for collective and hybrid intelligences (cognitive civilization), new ways and means of thinking, social relations and institutions, new socio-anthropological experience.
The hypothesis that university of the future (cognitive civilization) will cultivate methodological thinking ("thinking about thinking"), and that its target will be in generating collective and hybrid (with AI participation) intelligence, as well as in developing compliant technologies for their work is substantiated. It will generate a new agenda for the society and create plans and precedents for new practices.
Part II of the article presents the characteristics of the types of thinking that will be generated and reproduced by second, third and fourth generation universities.

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Университет 4.0: какое мышление будет культивироваться в будущем? (Часть II)

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Аннотация. Теоретической базой исследования являются концепты 1) «университет – когнитивный институт» и 2) «поколение университетов». Рассмотрены особенности типов мышления, которые рождались и воспроизводились в университетах разных поколений (университет в доиндустриальном обществе – схоластический, в индустриальном – исследовательский, в постиндустриальном – предпринимательский). Для характеристики типов мышления используется методологическая схема: «предмет – способ – направленность (интенция) мышления».
Мышление в Университете 1.0: предметность – Божественный порядок, его метафизические основания; способ – полагание мысленных сущностей, построение рассуждений; направленность – понимание авторитетных текстов и создание непротиворечивого учения (общего поля смыслов).
Мышление в Университете 2.0: предметность – Природа (объекты, процессы, законы); способ – построение моделей, создание идеальных объектов, мысленное экспериментирование, выдвижение гипотез; направленность – создание теорий (онтологии природы), постановка задач для наблюдений и экспериментов, создание оснований для производственных технологий и конструкций (базиса индустриальной цивилизации).
Мышление в Университете 3.0: предметность – Мир деятельности (субъекты, активности, технологии, среды, возможности); способ – анализ возможностей на основе полипредметных моделей, замысливание инноваций; направленность – создание предпринимательских схем, конфигурирующих деятельность участников инновации, создание оснований для новых социально-производственных практик.
Мышление в Университете 4.0: предметность – Мир мышления и практик (субъекты, принципы, нормы, основания и границы различных мышлений и практик); способ – методологическая рефлексия, полагание и преобразование оснований мышлений и практик; направленность – создание конструкций и технологий работы коллективных и гибридных интеллектов (базиса когнитивной цивилизации), новых способов и средств мышления, социальных отношений и институтов, новых социально-антропологических практик.
Обосновывается гипотеза: университет будущего (когнитивной цивилизации) будет культивировать методологическое мышление («мышление о мышлении»), его ключевой

задачей будет формирование коллективных и гибридных (с участием AI) интеллектов, разработка технологий их работы. Он будет обеспечивать генерацию новой повестки для общества, создание замыслов и прецедентов новых практик.
Часть II статьи представляет характеристики типов мышления, которые будут порождаться и воспроизводиться университетами второго, третьего и четвертого поколений.

Ключевые слова: Университет будущего, поколения университетов, Университет 4.0, когнитивный институт, методологическое мышление, когнитивная цивилизация.

Научная специальность: 5.10.1. Теория и история культуры, искусства (культурология).

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3.2. University 2.0

The industrial development, creation of devices and machines (spinning and weaving machines, steam engines, etc.), move from manufactories to factories and plants (the First Industrial Revolution) in the 17th-18th required knowledge about nature and materials used. Over the centuries, craftspeople, builders, sailors, and many others accumulated empirical knowledge, but it was odd information and recipes, and most importantly, there was no method for focused increasing natural science. Scholastic knowledge about nature was speculative, but it had useful logical tools for constructing knowledge systems based on certain "principles".

A "bridge" from scholasticism to science was natural philosophy. The creation of science was facilitated by the texts of Arab thinkers translated into Latin (on philosophy, mathematics, astronomy, optics, medicine, etc.) In the 14th century, at Oxford University, "*Oxford Calculators*[1]" sought to mathematize natural philosophy and created the foundations of kinematics (the science of body movement in space). Their key achievement was that mental images of mechanical movement were distinguished from verbal reasoning and their transfer to other signs – graphs, formulas, and theorems. Thus, the "calculators" defined a few actual physical concepts (steady motion, uniformly accelerated motion). Their followers[2] then turned to graphical analysis of the movement of bodies.

