Why Does Science Need Surplus Knowledge?*

Alexander ANTONOVSKI

Abstract. This article raises the problem of the functionality and a rational explanation of large bodies of surplus communicative scientific knowledge. To solve the problem and explain this phenomenon, it draws on the resources of the system-communicative theory of scientific communication and social-evolutionist approaches. The ability of the system-communicative theory itself to explain this phenomenon is seen as a possibility of its verification. The article proposes a working hypothesis that links the existence of a class of surplus research and researchers with the function of meta-observation: Through their online-network reactions on relevant electronic platforms (downloads, citations, readings, reviews, recommendations, etc.), the distribution of the scientific reputations of science leaders and the selection of the best scientific knowledge are ensured. This function, according to the author, compensates for the lack, in the system of scientific communication, of an external audience or a public capable of understanding and adequately evaluating scientific achievements. The conclusion of the article is that the past "collegial and deliberative" assessment of scientific achievements, with the corresponding distribution of reputations and support for research projects, is incompatible with the dynamic conditions of the "publication market."

Keywords: system-communicative theory, social evolution, science and society, social network society and science.

https://dx.doi.org/10.21557/SSC.96151651

A. Antonovski, D. Sc. (Philosophy), Chief Research Fellow, Institute of Philosophy, Russian Academy of Sciences. E-mail: antonovski@hotmail.

This article was first published in Russian in the journal *Epistemologiya i filosofiya nauki* (Zachem nauke luzery? O pereproizvodstve nauchnogo znaniya i yego funktsii. *Epistemology & Philosophy of Science*. 2023. Vol. 60, No. 2, pp. 75-93. DOI: https://doi.org/10.5840/eps202360226).

*This study has been supported by the Russian Science Foundation, Project no. 22-28-00804, "Science as Communicative System and Science Policy in the Social Network Epoch."

Formulating the Problem: Complexity vs. Rationality

The problem raised in this paper is whether the hyper-complexity of modern science is compatible with the rational organization of scientific knowledge and communication. Science, of course, has never been easy for the general public to understand, but at least scientists themselves had a general grasp of the problems of related scientific disciplines, to say nothing of various (methodological, instrumental) conditions of their study. Not infrequently, scientists themselves produced their own instruments (think of Galileo's and Newton's telescopes and the voltaic pile).

Thus, when we say that science is complex we mean not solely or largely the *incomprehensibility and inaccessibility of scientific propositions*, which in their objectivity today are obviously incompatible with the subjective experience of a lay person, and in their abstractness have become divorced from the realities of people's life world.[1] We will speak about *structural complexity from the system-communicative perspective* – i.e., the ability of communicative systems to use their structural diversity (the subject specializations, and disciplinary and social differentiation of science) to obtain ever more accurate and ever more profound true knowledge. *To achieve this goal*, *science has to become so complex as to become incomprehensible to itself.*

The technical-instrumental mediation of observations is a typical example. The biologist who uses an electronic microscope to study viruses or a sequencer to decipher genetic code often has to deal with "black boxes," such that today they are more often than not unfamiliar with their design and principles of operation. In that sense, correct interpretation of observations is not necessarily ensured by the observers' knowledge of their instruments. Obviously, such technicization of science, which brought into being a new cluster of scientific specializations and, accordingly, a new class of technical and engineering researchers specializing in the design and production of scientific instruments that *relieves*[2] other scientists, simultaneously leads to mutual misunderstanding. Indeed, such a technology may even be a fundamental and abstract theory – i.e., quantum physics – that defies visualization, understanding as visual representation, and yet is an "instrumental condition" of the production of various theoretical and applied scientific outcomes.

Thus, science being incomprehensible to itself as a result of its self-generated and successfully used complexity is today an obvious fact. Owing to this, science is to some extent losing its traditional system-communicative property – i.e., rationality.[3] Accordingly, a theoretical description of science itself can and must use scientific tools, and this ability is the key that ensures its rationality. But it is this rationality that faces the problem of complexity: *How is such self-observation and self-organization of science possible if scientists themselves do not understand how their instruments are designed*? What then can be said about the administration of modern disciplinary differentiated science?

