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Modern Science: A Case of Collective Intelligence? On the Role of Thought Economy and Gratifying Attention in Knowledge Production

*Georg Franck**

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Intelligence, however it may be defined, denotes the capability of using one's attention efficiently. Being intelligent means to selectively pay attention to what is relevant in the situation, and most useful according to one's own aspirations. William James gave the following definition of attention: "It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization and concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition that has a real opposite in the confused, dazed, scatterbrained state that is called 'distraction' in French and 'Zerstreutheit' in German".[1] Attention, in order to align the definition to the concept of efficiency, is the capacity of processing information in a both highly selective and fully conscious way. The point of James' definition is that this capacity is of limited volume. In fact, you can check immediately how narrow this capacity is if you try to pay attention to two independent processes simultaneously or to read this page by doubling the speed you are accustomed to. The capacity is frighteningly narrow, given the abundance of things that deserve observance. Paying attention, to put it economically, has considerable opportunity costs. It costs to simultaneously ignore everything except the particular object that is being focused on. The allocation of attention thus has to cope with a characteristic asymmetry between the potential uses and the realizable uses. In short, attention is a notoriously scarce resource for any person with vivid interests.

Thinking and theorizing are activities with significantly high demands on attention. Accordingly, attention is the critical input to scientific research. From its very beginning, doing science has meant to get to grips with the limited bandwidth of the capacity of consciously processing information. Since the bandwidth of simultaneous processing is defined organically, thinking starts with colonizing the dimension of succession, that is, of time. The most basic and proven technology of involving the dimension of succession into mental activity is language. To cast an idea into the form of language means to decompose it into standardized units (words), suited for sequentially passing the bottleneck of simultaneous processing and to be used repeatedly. By concatenating the units according to mechanical (syntactic) rules, content is sequenced into the form of sentences, which, in turn, can be linked up to descriptions of any complexity.

[*] Prof. Dr. G. Franck
Dept. of Digital Methods in Architecture and Planning, Institute of Architectural Sciences, Vienna University of Technology (Austria)
E-mail: franck@iemar.tuwien.ac.at

From Thought Economy to the Knowledge Industry

Language thus proves to be the basic technology of thought economy. It vastly amplifies the weak forces of unarmed attention. It overcomes the narrow limits of the naturally defined capacity of conscious information processing. Language empowers attention to deal, in a controlled way, with ideas whose complexity vastly overburdens the forces of unarmed attention. It was thus only logical that science started with developing the thought-economic potentials of language.[2] By applying language to itself, that is, by explicitly describing the meaning of words, words were turned into concepts with sharply demarcated meanings. The leverage of language was further enhanced by extending the specification and refinement of concepts through the elaboration of terminologies, which, in turn, paved the way to the definition of artificial languages such as symbolisms that allow formalization. It was by way of the formalization of language that thought economy could cross the threshold to mechanization. The upshot of formalization is calculation, that is, the gain of precise information by a purely mechanical manipulation of symbols. Mechanization advanced when mathematics was utilized as a language of description (and when empiricism, accordingly, developed systematic observation into the methodology of measurement). Simultaneous equation systems are capable of turning descriptions into models that work as abstract machines. These abstract machines can be turned into concrete machines when translated into algorithms implemented by digital machinery. By involving digital machinery, mechanization of cognitive labor finds itself extended to automation.[3] Eventually, cognitive labor thus harnesses external sources of energy, as does physical labor in heavy industry.

Progress in science remains poorly understood if it is only seen as an accumulation of discoveries. Progress in science has

always had roots in, and repercussions on, progress in thought economy. Remarkably, progress in thought economy materialized not only in technology, but also in methodology and even in the social organization of cognitive work. A case in point is Descartes' contribution to the methodology of modern science. Descartes is famous for having introduced the "rational method" (laid down in his *Discours de la méthode*, 1637) to science. The rational method is an extension of the know-how of dealing with complex ideas, which natural language has incorporated ever since. Scientific research starts with describing, that is, with sequencing the problem. However, description as such is not enough. The problem has to be analyzed. Analysis, according to the rational method, means decomposition of the complex problem into components of manageable sizes. The rational method is the instruction of how to decompose complex problems into simpler and simpler ones in such a way that the solution to the complex problem can be recomposed out of the solutions of the simpler ones. The composition of the solutions of the decomposed problems is called synthesis. Analysis and synthesis are two sides of the same coin. Most remarkably, the interplay of analysis and synthesis was not only a significant innovation in thought economy, but also an anticipation for a century or so of the methods of what then became known as "industrialization".