Galileo Galilei[3], who knew these papers, made a breakthrough by suggesting a method of inquiry that combines empirical observations, natural experiments (measurements and data recording), and thought experiments. The last one was a series of questions to an imaginary interlocutor, formulated so that they forced this "pattern-like mind" to abandon common ideas and generate a new ideal object, a "seed" for a coming detailed thought (theory) (Bibler, 1975).

During the 17th – 18th centuries, a new type of thinking – natural science – developed its "equipment": schemes and models, methods of mathematical description for physical processes (I. Newton[4] proposed the mathematical framework to be used in science, including differential and integral calculation), making and testing hypotheses, using natural science experiment with specific tools. Schemes, models, and laws developed by science were used in factories, construction, transport, military affairs, etc.

[1] Or the "Merton Calculators" – a group of philosophers affiliated to Merton College, Oxford (T. Bradwardine, W. Heytesbury, R. Swineshead, J. Dumbleton). See: Gaidenko, Smirnov (1989).

[2] Nicholas Oresme, affiliated to the University of Paris (mentioned in the documents in 1348); Giovanni di Casali, a teacher of Cambridge in 1340–1341 and of the University of Bologna in 1346–1352.

[3] He worked at the University of Pisa (in 1589) and Padua (1592–1610).

[4] I. Newton worked at Trinity College, Cambridge University, for more than 30 years, becoming a student in 1661, a master – in 1668, and a professor – in 1669.

There is a huge demand for skilled people who can apply scientific knowledge in practice, and industrialized countries (France, England) welcomed technical and engineering schools. However, these schools could not become a place for science's life and growth as their graduates could use scientific knowledge, drawings, and diagrams in their activities, but could not "spread" scientific theoretical thinking and research methods.

In a sense, this state was much like of the 13th century – carriers of an advanced type of thinking were few and lived "in the gaps between institutions", i.e. either among the courtiers, or at the university (unfriendly environment), or among industrialists, or in their domain, turned into a laboratory ("science as a hobby for gentlemen")[5]. It was necessary to re-institutionalize intelligence – this time a scientific one. To sample, Germany solved this problem by establishing a new university relying on the Humboldtian model. University 2.0, a research-oriented, has become a "social body" of scientific and theoretical thinking.

In this reality, students mastered scientific knowledge, practical and theoretical thinking, and research methods. Firstly, they had to try the "academic line", i.e. by listening to lectures, reading textbooks and scientific papers, solving problems in seminars and laboratories; secondly – to participate in the work of their scientific school, conduct research and then, to write and defend a thesis.

• ***Object***: Nature as objects and processes that are comprehended through concepts: body, movement, speed, probability, field, basic particle, etc.; "laws of nature" that determine objects-and-processes interaction in the form of variables-function relation[6].

•***Manner***: Creating ideal objects ("particle", "steady motion", "probability", "field", etc.); operating with them and constructing theoretical models; hypothesizing; thought experimentation; modelling-into-formulas transition (algebraic, differential, and integral equations, etc.); thinking development through terms, schemes, graphs, mathematical formulas; creating theories as systems of logically coherent knowledge (evolving models from simple to complex).

• ***Intention***: 1) setting tasks for observations and experiments, interpreting their results; discovering the "laws of nature", constructing scientific theories, and formulating the ontology of nature; 2) identifying principles for technologies and designs as the basis of industrial civilization.

3.3. University 3.0

The 20th century completed industrialization in the leading countries. Not only production (factories, plants) took the form of "machines" (assembled partial activities), but also agriculture, trade, finance, services, medicine, education, etc. Companies put on a leading role in economic activity – ensembles of factories and plants, trade and service organizations, innovation-targeted units (industrial laboratories and engineering bureaus, design bureaus, etc.) (Kniaginin, 2005). A post-industrial (or super-industrial) economy and society have been formed.

J. Schumpeter (2011), who studied the impact of innovation on economic processes, identified a new type of activity – entrepreneurial – which took the frontier in the post-industrial era. An entrepreneur constructs a new "set" of existing ideas, technologies, and activities, which supports them in producing new goods and services, creating new demands and markets. Thus, new opportunities appear.