For all that, it is obvious that science itself – on the practical level of its experiments, observations, and theorizing – has no problem with its own hyper-complexity and is not bothered by its (ir)rationality. The challenge, then, is to find a theoretical explanation of this paradoxical circumstance. In the concluding part of this paper, we will propose such an explanation and show that rational self-description, self-assessment, and self-organization of scientific knowledge are made possible by a huge body of scientists often dismissively referred to as "scientific ballast." In the meantime, let us look at the social consequences of the growing complexity of science.

Social Consequences of Growing Complexity: Indicators Instead of Collegial Assessment

Let us now narrow the problem of the complexity and rationality of science to a single aspect. In accordance with the system-communicative theory (SCT), which we will use, the complexity of a system may change not only in the subject-specific (thematic, disciplinary) but also in the social and temporal dimensions. Thus, the disciplinary differentiation of sciences entails corresponding structural and social changes (the emergence of new classes of scientists, specialties, competences, etc.), which necessitates *socio*-organizational decisions and what is more, *swift* (better still, instant) decisions. Failing that, a science organization cannot count on success in the context of world scientific competition. Temporal and social conditions (dimensions) seem to block decision-making in the subject-specific dimension of science communication. Thus, in making decisions regarding the assessment of an achievement of a candidate for an academic position or who should evaluate a project seeking funding, the relevant authority (collegial body, academic council) often has no opportunity (typically, *time* but also corresponding *experts*) to thoroughly examine the *substance* of the projects and on that basis deliver a substantive collegial assessment. Collegial bodies and administrations of institutes have to go by what is called scientific reputation. Today, scientific reputations are formalized in the shape of generalized indicators of a researcher or a group implementing its project. Reputational indicators compensate for the unwieldiness and slowness of scientific organizations, but such formalizations call for crystallized alternative algorithms in measuring scientific achievements. At present, this is the responsibility of the emerging new network organizations that provide the "structural interface"[4] between science and its (administrative and economic) support system. This is not the case everywhere or always, but the trend toward using formal and generalized indicators of results is there. Hirsch indices, impact factors of journals, variables of citations, downloads, readings, recommendations, and reviews are just some of the present-day scientific reputation variables. This does not eliminate substantive expert examination of research results. But *in the majority of cases*, substantive expert examination takes place *at a primary level of perception* or, so to speak, "the first layer" of entry into "artificial neural networks" that today are embodied by numerous Internet communities. Here, articles are indeed downloaded and read, the power of arguments and novelty of ideas are analyzed, but then, at the following levels of this "artificial neural network," substantive information is reprocessed, partly lost, and eventually turns into generalizing "success indices" (of researchers, projects, journals, and institutes).

Of course, substantive discussions in the form of the rational exchange of arguments in scientific journals have not gone away. New knowledge is perceived, assimilated, criticized, combined in new ways, and translated from text to text. But decisions on supporting or turning down a project or including a researcher in an academic organization are not made on the basis of an argument winning on its merits, whatever Jürgen Habermas might say to the contrary. In the process, the substantive critique of a scientific achievement also has to be presented in the form of an article, hence, become an impulse in a network perception on an electronic platform, pass through filtering levels, and turn into an indicator. Only then will the "true strength" of the critical arguments contained in it come out.

As a consequence, the general network assessment becomes anonymous (although the authors, if they wish, may look up who downloads, quotes, and "likes" their articles). In some sense, the anonymity reproduces the familiar anonymity of collegial decisions, and secret voting by members of dissertation and academic councils and competition commissions. These secret voting procedures in the process of collective deliberative choice are still widespread, for they ensure impartiality and, as a result, the *objectivity* of scientific assessment of projects and qualifications. But today, this seems to be superfluous, because decisions are based on "*objective* algorithms" of calculating scientific reputations.

As a result, the scientific organization where a researcher works or where a project is being carried out is not only *relieved* of the need to thoroughly examine the researcher's work (which is not always possible considering specialization), but is *protected* against possible charges (of arbitrariness and bias of the panel) on the part of the researcher first and foremost by invoking the "objectivity" and "independence" of online-network expert assessment. Nor should one discount the fact that science organizations themselves are subject to similar assessment of scientific effectiveness, hence are forced to get rid of researchers who "worsen" their ratings and jettison topics deemed to be unpromising. This circumstance, triggering positive feedback, further motivates the administration to proceed from reputational success indices of their employees in their personnel and financial decisions.