Industrialization means systematic exploitation of the potentials that the division of labor holds for productivity. It means, on the micro level, decomposition of complex operations into simpler and simpler steps in such a way that the single steps become susceptible to mechanization and, in part at least, to machination. Industrialization means, on the macro level, differentiation of specialized lines of production that produce inputs to other specialized lines of production. On the micro level, the analogy between the industrial and the scientific division of labor is close to perfect. As in physical work, the division of cognitive work exploits the economies of routinization and mechanization. Tangible machinery in material production immediately corresponds to those "abstract machines" built of symbolisms. Regarding the efficiency they enhance in human labor, theories built of symbolisms such as differential calculus or chemical symbolism need not fear comparison with the machinery that assists physical labor in heavy industry.

On the macro level, the analogy between scientific and industrial production is not so obvious. There have indeed been specialized lines of knowledge production since ancient times. Regarding efficiency, however, the point of differentiated lines of industrial production lies in their reintegration by markets that organize exchange as well as the evaluation of output. It is first the pricing of inputs and outputs that instructs how to economize production. In science, output is exchanged by way of publication, which means that the output is not sold for money but delivered free of charge. Accordingly, there is no formation of money prices in scientific communication. In the case that there is no evaluation involved in the exchange of scientific information, it is pointless to ask scientific production to be efficient. As rational as the thought economy may be on the individual level, there will be nothing securing rationality on the collective level.[4]

Remarkably though, at the same time as Descartes' rational method became a professional standard, scientific communication underwent a substantial transformation. Up to the 17th century, scholars, even in mathematics and astronomy, were preeminently concerned with protecting their claims to priority through secretiveness and mystification.[5] Since information is power, there is a constant temptation to monopolize it. Why communicate a discovery, why share it with other researchers if you can sell it to some ruler or patron in order to earn your living? It was only through the emergence of a novel kind of entertainment business that publication became the regular completion of making discoveries. Rumors of exciting discoveries stimulated the interest of a bored aristocracy in being introduced to the new continent of science. The interest could be met by utilizing the novel involvement of science into experimentation. Presenting experiments is like performing tricks in front of an audience. A wave of start-ups took the opportunity of meeting the demand of challenging entertainment. The entertainment of noblemen was one of the purposes of the academies and learned societies founded in the 17th century.[6] Aristocrats were supposed to observe a code of conduct different from that of researchers and businessmen. Noblemen should be free of the temptation of selling what they learnt today in a scholarly lecture as their own discovery tomorrow. Accordingly, there was no risk that the scholar's right of authorship and priority would be stolen. As long as there were reliable witnesses around, this risk was minimal even when other scholars were in the audience. Testimony of a noble audience, rather, became the first step to what later came to be called "intellectual property".

By publishing your findings in the right place you could acquire two things: reputation as a scientist and intellectual property of your discovery. Acquiring reputation means to become known for what you have achieved. It means to be paid attention by others for the achievement in which you have invested your own attention. Being paid attention is an excellent form of gratification, it is the *wage of fame*. As soon as scientists work for acquiring reputation, scientific communication assumes the character of a market. Scientists henceforth publish in order to be paid attention. The role of intellectual property finds itself changing accordingly. Its primary purpose turns into the justification of the claim of earning attention. In this regard, the publication of the

Georg Franck was born in 1946 and studied philosophy, economics, and architecture in Munich. His doctorate is in economics. In 1974, he became a practising architect and town planner. In addition, he was active in software development and produced a planning information system, which has been marketed since 1991. He has held the Chair of Digital Methods in Architecture and Planning at the Vienna University of Technology since 1994. Beyond the confines of his discipline, he became known for his work on the economy of attention and the philosophy of time.

proceedings of the meetings in written form proved an effective and productive system for the authentication and protection of the stake of the creative scientist in the intellectual property created by his innovative efforts.[6] Publication puts intellectual property at the disposal of the general public under the sole condition that its processing into the user's intellectual property is credited by citation.

