What is the Noosphere?

Planetary Superorganism, Transition and Emergence

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Abstract:

The noosphere remains an underappreciated and understudied idea despite that it gives hope towards a positive and meaningful globalization. A core reason for this lack of attention is that its very definition is often unclear both in the West with Teilhard de Chardin, and in the East with Vernadsky. I show how Living Systems Theory can clarify two fundamental meanings, the *planetary superorganism* and the noosphere as the sum of information processed by humans and machines. I review also two key aspects to better grasp the concept: the noosphere as a planetary *major evolutionary transition*, and the noosphere as a radically new emergence, which might be a planetary *consciousness*, a planetary *heart* and a planet seeking *other noospheres*.

Keywords: noosphere, globalization, anthropocene, superorganism, major evolutionary transition, living systems theory

Introduction

Existing discourses about globalization are not very encouraging for the future of humanity. The *Anthropocene* focuses on problems and the negative impact of humans (Steffen, Crutzen, and McNeill 2007). *Globalization* discourse is focused on socio-political and economical issues, and has troubles caring about and integrating growing geosphere and biosphere challenges (e.g. Odum 2001). The *Gaia hypothesis* (e.g. J. Lovelock 1979) takes an organic view of planet Earth but neglects or sees in a negative light human activities and technologies. The *techno-singularity* discourse (e.g. Kurzweil 2005) is more positive by focusing on the promises of artificial intelligence and machines, but it has been criticized as a techno-utopia (e.g. Cole-Turner 2012; Hughes 2012), and has not much to say about pressing real-world issues affecting the geosphere or the biosphere.

By contrast, a growing *Noosphere* discourse (e.g. Arquilla and Ronfeldt 1999; Christian 2017; Ronfeldt and Arquilla 2020; Shoshitaishvili 2021) proposes a meaningful narrative and vision for the future, where the geosphere, the biosphere and the noosphere -including humans and machines- could work in concert to unleash a new level in evolution. But where does the idea come from and what is the noosphere more precisely?

Its history starts in 1922-1923, when Vladimir Vernadsky visited the Sorbonne in Paris and started lecturing about geochemistry and the biosphere (V. I. Vernadsky 1924; 1945). This triggered discussions and collaborations with two Bergsonian thinkers, palaeontologist Pierre Teilhard de Chardin and mathematician Edouard Le Roy who proposed that the biosphere is evolving a new thinking layer, or *noosphere*. Teilhard first wrote the word "noosphere" in an unpublished essay dated May 6, 1923 (Teilhard de Chardin 1966), while Le Roy (1928) was the first to publish the word in press, as a publication of his 1926 lecture. Teilhard later expanded on the idea in a notable 1947 essay *The Formation of the Noosphere* (Teilhard de Chardin 1959a), and in his major posthumous book *The Phenomenon of Man* (Teilhard de Chardin 1959b).

Despite the continuation logic of "-spheres" from geosphere (lithosphere, atmosphere, hydrosphere, etc.), to biosphere the latest "noosphere" step has been criticized to be ambiguous. Notably, in his introduction to *The Phenomenon of Man*, Julian Huxley (1959b, 13–14) wrote that Teilhard

> may perhaps be criticised for not defining the term more explicitly. By *noosphere* did he intend simply the total pattern of thinking organisms (i.e. human beings) and their activity, including the patterns of their interrelations; or did he intend the special environment of man, the systems of organised thought and its products in which men move and have their being, as fish swim and reproduce in rivers and the sea? Perhaps it might have been better to restrict *noosphere* to the first-named sense, and to use something like *noosystem* for the second.

Some also tend to be wary of the spiritual and religious implications of the noosphere idea, as Teilhard also argued that the Noosphere would ultimately develop towards an "omega point", a kind of God-like state.

Turning to Vernadsky, a great Russian and Ukrainian scientific polymath, he also championed the noosphere idea and interprets it mostly as a new evolutionary stage in a purely atheistic and materialistic way. This interpretation, despite being more empirically grounded, also suffers from ambiguity. For example, it has been said that "it is unclear exactly what is meant by the noosphere and what mechanisms exist to facilitate its emergence" (Oldfield and Shaw 2006).

The purpose of this essay is to use modern scientific theories and insights to clarify various ambiguities surrounding the concept of the noosphere. In particular, I'll use Living Systems theory to define the noosphere as a planetary superorganism, major evolutionary transition to approach the noosphere as a planetary transition, and recent future extrapolations that may anticipate a new planetary emergence.