It would seem that under these conditions, scientific organizations should seek total optimization by getting rid of all "unsuccessful" colleagues. And yet, this practically does not seem to be the case and indeed the balance between successful and less successful researchers has not shifted to any appreciable degree. A hypothesis explaining this paradox will be presented at the end of the article.

Communicative Losses and Monopolization of the Publications Market

From the socio-evolutionary point of view, it can be assumed that today we are observing a transformation of important evolutionary mechanisms of science communication responsible for renewal, selection, and acceptance of the best scientific knowledge. Like any transformation, it involves communicative losses.

One of the most important communicative losses due to the new expert assessment procedure is that the new selection organs (network expert observations) as the external world of a scientific organization simply do not notice or ignore a major part of the scientific output of such organizations.

Thus, on the one hand, up to 80% of scientific texts are never quoted, and 50% are never even read.[5] This is especially true of social and humanities studies. As a result, a huge mass of offers of scientific communication (on the understanding that scholarly articles are offers of communication) draw no communicative response, which means that a vast part of the apparatus of science is essentially running idle. At the same time, it cannot be asserted that these texts are rejected as unscientific, mistaken, or irrelevant. They simply do not reach the so-called linguistic market, as Pierre Bourdieu understood it [9].

On the other hand, as if to counterbalance the diminishing chances of communicative success, large scientific consortia or collaborations are being formed (CERN, IARC, and many others, typically created around Mega-Science facilities). Under the auspices of these new types of organizations (successful by their very type), publications come out under the authorship of hundreds and even thousands of researchers. These "communicative offers" cannot but be successful in the world market of scientific publications, unlike the competing "individual author" products. They have ready access to the most prestigious world publications and can be assured of a large number of response citations. And yet, the personal contribution of a specific author to these publications may be close to zero. This is a manifestation of a new anonymity – anonymity of real credit for the achievements of Mega-Science, which in a way corresponds to the anonymity of network assessment of scientific knowledge.

This circumstance, in turn, speaks to the transformation of the mechanisms of evolutionary selection of the best scientific knowledge. Positive assessment, recognition, and acceptance of a collaborative product de facto occurs *before* it hits the "publication market" and *before* it is selected by external filters, experts of scientific journals and network reviewers (responsible for the functioning of the binary *true/false* coding): Collaborations cannot err. This prompts the need to take a closer look at the transformation of the mechanisms of the evolution of science.

Evolution of Evolutionary Mechanisms of Scientific Communication

The foregoing would seem to suggest that science's systemic selectiveness, its capacity to effectively choose its following operations, is partly failing. From the Darwinism-oriented system-communicative point of view, the aforementioned mechanisms at the first stage provide preliminary generation of a pool of random variations of scientific messages (the first mechanism), which then are "selected" through a *binary true/false code* (the second evolutionary mechanism) [5; 15; 1] as the article is considered for publication in a scientific journal and is subsequently criticized. The two mechanisms function independently of each other, just as mutation in the course of organic evolution does not occur *specially* or *purposively* with an eye to external world conditions of subsequent natural selection and the formation of a new population.

The second selection mechanism *ascribes truth*, which ultimately ensures system formation – i.e., connection of communications in time (transformation of one text into further texts oriented toward and based on the previous text). By contrast, declaring falsehood or error paved the way for systems *reflection*, recourse to past experience in the course of analysis of the circumstances that caused the failure in science production.

The evolutionary theory of science assumed that the mechanisms of variation and selection – i.e., generation of scientific knowledge and expert assessment of scientific knowledge – operate autonomously. In the standard language of the philosophy of science, this distinction took the form of the distinction between "the logic of discovery" and "the logic of grounding." Systemic conceptualization of the *randomness* of a scientific achievement was formulated by Robert Merton in the concept of *serendipity* [17]. Stock examples of such accidental discoveries include the discovery of "animal electricity" by Luigi Galvani, which eventually led to the invention of the voltaic pile, and the discovery of penicillin by Alexander Fleming. In the aforementioned cases, there was no prior planning or expectation of scientific discoveries in pursuit of corresponding scientific goals.