The entrepreneur works in a specific reality, which relies on production and consumption, services, and intermediary activities; processes ("what happens") means intending and initiating activities, communication, partnership, and competition; these processes are influenced by different "environments" – social, cultural, political, and institutional. To see new ways and suggest innovations, new knowledge, approaches, and tools are needed. The object of entrepreneurial thinking is "subjects", "activities", "performance", "markets", "communications", "environments", etc.

The 20th century experienced two World Wars and several socio-political revolutions;

[5] Gentleman scientist is a wealthy person who conducts research at his own expense, regardless of any institutions.

[6] Philology, history and similar subjects partly remain scholastic, speculative, and partly follow the models of empirical science.

thinkers, writers, and artists interpreted these events as catastrophes that questioned the "humanity of man". At the turn of the millennium, the information and digital revolution dramatically accelerated the erosion of traditional life. Thus, a person became a problem for himself (Akhutin, 2016; Smirnov, 2010), which pushed humanitarian science and practices forward.

In this reality, the 20th and 21st centuries develop such science branches and research areas as economics, political science, management, sociology, cultural studies, psychology, etc[7]. Note that in each area, more often – independently, two sciences emerge (natural and humanities). Thus, economics as a natural science studies the processes of values creation and movement of goods and money that occur independently of human consciousness; as a humanities science, it studies how rational and irrational motivations, ideas about well-being and ways to achieve it influence the human behavior. Psychology focuses on behavior and psyche in terms of "processes" and "functions"; as a humanities science – on the inner worlds of people, their actions (subjective realities). Management regarded as a natural science represents an applied version of cybernetics, and as a humanitarian science – investigates the work in systems with multiple subjects/actors (collective goals, initiatives creation, coordination of activities, reflexive model development). Thus, in the post-industrial era, a new type of thinking is humanitarian. It differs from the natural science not only in subject (person, society, culture), but also in method and basic categories ("subject", its "reality", "communication", "event", etc. (Bakhtin, 1986)).

Project thinking takes a special form there, while in the previous stage it focused on things and processes and the project was much a drawing or technical guide. If a complex thing, such as a seaport, was designed, then the project contained a lot of drawings and regulations interweaved into the system. New activity systems were set indirectly, through new material-and-process systems.

By changes, it is precisely systems of activities indeed that are designed; at the same time, framework (supersystem) structures, such as values and missions, remain. The projected objects are the setting of positions and communications between them; a designer has in mind (and, in a sense, sets) activities and goals for these positions. For such systems designer develops the "mechanisms" for their self-change – reflexive patterns, self-learning. Thus, the project becomes a multi-layered, multi-subject phenomenon, and designing itself inevitably becomes a collective work – not just functionally distributed, but multi-positional. Project thinking merges with organizational and managerial thinking, but, unlike the "ordinary" one, it is aimed at the future.

For students to master entrepreneurial activity and humanitarian thinking, team and network research, and project activities must be developed (and integrated in the educational process) at the university. The student should be able to develop and implement a project – in particular, to create a startup and present it on the market.

• ***Object:*** active reality, its components, and terms (subjects, activities, technologies, markets, environments, innovations); configurations of activities – cooperation, opportunities, productivity, challenges, risks; specific objectivity of humanitarian thinking is formed (subjects, their reality, communications, eventfulness).

• ***Manner:*** identifying opportunities (product, technological, functional, market, etc.); analyzing possibilities based on models in different spheres (multi-subject thinking); conceiving an innovation, i.e. a new activity (goods, technology, organizational chart, market entry). Intellectual work explicitly involves communication and reflection, including identifying cultural and personal basis for the positions (humanitarian shift).

• ***Intention:*** 1) identifying problems and setting tasks for humanitarian research and project development (in economics, psychology, education, management); constructing principles and methods of entrepreneurial activity; creating an ontology of activity; 2) determining conceptual foundations and developing technologies for new socio-production and socio-cultural practices.

[7] Politicians and managers graduated from University 1.0 and 2.0, but this happened as a result of "planting discourses on people" and developing personal skills, rather than mastering scientific subject matter.

3.4. University 4.0

The 21st century brings a new and very difficult situation. Current civilizations, already united at the economic level (global commodity exchanges and production chains), clash by their beliefs and ideas about the future; these conflicts are in the wake of a "dense" world and 9 nuclear powers' activity.