Noosphere as a Planetary Superorganism

The human body metaphor is a natural way to apprehend human societies. It has been defended both in the West (e.g. by Plato, Hobbes) and in China (Huang 2007). When interpreted literally, this *body politic* has been (ab)used by those in power. For example, to justify the status quo, the roman consul Agrippa Menenius Lanatus argued that the hands should not rebel against the other organs of society because otherwise the entire body would be destroyed. In China, Huang (2007) concluded that “all the Confucian theories of ‘body politic’ served the imperial oppression of the daily details of the lives of common people. This is a sad story in Chinese history.”

In the 19th century, the philosophy of organicism influenced the foundation of sociology (Barberis 2003) and it is within this context that Teilhard thinks about the noosphere, and extends organic sociology to the planetary scale, in an evolutionary worldview.

Today the noosphere as a superorganism can be much better articulated thanks to living systems theory (henceforth LST, J. G. Miller 1978; J. L. Miller 1990), a theory of the living that has been applied from cells and organs to society and supranational levels. The main proposition is that every living system has 20 critical subsystems (or functions) processing either matter-energy (top part of Fig. 1) or information (bottom part of Fig. 1). Two particular cases are the *boundary* and the *reproducer* functions that involve both matter-energy and information.

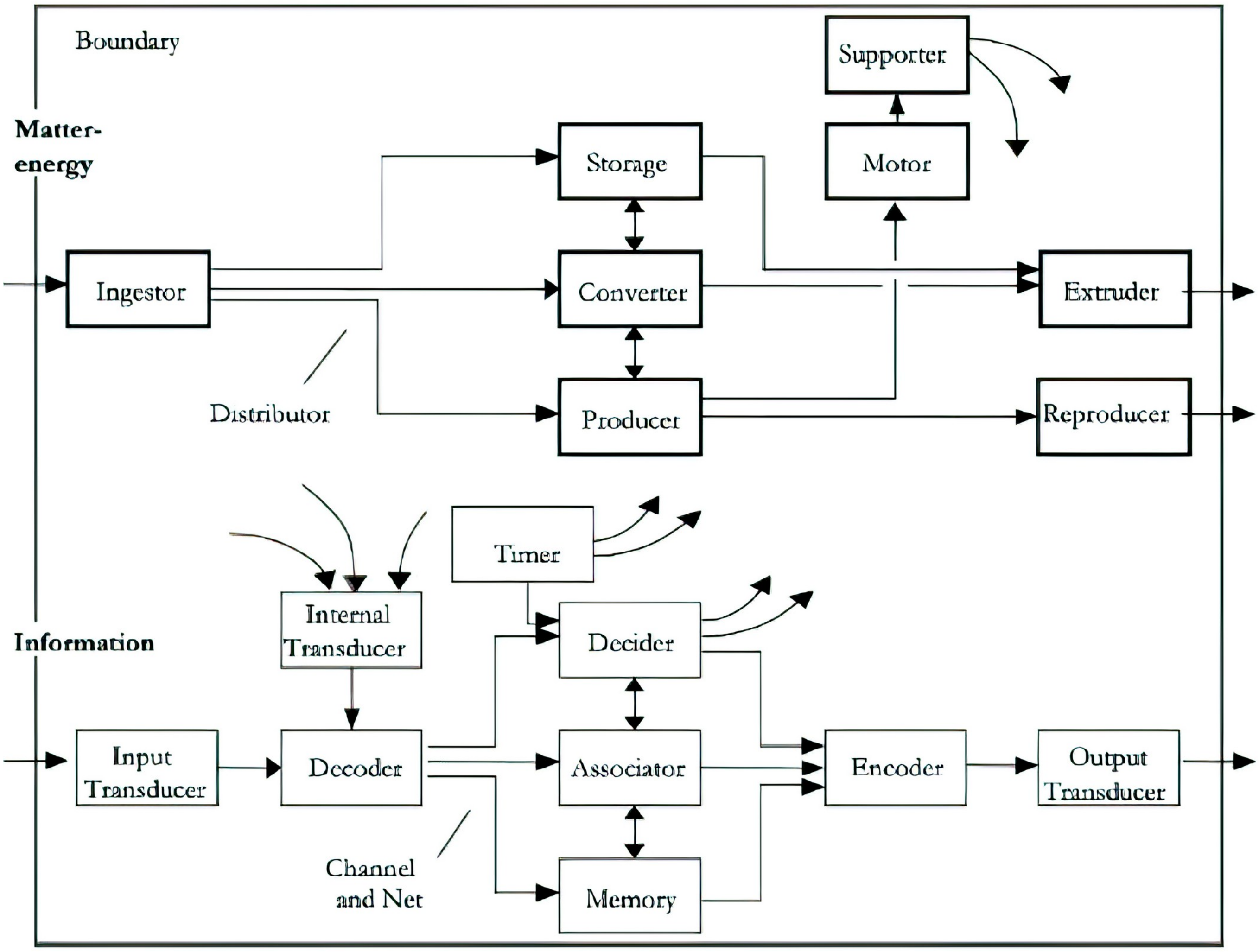

Fig. 1. Critical living subsystems according to living system theory (diagram from (Tracy 1989)). Matter-energy processes are on the upper part, information processes are below.

In table 2, I have given Miller's definitions of each of the 20 functions, and identified 14 functions that Teilhard (1959a) described at the planetary level.

MATTER + ENERGY + INFORMATION				
	A. DEFINITION	**B. ORGANISM**	**C. SUPRANATIONAL SYSTEM**	**D. TEILHARD's 1947/1959 ESSAY**
1. Reproducer	"The subsystem that is capable of giving rise to other systems similar to the one it is in."	Sexual organs	" Supranational system which creates another supranational system"	-
2. Boundary	"The subsystem at the perimeter of a system that holds together the components making up the system, protects them from environmental stresses, and excludes or permits entry to various sorts of matter-energy and information."	Skin	"Supranational organization of border guards"	Surface of the globe (p165)
MATTER + ENERGY				
3. Ingestor	"The subsystem that brings matter-energy across the system boundary from the environment."	Eating, drinking, inhaling	"Supranational system officials who operate international ports"	Nutritional system (p156)
4. Distributor	"The subsystem that carries inputs from outside the system or outputs from its subsystems around the system to each component.	Circulatory system (e.g. blood and hormonal distribution).	"United Nations Childrens Fund (UNICEF), which distributes food to needy children"	"Circulatory system applicable to Mankind as a whole" (p156)