However, the above analysis suggests that in the modern world, these two evolutionary mechanisms have diverged too far. On the one hand, primary selections (generation of a scientific communication as a result of serendipity, "mutation," "crazy hypotheses") may well go unnoticed or be inaccessible for the mechanism of their external (online-network) selection, hence for inclusion in (or exclusion from) the pool of true and validated knowledge. On the other hand, in some cases (especially in giant collaborative entities), generation of primary selections is so intensive and the discoveries so expected, prepared, and planned that their "communicative offers" (in the shape of publications) cannot be ignored or rejected. As a result, the concentration and expectedness of accidental discoveries in one place (Mega-Science projects, large R&D laboratories) compensate, as it were, for huge losses of surplus scientific products in the rest of science. This resembles competition between giant monopolies and small enterprises, which are incapable of delivering a comparable market product.

Does the System-Communicative Theory Explain the Phenomenon of Surplus Knowledge?

It is important to note that science itself, at the level of its operations, is none the worse for the fact that large bodies of "scientific supply" on the academic market remain unused. The challenge is theoretical description and functional-rational explanation of this phenomenon. I submit that the functional and rational meaning of this phenomenon can be explained not only in the system-communicative meaning of rationality, but also in its narrow economic meaning. *Why does the political system that administers science spend colossal resources redistributed from the economic system to produce surplus scientific knowledge*? Let us see how the new state of science can be classified.

I believe that in this case, we are looking at another "communicative disaster" brought about by the advent of world and global network communication. Similar processes are taking place in other communicative systems. More and more social movements are formed in online-network communities that share their protest sentiments but do not have a uniting idea (communicative medium, binary code) and thus a rationally interpreted *task or function*.[6] As a rule, they have no formal leaders or organizational forms of administration, being generated through spontaneous self-organization in Internet communities and then spilling out into the streets in an off-line, physical form. The society of the future is likely to be a network society whose outlines are just emerging [6].

How could the system-communicative theory, proceeding from its premises, explain the new character of modern science? Before presenting my working hypothesis explaining the stated problem of surplus scientific knowledge and the function of the "scientific ballast," let us see which postulates of the SCT are borne out by the current state of science communication and which do not pass the falsehood test and can be rejected or adjusted.

SCT and Complexity

The growing inner *complexity* of science, first and foremost in the form of proliferating and ever more extended descriptions of external reality (big data) in the framework of ever more extended and specialized disciplines, obviously corresponds to the basic principles of the system-communicative approach, which links the functioning of systems with constant growth of their internal complexity. The only question is: What happens to the key functional task of a communicative system – i.e., reduction of its own complexity with the help of its systemic binary mechanism, assessment of its descriptions of reality in terms of true or false? Why is this task not being performed?

SCT and New Communication Media

The emergence of *online network media* also corresponds to the basic premises of the SCT. As a rule, such new developments cause "communication disasters." Such disasters have already happened in the history of human communication [2].[7]

SCT and Anonymization of Communication

The fact that a scientific article as an invitation to communication turns "anonymous" and thus "loses individual authorship," in turn, corresponds to the so-called "anti-humanistic" character of the SCT. Participants in communication are seen as operators, as mediators in recursive generation of one communication by another communication, of one scientific text by another scientific text. Individuals merely "put at the system's disposal" their capacity to perceive impulses from the external world, something systems have not (yet) learned to do. In a certain sense, the hyper-complex communication becomes the "author" of the scientific article. In that sense, critiqued authors are also co-authors of the corresponding scientific text.

But the immediate producer of knowledge ("the experimenter"), which has not yet received the form of a communicative message, in turn, cannot receive an unequivocal individual identification. Stressing this circumstance, Rudolf Stichweh quotes the American physicist Alan Thorndike:

> Who is the experimenter… Rarely, if ever, is he a single individual.… The experimenter may be the leader of a group of younger scientists working under his supervision and direction. He may be the organizer of a group of colleagues, taking the main responsibility for pushing the work through to successful completion. He may be a group banded together to carry out the work with no clear internal hierarchy. He may be a collaboration of individuals or subgroups brought together by a common interest, perhaps even an amalgamation of previous competitors whose similar proposals have been merged by higher authority.… The experimenter, then, is not one person, but a composite. He may be 3, more likely 5 or 8, possibly as many as 10, 20, or more. He may be spread around geographically, though more often than not all of him will be at one or two institutions.… He may be ephemeral, with a shifting and open-ended membership whose limits are hard to determine. He is a social phenomenon, varied in form and impossible to define precisely [19, p. 186].