Industrial activity has caused large-scale environmental and climatic shifts; if there are no changes in its form, so the existing biosphere will be ruined. With global coherence and mobility, pandemics (e.g. COVID-19) will become an integral part of life.

The emergence of AI gives rise to new risks, among which – replacing humans in production processes or "intellectual competition" between humans and AI, which can become a significant source of change on the planet. Finally, changes in a person himself are unpredictable because of virtual realities, psychological "merging" with digital gadgets and AI.

There are only the most relevant challenges to the humanity. It is too massive and dynamic to resolve the problems by turning to the past, to previous technologies, forms of management, and life in general. Thus, abandoning the use of genetically modified organisms would make tens of millions of people suffer from starvation. The path to well-being lies only through innovation, creation of new economic, cultural, social-organizational, political, management – namely, the practices, i.e. holistic and sustainable realities, and not detached technologies or types of activities.

As noted earlier, practice means "implementing" a certain system of views, activity patterns, and values. Practice is built and develops relying on ontological, value, and ethical principles, i.e. the result of thinking. Given a new practice must be conceived, tested, and spread quickly (there are no centuries left for a steady movement), thinking becomes a "business number one", that allows drilling the new practice in an ideal way, on a model or on special "samples of thought[8]", reducing the possible risks for innovation impacts.

Thinking shortens time, because it "packs" and adds past activities in the future in a non-evolutionary way through idealization, transformation of ideal objects and constructing a new reality. Such thinking as meta-technology itself requires design, construction, and experiments.

Right now, people are transferring the mechanical component of thinking – processing information by algorithms – to computers. Self-changing algorithms (artificial neural networks) and technologies that can link computers to the reality (computer vision, etc.) are being developed. There is also a "weak" artificial intelligence, and new attempts to create a "strong" AI are being made. In the future, hybrid collective subjects of thinking – people and AI agents – will be produced. The subject of "thinking about thinking" will be collective and hybrid intelligences, their capabilities and limits, efficiency, and work technologies.

To summarize, in University 4.0, thinking means establishing rational and value-based foundations for new practices; this is "thinking about thinking", designing new technologies for collective and hybrid intelligences. This thinking is methodological, reflexive, and voluntary in relation to its own objectivity and the means used.

To master such thinking, students should participate in the work of collective and hybrid intelligences, creating virtual realities and designing new practices; they also should be involved in communications between different realities, practices, maintaining the general frame of the "world of the worlds".

• ***Object***: World of thinking: individual, collective and hybrid subjects of thinking and their activity; rules, norms, principles of thinking; foundations, possibilities and limits of different thoughts and practices; thinking and practice as a collective and multi-positional reality; "delicate" structures of collective thinking and practice (communication, consciousness and will) – search, generation, reflection, awareness, volition, concentration, transcendence, etc.

• ***Manner***: identifying / setting / transforming the foundations (ontological, value, ethical) and boundaries of thoughts and practices; analysis/reflection of objectivity and the means used (thinking and practice); creat-

[8] A sample body may be a practice of experiments.

ing sample bodies of thought – virtual reality (world); testing thoughts through actions; creating, testing and configurating collective and hybrid intelligences.

• ***Intention***: 1) to suggest new tools for objective thinking; to develop principles and laws of methodological thinking, to construct a general field of thinking[9]; 2) working with subjectivity (self-development), creating designs and technologies for the collective and hybrid intelligences; grounding cognitive civilization: technologies, organizing principles for activities; social relations and institutions; new antropology orientated practices.

Conclusion. Thinking institutions in the Modern World

Philosophers, sociologists, cultural scientists, and futurologists interpret the 20th –21st centuries as a dynamic transformational era – a change for "post-industrial society" (Bell, 1976); "knowledge society", "network society" (Castells, 2005), "cognitive phase in social development" (Pereslegin, 2007). Technological development, and digital revolution join economic, social, and cultural "shifts" and turn into a systemic transformation affecting all spheres and aspects of human activity and life. From the point of view of institutions of thought, the following is important.

1. Increasing importance and scale of intellectual activity. Knowledge production, technologies, innovations, new meanings, and lifestyles are becoming extensive areas of activity by the volume of value created and the number of people involved. Innovations that change products, processes, management, and markets become a drive for the economic entities. "Collective intelligence" – "project teams" which handle challenges and generate knowledge and innovation – becomes a major productive force, as it determines performance of other social and production systems.