5. Converter	The subsystem that changes certain inputs to the system into forms more useful for the special processes of that particular system."	Digestive system, lungs	"European Atomic Energy Community (EURATOM), concerned with conversion of atomic energy"	Nutritional system (p156)
6. Producer	"The subsystem that forms stable associations that endure for significant periods among matter-energy inputs to the system or outputs from its converter, the materials synthesized being for growth, damage repair, or replacement of components of the system, or for providing energy for moving or constituting the system's outputs of products or information markers to its suprasystem.	Stem cells	"World Health Organization (WHO)".	-

7. Matter-energy storage	The subsystem that retains in the system, for different periods of time, deposits of various sorts of matter-energy."	Fat, bones	"International Red Cross, which stores materials for disaster relief"	-
8. Extruder	"The subsystem that transmits matter-energy out of the system in the forms of products or wastes."	Urine excretion, defecation, exhaling	"Component of the International Atomic Energy Agency (IAEA) concerned with waste extrusion"	-
9. Motor	"The subsystem that moves the system or parts of it in relation to part or all of its environment or moves components of its environment in relation to each other."	Muscles	"Transport component of the North Atlantic Treaty Organization (NATO)"	"this whole is capable of breaking into motion" (p164)
10. Supporter	"The subsystem that maintains the proper spatial relationships among components of the system, so that they can interact without weighting each other down or crowding each other."	Skeleton	"Supranational officials who operate United Nations buildings and land"	"forming a single gigantic network girdling the earth." p160
INFORMATION				
11. Input transducer	"The sensory subsystem that brings markers bearing information into the system and changes them to other matter-energy forms suitable for transmission within it."	Sensory organs	"News service that brings information into supranational system"	"the electronic microscope whereby our sensory vision, the principal source of our ideas, has been enabled to leap the optical gap between the cell and the direct observation of large molecules." p162 Teilhard does not think about sensing at a planetary scale here, but in an extended, technological way.
12. Internal transducer	"The sensory subsystem that receives, from subsystems or components within the system, markers bearing information about significant alterations in those subsystems or components, changing them to other matter-energy forms of a sort that can be transmitted within it."	Neuronal processing, generation of electrical neuronal impulses	"Supranational inspection organization"	"a Brain of brains" p161
13. Channel and net	"The subsystem composed of a single route in physical space, or multiple interconnected routes, by which markers bearing information are transmitted to all parts of the system."	Nerves, neurons	"Universal Postal Union (UPU)"	The physical substrate of "the extraordinary network of radio and television communications" p162