SCT and Scientific Rationality

The system-communicative thesis about reflection or rationality in the form of re-entry is also confirmed. Science (as represented, for example, by epistemology or the SCT itself) can identify itself in its own environment and can distribute true/false indices in relation to how these true or false attributions are distributed in its external world (in the science itself being analyzed). From the standpoint of the SCT, any observation must, by definition, co-consider and co-represent (preserve or potentialize) meanings rejected through the use of systemic distinctions (for example, truth and falsity) [15]. From that perspective, errors, delusions, false claims, and rejected theories may acquire "reflexive meanings" that, while stopping scientific process, launches mechanisms of recursive self-analysis of second-order observation capable of concentrating precisely on what has been rejected and on the causes of errors made. Thus, many scientific messages or theories (for example, the famous Prout programme), rejected as insufficiently proven, became relevant over time [10, p. 284].

So why are huge masses of scientific proposals left outside the realm of observation and reflection? I believe that in this case it is incumbent upon the SCT to try to explain the overproduction of huge amounts of surplus scientific knowledge. On the one hand, this surplus knowledge is in a "potentialized" state, waiting to be assessed as true or false. On the other hand, it is well-nigh unimaginable that it will ever receive attention. It is as if it were excluded from the process of evolution of science, as witnessed by the next SCT thesis.

SCT and the Evolution of Science

The system-communicative interpretation of the evolution of science implies increased diversity of scientific proposals (crazy ideas, idiosyncrasies, working hypotheses, insights, and brainwaves) that, as established above, constitute the first knowledge-selection mechanism. Thereafter, in the course of subsequent evolutionary selection (the second evolution mechanism, i.e., reviews and selection of journal publications, as well as in the process of subsequent critique and analysis in other journal publications) the variants are either rejected as false or accepted as true [13].

However, at this point another question crops up. Why is it that the majority of variants simply *do not reach* the corresponding filters of coding and selection? The question of their being true or false is not even asked. Production of scientific knowledge runs idle, and this fact, in our opinion, the SCT has not yet explained. Meanwhile, the mass of surplus scientific supply in the market of scientific publications is snowballing, a situation that is compounded by the specific academic "demography": The number of scientists doubles every 15 years, such that the number of living scientists today is greater than in the whole history of science until the late 20th century. If this trend continues (which of course is hard to imagine), by the middle of the century, the whole population of the planet will consist of researchers.

SCT and Binary Coding in the Medium of Truth

Obviously, unused scientific publications are not coded either as true or false; they are not granted the third scientific status, the status of a *problem* (i.e., deferred knowledge that is neither true nor false). In a sense, the generalizing fourth coding of scientific knowledge is crystallizing (as forgotten or, conversely, protected from oblivion), which in some way reproduces the "archaic" interpretation of truth proposed by Martin Heidegger [7].

It is true that this hypothetical communicative catastrophe (like all previous catastrophes), which threatens to disrupt system-forming and the functioning of binary coding (rejection or acceptance of systemic operations) is being overcome in the course of the evolution of scientific communication, which chooses optimal ways of reproducing itself. Thus, the *monograph* is being phased out as a primary offer or an expression of scientific communication – a *scientific operation* as an elementary event in the science system. The scientific article reduced to a single thesis allowing unambiguous verification (and as a consequence, acceptance or rejection) has become practically established as a unit of knowledge or elementary communication operation. On the contrary, more voluminous scientific works have too many meanings to make them a unity, to give them a form that permits a communicative answer of "yes" or "no," which in the positive case would make it possible to plug in other operations. A monograph, if it claims to be inwardly consistent, is a kind of summing-up codification of knowledge (paradigm) that constitutes the third evolutionary mechanism: stabilization of the idea as a target of new variations and innovations.