In terms of attention, citation is not free of cost. It means, rather, the transfer of a part of the attention that the citing author earns for her or his work to the cited author. Citation thus tests the willingness to pay on the part of the scientist looking for preprocessed information as a means of production. Moreover, citation tests the willingness to pay on the part of those who are competent to understand and thus to judge the value of the information offered. Since the amount of citations a theory or a theorem earns measures how often it is used as a means of production, the process of citation amounts to a process for measuring the pragmatic value of scientific information.

Even though it seems that scientific information is withdrawn from price formation at first sight, we thus discover that there is a pricing of scientific output. Moreover, the pricing is done by a regular market. The introduction of open scientific literature can be seen as the emergence of a producer's market for preprocessed information. Scientists offer their own product as a means of production for subsequent stages of knowledge production. The product is not sold before its reuse is documented by way of citation.[7]

For the piece of information, being cited means showing its reentering the production as a means of production. It means, in short, that it is shown to be productive. For the author, being cited means to be paid attention. It is only through being amply cited that you can grow rich in terms of expert attention, which means to accumulate reputation up to the level of fame. On the other hand, there is nothing you can do better for the collective advancement of science than being productive in the eyes of those competent to judge the value of your work. Scientists are thus doing exactly what they are supposed to do when they maximize citations in the way that entrepreneurs maximize profits.[8] The collective progress of knowledge is maximized, in the eyes of those capable of judging it, when the ruling motive of the working scientist is the maximization of the attention he or she receives from his or her peers.[9]

As soon as scientists work for publishing the output, and as soon as scientific communication works as a market where information is exchanged for attention, the analogy of scientific production and industrial production is established also on the macro level. The development of efficiency-enhancing technology in thought economy finds itself complemented by the building of markets that connect exchange with the evaluation of output. The joint result was the transition from an artisan to an industrial mode of knowledge production. The proverbial unleashing of productivity that industrialization is known for was paralleled if not anticipated by the breakthrough of modern science.

The Market Called Scientific Communication

Even though textbooks tend to demarcate modern from medieval science only in terms of methodology, the line drawn in terms of economy is equally relevant, if not even more revealing. Involving economy into the theory of science does not mean to join the chorus that money rules the world. It means, rather, that economy is not only about money. It is only by describing science as a closed economy of attention where scientists invest their own attention in order to gain the attention of other scientists, that science reveals its basic structure as an industry. And it is only by accounting for the potentials of the industrial mode of production that the stupendous success of science and its power to gain cultural leadership can be fully appreciated.

In ancient times and the Middle Ages, there were eminent scientists—think, for example, of a mathematician such as Euclid, a physicist such as Archimedes, or a logician such as Ockham—but there was no cultural leadership of science in those times. Both the world view and the prevailing lifeworld were dominated by religion. It was only by the revolution that knowledge production underwent in the 16th and 17th centuries that science could grow into a rival to the established religious superpower. In this revolution, methodology indeed played a crucial role, but it played this role for reasons of efficiency. Research is a resource-consuming activity. Inefficient use of resources consumed by knowledge production is as detrimental to the collective advancement of knowledge as are deficiencies in methods. Economic inefficiency even encompasses methodological inadequacy. Methods are inadequate if they tend to misallocate time and effort. The grand answer to the widespread misallocation of time and effort in artisan knowledge production was the overall industrialization of science.