Complex systems become the object of thought and project activities: socio- and eco-systems, climate, genomes of organisms, psyche, culture, anthropotypes (cultural versions of what it means to be a human), artificial intelligent agents (as parts of other systems as well) and other new areas (Efimov, 2014).

2. Articulating collective intelligence. Thinking and creativity are fundamentally collective – they imply a dialogue of different points. Therefore, "setting of collective intelligence" and searching for effective forms of their work drives the human capital enrichment. Thus, citizens participate in municipal and state management; expert intelligence is institutionalized in the form of think tanks, "expert clubs," etc. Online media publish not only articles by journalists, but also readers' discussions. On the Internet, there are "citizen science" platforms, networks of scientists, problem-oriented platforms, etc. In intellectual search, spontaneous self-organization of participants is insufficient; it is necessary to develop organizational formats, "protocols" and psychotechniques to launch and control collective intelligence, building a culture of collective creative activity. A new direction will be a hybrid human-machine intelligence.

3. Expanding cognitive technologies. Currently, "cognitive" technologies relate to data analysis, computer memory, artificial intelligence, and computer-brain interfaces. For collective intelligence, a wider range of technologies is important: 1) intellectual functions exteriorization (display on external screens); 2) creating sign-symbolic systems (models, languages) that enables objectifying the search movements of thought; 3) gathering and functioning of collectively distributed intelligence; 4) supporting awareness and thinking, including absence of routine intellectual functions; 5) gathering and functioning of complex knowledge – multi-subject, cross-subject; 6) supporting creative mood of participants in intellectual work. Interfaces are required for internal communications of collective and hybrid intelligence: person – to – person; human – computer; computer – to – computer.

Technologies will be complexes that connect technologies in the usual sense (for example, information and computer) with the forms of co-organization of people, people and artificial intelligence, methods of knowledge cir-

[9] It is still not clear in what categorical or metaphorical patterns the foundations and boundaries of methodological thinking can be determined.

culation, ways of matching interiorized and exteriorized intellectual work (Efimov, 2014).

4. The task for making a cognitive society and developing universities. The future of a cognitive society and cognitive technologies development order upgrading in higher education institutions. It is necessary to understand what new processes in society need institutionalization; a university can "capture" these trends, interpret them on its own base and transmit the results to the society. It can become a testing ground where new technologies and forms of collective intelligence and human subjectivity are developed. To become drivers for a cognitive society, universities need to bear in mind:

1. Generation of a new social agenda (in groups and communities, nations, and countries, all the mankind). It is necessary to ensure a full cycle of intellectual work: a) comprehending new realities and challenges, formulating contents, and problems; b) analyzing problems, generating concepts, models, tasks; c) creating tools and activities to solve the problems.

2. Creation and implementation of new practices in economics, culture, human development, etc. The cycle includes a) designing a new practice; b) forming a project team, creating a precedent – a pilot practice; c) understanding the precedent, highlighting new ways of thinking and acting in the practice, defining the boundaries; d) designing a practice prototype, its scaling and replication.

3. Ensuring the processes of human evolving – implementing an individual educational trajectory and mastering professional activities. First, this is the "funding of a person" – understanding the intentions, goals, and targets of his development. At the same time, semantic and substantive grounds for a person's education are formed, in contrast to accidental interests that drive him/her in the "sea" of educational resources. Mastering a profession is conceived not in terms of individual skills and competencies, but as learning an integral system of activities, including subject ontology, methods, norms and techniques of thinking and activity.

All the above cannot be implemented by business corporations or government bodies. What is needed is a "universal" subject that freely operates with positions, ontologies, organizational schemes, i.e. Universitas as a special type of community. The current universities remain traditional, but those of them who take leading positions can take this ideal image as a development task and create themselves a new generation of university prototype.

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Three generations of universities were communities that created new mindsets and founded new practices. With the active participation of university "communities of thinkers", basic ontologies of pre-industrial, industrial and post-industrial civilization were formed. A new generation university – University 4.0 – can significantly contribute to cognitive civilization forming, to its ontological and value principles.

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