SCT and Structural Interfaces Between Systems[8]

One way of solving the problem of growing complexity and the resulting surplus of knowledge has been structural coupling of science and business, above all publishers and aggregators of scientific texts (Web of Science, Scopus, RSCI, to mention just some). The latter have undertaken the tasks of the disciplinary-distributed accumulation of scientific achievements and statistical assessment of the demand for them. This industry creates network electronic platforms, offers business services (on a scientometric basis) of filtration and assessment not only of science texts, but also of research and educational institutions, laboratories, research trajectories of scientists, scientific journals, research topics, and grant projects. These electronic platforms and the scientific experts they employ are new instances of selecting the best and most needed knowledge. In the process, the classical filters of selecting knowledge – i.e., scientific journals – are ranked self-referentially in terms of reputation, indexed, and ultimately "selected." This goes some way toward solving the problem of reworking the internal complexity of communication: Thanks to the structural coupling of science and the network industry, the improbability of reading and binary coding of new texts becomes a probability.

SCT and Comparative Analysis of Communicative Systems

The methodological basis of SCT is comparison of functional solutions of social problems offered by different systems. In that sense, the "market" of science publications does indeed replicate in many ways the structural features and dynamics of economic markets in which goods are purchased in the medium of money or rejected (with all the consequences in terms oversupply and inflation). In this context, the "glut of texts" in the publication market and noticeable "deflation of truth" (public mistrust of research results leading to "denialism") may be compared to the functioning of the economic market. This kind of "market relations" generates a specific medium[9] of scientific communication or combinatory potential for constructing and delivering new texts. Even so, the exclusion of some texts from "text communication" prevents the use of the full potential of this medium: Texts are gathering dust in libraries, on hard drives, and more recently, in cloud systems.[10]

Working Hypothesis: Verification of SCT and Solutions to the Problem of the Surfeit of Scientific Knowledge

What communicative use can there be in the overproduction of scientific knowledge for which there is no demand in scientific communication? The answer is similar to the solution offered in the SCT to the problem of the generation of excessive meanings in communication as a whole. What is the communicative benefit of the fact that every utterance about the world is matched by its linguistic negation, which makes possible the duplication of the reality being described? The particle “not,” which carries the linguistic potential of negation (and simultaneously construction) of reality, obviously makes socio-evolutionary sense in that it multiplies the *pool of variability* of communicative messages and sets in motion the mechanism of variation (read: change, innovation) of the communicative process. Following this logic, let us try to give a positive answer to the question about the *evolutionary function* of the overproduction of scientific texts.

My working hypothesis is that overproduction of scientific messages is an epiphenomenon connected with some evolutionary advantages and benefits that accrue from seemingly “resource-wasting” communication for the overall optimization of the scientific process. Thus, I maintain that it is “good for science evolution” to have a large pool of *specifically trained and oriented minds*. This mass of minds compensates, as it were, for the fact that science (unlike other communicative systems) does not have a specific “role asymmetry,”[11] and therefore does not have an external public or audience that perceives and appreciates its achievements.

As a kind of compensation, “surplus scientists,” by creating an internal scientific “public opinion,” provide scientific publicity and in this capacity are a key factor (but not an actor!) in making “science organization” decisions and science policy.[12] In consuming and assimilating the latest scientific information, these researchers exercise their “active right” to select worthy representatives of science: By their reactions in networks (likes, downloads, reposts, reading, citations, recommendations, network reviews), they ensure quantitative distributions and the “awarding” of scientific influence and reputations (to institutes, projects, laboratories, and researchers). In that respect, they are the ones who “transform” scientific messages into scientific achievements, their mission consisting in the “representative democratization” of science. Together, they comprise the “selection authority” (the second evolutionary mechanism), which ensures the assessment (currently mainly in online networks) of the achievements of science leaders.[13]

At the same time, this “internal scientific audience” performs an even more important communicative function by subjecting pioneering research to adequate and thorough scientific reflection and coverage and, in this sense, *genuine publicity* of scientific achievements. Thousands of readings and analysis make sure that mistakes, falsifications, poor grounding, or lack of originality do not go unnoticed for the reputation of science leaders.