In an industry where cognitive work, on the individual level, is organized according to rational methods and where, on the collective level, the specialized lines of production are reintegrated by competitive markets, a tendency towards overall efficiency is free to organize itself. Of course, how powerful this tendency can become depends on circumstances. Key conditions, however, are strong incentives and effective competition. Earning expert attention is a strong incentive indeed. It is an almost inexhaustible source of energy, it motivates enduring efforts and ample frustration tolerance, and is particularly well suited to attract talented people. Even for the exceedingly ambitious and the slightly megalomaniac, the wage of fame can compensate for the higher monetary incomes to be earned in business or the power to be gained in public offices. Strong incentives are functional in connection with social control. Social control is expensive and unpleasant when exerted by personal surveillance. It is cheap and much more agreeable when exerted implicitly in social exchange. That is why competition is a superior means of social control. Though far from perfect, competition on the market of scientific information is effective. It cannot strictly prevent plagiarism and downright fraud, but it ensures that violations are risky. Wherever there are markets, there are shadow markets as well. It depends on the proportions whether social control can be said to work. If

you have an eye for proportions you should agree that social control works in scientific communication.

When describing science as a closed economy of attention, we face an industry where a tendency towards efficiency organizes itself. It even seems safe to say that we face a social organization that tends to efficiently allocate the attention at its disposition. The organizational goal of science is the collective advancement of knowledge. The advancement of knowledge cannot be measured from without science itself. It can be judged only from within. The crux regarding the collective intelligence of science is how those competent to judge are made to utter their considered judgment overtly. By the requirement that the use of external output as a means of one's own production is marked by citation, the willingness to pay is queried on the part of those working in the field and thus expected to be competent to judge the value of the means of production. Citing means to transfer a part of the attention earned by one's work to the cited author. It is generally rational to be honest in citing. If you cite too much, you forego an income that is rightfully yours. If you cite too little, you risk of being found guilty of plagiarism. Hence, there is reason to assume that the judgment works reasonably from within.

Insofar as intelligence means the efficient use of one's attention, it seems thus fair to attribute collective intelligence to the knowledge industry into which modern science has developed. It seems reasonable to assume that a self-organized tendency towards efficiency manifests itself in the scientific economy of attention. Assuming that such a tendency prevails does not mean to suppose that the overall efficiency of scientific production is particularly high. It rather means that cases of serious malfunctioning and gross misallocation are probably *not* due to the search for attention. Instead of being suspicious of the self-organized exchange of information for attention, we should focus on the ways science is financed and organized from outside when looking for remedies against its major defects.

Science: A Case of Collective Intelligence?

Even though it is possible to identify a tendency towards efficiency in the use of the attention working for the collective advancement of science, there is a widespread hesitation to grant collective intelligence to science. One of the reasons is misconduct, which is to be expected wherever humans are involved. As misconduct indeed occurs in science, but is not excessive, the hesitation has to be taken seriously and further reasons for it have to be found. One of the more serious reasons might have to do with a blind spot in the scientific view of the world. The kind of economy described, even if effective, is hard to be recognized by science. In science and scientific-minded philosophy alike, attention is defined as the capability of selectively processing information. This definition may be sufficient to account for attention as the resource energizing cognitive work, but certainly insufficient to account for attention as a means of gratification. Attention, as a means of gratification, derives its charm from the subjective nature of consciousness, which must not be confused with the capacity of selectively processing information. This capacity can be technically reproduced (at least in principle), the quality of being conscious cannot. Being conscious denotes a "how it feels" quality to which only its own subject has access. This "how it feels" or, as it is called, *phenomenal* (or P-) consciousness (simply a raw experience: it is moving, colored forms, sounds, sensations, emotions and feelings with our bodies and responses at the center) does not exist in the perspective of the third person, the detached observer. Since the scientific view of the world is committed to the perspective of the third person, phenomenal consciousness seems to have no place in the scientific view of the world.