It is mainly from among its own ranks that units of “internal science police” are recruited [3] to conduct “science purges” and rid science of what is unworthy. In Russia, until recently, the “science police” was network scientific communities like Dissernet, Disseropedia, the Scientific Workers’ Society, the Russian Association of Science Editors and Publishers (ANRI; RASSEP), and the Internet newspaper *Troitsky Variant*. Through this audience, institutionalized in network communities as a self-monitoring authority, science keeps itself on its toes, demanding that researchers leave the infamous "comfort zone." Now, decisions on academic appointments and the fate of research projects are based on "objective indicators" and do not depend entirely on the arbitrariness and cronyism of corresponding "colleges" (academic councils, dissertation councils and competition commissions) whose members tend to favor their own candidates, expecting their support at future sessions. All this greatly increases the competitiveness, criticality, and general agonality of science communication.

Thus, in my opinion, the process of producing surplus knowledge is linked with the mobilization of the perceptiveness of science as a whole. The involvement of a huge number of "sensors" equipped with research instruments and competences makes it possible to process, externally and internally, unprecedented amounts of science information. Accordingly, this function is divided into *external referential* and *self-referential* tasks. In this way, on the one hand, a gigantic "sensor" is created that captures and describes the hyper-complex *external world of science* and generates big data (countless descriptions of types of micro-organisms or countless stars) that *do not require a direct communicative response* or acceptance by other scientists in the form of critique or citation. On the other hand, by their network online reactions, this class of researchers observes and records the *inner hyper-complexity* of science communication, which is expressed in indices of influence, scientific reputations, and assessment of the quality of scientific work.

References

1. Antonovski A. Yu., Barash R. E. The Evolutionary Dimension of Scientific Progress. *Social Epistemology*. DOI: 10.1080/02691728. 2021.2000662. Published online: 28 Nov 2021.
2. Baecker D. Niklas Luhmann in the Society of the Computer. *Cybernetics* & *Human Knowing*: *A Journal of Second-Order Cybernetics*, *Autopoiesis*, *and Cyber-Semiotics*. 2006. Vol. 13 (2), pp. 25-40.
3. Brunner J. Policing Epistemic Communities. *Episteme*. 2013. Vol. 10 (4), pp. 403-416.
4. Bühl W. L. *Einführung in die Wissenschaftssoziologie*. München: Beck, 1974.
5. Campbell D. Blind Variation and Selective Retention in Creative Thought as in Other Knowledge Processes. *Psychological Review*. 1960. Vol. 67 (6), pp. 380-400.
6. Castells M. *The Theory of the Network Society*. Bodmin, Cornwall: MPG Books Ltd, 2006.
7. Heidegger M. On the Essence of Truth. Id. *Existence and Being*. Chicago, Il.: Henry Regnery Company, 1942, pp. 319-351.
8. Husserl E. Phenomenology. *Logos*. 1991. Issue 1, pp. 12-21. (In Russian.)
9. Jaffe A. Pierre Bourdieu, Language and Symbolic Power. *Language in Society*. 1993. Vol. 22 (1), pp. 154-157.

10. Lakatos I. History of Science and Its Rational Reconstructions. Id. *Methodology for Research Programs*. Moscow: AST, 2003, pp. 5-40. (In Russian.)
11. Lovelock J. *Novacene*: *The Coming Age of Hyperintelligence*. London: Penguin Books, 2019.
12. Luhmann N. *Evolution*. Moscow: Logos, 2005. (In Russian.)
13. Luhmann N. Evolution of Science. Trans. by A. Antonovskiy. *Epistemology & Philosophy of Science*. 2017. No. 2, pp. 215-233. (In Russian.)
14. Luhmann N. *Truth*, *Knowledge*, *Science as a System*. Moscow: Logos, 2015. (In Russian.)
15. Luhmann N. *Wissenschaft der Gesellschaft*. Berlin: Suhrkamp, 1991.
16. Meho L. I. The Rise and Rise of Citation Analysis. *Phys*. *World*. 2007. Vol. 20 (1), pp. 32-36.
17. Merton R. K., Barber E. *The Travels and Adventures of Serendipity*: *A Study in Sociological Semantics and the Sociology of Science*. Princeton, NJ: Princeton Univ. Press, 2004.
18. Ridley M. Evolution. Hoboken, NJ: Wiley-Blackwell, 2004.
19. Stichweh R. Der Wissenschaftler. *Der Mensch des 20*. *Jahrhunderts*. Magnus Verlag GmbH, Essen, 2004, S. 163-196.

Notes

[1] This prompted ever new “back-to-the-things-themselves” projects of Edmund Husserl, Martin Heidegger, and early Jürgen Habermas, who reconstructed the sphere of “immediate evidence” as the “pre-scientific attitude” of “life-world,” in Husserl [8].

[2] For more on the significance of “growing complexity” as a pre-condition of “relieving” science communication, see [19].

[3] Rationality from the communication systems perspective differs markedly from its classical meaning (planning, goal orientation, control of the means, conditions and alternatives of achieving the goal). It is seen as the system’s ability to define itself (or its own distinctions) in the system’s external world. It is the capacity of the communicative system to fix its own key observation distinctions (power, truth, faith, morality, money, love) on one aspect of the corresponding distinction, hence to identify itself in the external world. Thus, in the system of science (for example, from the epistemological, sociological perspective, i.e., through *true-false* distinction) we can study how the *true/false* distinction is actually used in science and show that it is not only distinction, but also unity [14].

[4] There has emerged a whole network industry of assessing scientific achievements: a professional staff of network reviewers, network platforms that conduct regular anonymous assessment of the achievements of researchers, institutes, laboratories, and scientific publications. The scientific organizations themselves, while still de facto including and excluding their members themselves, by self-loading, partly outsource substantive assessment of scientific achievements to these commercial organizations.

[5] “as many as 50% of papers are never read by anyone other than their authors, reviewers, and journal editors” [16].

[6] Unlike politics (generation of collectively binding decisions according to the government’s binary code), science (conducting research regulated by the truth code), and the economy (market regulation of transactions through the medium of money and so on).

[7] Thus, the emergence of oral *language* made it possible to say “no” to any message (= a bid for contact), which generated social conflicts; the development of *writing* obviously

severed direct interactive links by removing communication from the direct influence of real normative bans; the invention of *printing* was a key factor in religious reformation and generally a key precondition of European modernity with all is wars and revolutions; and finally, electronic media, which opened up unprecedented opportunities for rival forces and power centers to influence and capture audiences.

[8] Classic examples of structural bonds between communicative systems are: *language* (which binds psychic structures and communications); the *brain* (which binds the activity of consciousness and the activity of the body); the *constitution* (which binds the structures of the legal and political systems); the *contract* (which binds the structures of the legal and economic systems); *taxes* and *levies* (which bind the structures of politics and the economic system); *copyright* (which binds the legal system and the arts); and *patents* (binding the economy and the legal system).

[9] Standard examples of communicative media as a potential of all manner of combinations are money and power (respectively, every payment or purchase is a specific form out of a multitude of possible transactions, and every political decision is one form in an infinite variety of other decisions).

[10] Today, there are some grounds for interpreting this surplus big data in the context of *pre-adaptive advances*, which anticipate and prepare new evolutionary breakthroughs and leaps forward, which explains the speed with which they happen [12, p. 125; 18]. If one agrees with James Lovelock that the advent of the *Age of Novacene* is inevitable [11], its future inhabitants may well need the vast and detailed scientific *big data* that is not needed today.

[11] In the process of differentiation, functional systems create asymmetries, transforming archaic stratified structures – for example, the asymmetry between production and consumption in the economy, asymmetry between the rulers and the ruled in politics. The education system involves the distinction between teacher and pupil, and the medical system has doctors and patients. The religious system is based on the distinction between the clergy and the laity. The legal system, too, juxtaposes the profession of lawyers and the wide audience interested in legal matters. It looks as if the science system is an exception. It reads – asymmetrically – the results of its work from the reaction of the audience, which it serves [15, p. 625]. "The audience of scientists is the scientists" [4, p. 242].

[12] Analogies with the features of political communication are evident.

[13] Not the least of their motives is the hope that some day they may be able to turn the asymmetry in their favor, such that their texts will be discussed and quoted. Here, though, comparisons may also be drawn with similar asymmetries in the mass media system in which the only way the audience can react to the views of media editorial offices is to switch to a different program. However, sometimes viewers manage to get through to a program or channel, and (oh, miracle!) they see or hear themselves live.

Translated by Yevgeny Filippov