The crux of the attribution of collective intelligence to science lies in the question: How much ignorance about oneself is compatible with one's intelligence? By being ignorant of the phenomenal consciousness, science is ignorant of an essential property of its main productive factor. Being conscious is a regular if not necessary concomitant of self-assured cognitive and creative functions. But that is not all. The supposedly phenomenal foreign consciousness is what makes the exchange of attention so attractive.[10,11] When striving to obtain the attention of others, it is not the processing of data in foreign nervous systems that we have in mind. What we are looking for is entering another sphere of conscious experience. The wish to earn attention is the wish to play a role in other people's consciousness. What we are addicted to are the feelings that welcome us there.[10] We are definitely not satisfied with unconsciously or half-consciously processing of data related to ourselves. It would be even one of the hardest offences to our vanity if we found ourselves fooled by an automaton that only mimics conscious behavior.

Without a notion of the quality of subjective awareness, science is poorly equipped to understand its own strength in making efficient use of the attention that is at its service. This mild form of schizophrenia could be overlooked if it had no impact on the role that science plays as a social system. Yet, its being oblivious to the nature of subjectivity not only blurs the image science entertains of itself, it also taints the view that the scientific community entertains of the outside world. Whether a world view implies or excludes phenomenal consciousness makes a big difference concerning the value attributed to certain research projects and to the ethical questions involved. A collective kind of intelligence that is blind to the needs and wants of subjectivity is without soul and void of morality. It is due to this blind spot that people intuitively hesitate to award science the attribute of collective intelligence.

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[1] W. James, *The Principles of Psychology*, Henry Holt, New York, **1890**, p. 403.
[2] It is strange, thus, to find that the theory of science grossly ignores the role that thought economy plays in scientific research. Remarkable exceptions to the rule are the classics by Mach (E. Mach, *The Science of Mechanics*, trans. from the German by Thomas J. McCormack, The Open Court Publishing Co., Chicago, **1911**) and Husserl (E. Husserl, *The Crisis of*

European Sciences and Transcendental Phenomenology: *An Introduction to Phenomenological Philosophy*, Northwestern University Press, Evanston, IL, **1935** (1970 transl. by David Carr)). Until today, even psychology, sociology, and economics of science feel justified to circumvent the topic.

[3] Today, even the borders between theory and experimentation are blurred by the role that simulation models play in, for example, materials science or the study of climate change: P. Galison: "Computer simulation and the trading zone" in *The Disunity of Science*, *Boundaries*, *Contexts*, *and Power* (Eds.: P. Galison, D. J. Stump), Stanford University Press, Stanford, **1996**.

[4] G. Franck: "The scientific economy of attention: A novel approach to the collective rationality of science" in *Scientometrics*, *Vol. 55*, *no. 1*, **2002**, pp. 3–26.

[5] N. Rescher, *Cognitive Economy. The Economic Dimension of the Theory of Knowledge*, Pittsburgh University Press, Pittsburgh, **1989**, p. 34.

[6] J. R. Ravetz, *Scientific Knowledge and its Social Problems*, Clarendon Press, Oxford, **1971**, p. 249, and references therein (new edition: Transaction Publishers, New Brunswick, **1996**).

[7] It may be even rational for the scientist to bear the financial cost of publication by publishing her or his output in "open access" media that offer it free of charge on the internet. By thus enhancing accessibility on the part of potential users, the financial costs born by the supplier are an investment in the prospects of attention returns. It is what in other contexts is called outlay on sales promotion.

[8] "Scientific communication: a vanity fair?": G. Franck, *Science* **1999**, *286*, 53–55.

[9] G. Franck, *Mentaler Kapitalismus*, *(Mental Capitalism)*, Carl Hanser, Munich, **2005**, chap. 3. There are exceptions to the rule, of course. Moreover, they are not negligible. However, the exceptions do not undermine the basic strength of the argument.

[10] G. Franck: "The economy of attention" in Telepolis: http://www.heise.de/tp/english/special/auf/5567/1.html (English translation of "Die Ökonomie der Aufmerksamkeit" in *Merkur no. 534/535*, **1993**, pp. 748–761).

[11] G. Franck: "Mental presence and the temporal present" in *Brain and Being* (Eds.: G. G. Globus, K. H. Pribram, G. Vitiello), John Benjamin, Amsterdam, Philadelphia, **2004**, pp. 47–68.