14. Timer	“The subsystem which transmits to the decider information about time-related states of the environment or of components of the system. This information signals the decider of the system or deciders of subsystems to start, stop, alter the rate, or advance or delay the phase of one or more of the system’s processes, thus coordinating them in time.”	Biological clock	Note that the timer subsystem was a later addition (J. L. Miller 1990), but we can clearly identify it with the International Atomic Time and Global Navigation Satellite Systems (e.g. GPS, GLONASS, GALILEO).	-
15. Decoder	“The subsystem that alters the code of information input to it through the input transducer or internal transducer into a “private” code that can be used internally by the system.”	Neuronal treatment of perception	“Supranational language translation unit”	“the insidious growth of those astonishing electronic computers” p162
16. Associator	“The subsystem that carries out the first stage of the learning process, forming enduring associations among items of information in the system.”	Synaptic learning	“Supranational university”	“everything that accumulates, arranges itself, recurs and adds to itself, becoming the collective memory of the human race” p157 (if one can read that he implies learning here).
17. Memory	“The subsystem that carries out the second stage of the learning process, storing various sorts of information in the system for different periods of time.”	Neural memory	“United Nations library”	“everything that accumulates, arranges itself, recurs and adds to itself, becoming the collective memory of the human race” p157
18. Decider	“The executive subsystem that receives information inputs from all other subsystems and transmits to them information outputs that control the entire system.”	Higher brain functions	“Council of Ministers of the European Communities”	“mankind tomorrow will awaken to a "panorganized" world.” p170
19. Encoder	“The subsystem that alters the code of information input to it from other information processing subsystems, from a “private” code used internally by the system into a “public” code that can be interpreted by other systems in its environment.”	Internal language processing	“United Nations Office of Public Information”	-
20. Output transducer	“The subsystem that puts out markers bearing information from the system, changing markers within the system into other matter-energy forms that can be transmitted over channels in the system’s environment.”	Speaking, writing	“Official spokesman of the. Warsaw Treaty Organization”	The physical substrate of “the extraordinary network of radio and television communications” p162

Table 1 – Basic organization, definitions and three illustrations of living systems. Column A gives the definition of each subsystem, column B illustrates with the human body (my interpretation), column C is J.G. Miller's (1978, 1028–29) own "supranational system", and column D are the subsystems that Teilhard identifies in his (1959a) essay about the noosphere. Note that Miller's supranational system is narrower than the noosphere defined as a full planetary superorganism including geo- bio- and noo- spheres.

It is remarkable that Teilhard identified at least 14 of these living functions at the planetary scale and, somehow surprisingly, this immediately shows that Teilhard most oftens speaks of the noosphere as a planetary superorganism. Within this LST framework it is thus possible to resolve the ambiguity that Julian Huxley pointed out about the noosphere. It can be defined either as a *planetary superorganism*, composed of all the 20 subsystems, or the noosphere is purely a *sphere of mind*, i.e. information processing, that includes only the 10 information processing subsystems.

Although the philosophy of organicism can be very inspiring and fascinating, it can lead to many pitfalls and dangers when understood literally and used without care. Indeed, the language of health and parasite at a societal scale has been used to motivate and justify the worst atrocities and totalitarian systems in human history (see Hitler 1939). The philosophy of organicism in sociology has emphasized synergy and cooperation, but this is not a common view in socio-political discourse anymore. On the left-wing, a major political figure like Marx rather emphasized competition between classes and revolutions. On the right wing of politics, organicism is not popular either, as the idea that humans are nodes serving a collective goes against the spirit of the free market and indeed flirts with ideas of totalitarian systems of Mao, Hitler or Stalin (see also Heylighen 2011).

The idea to define health markers at a planetary scale is certainly worth exploring and the United Nations (2021) 17 sustainable goals may be interpreted in this way. LST might actually also be useful to continue to define goals related to the well-functioning of each subsystem. Actually, Robert Aunger (2017) used LST to argue that the key role of morality is to regulate the human superorganism. Authors reflecting on human superorganism unfortunately often suggest embarrassing implications, for example Aunger (2017, 8a) writes that superorganism theory "thus suggests that it is legitimate to injure or take the life of others if they are outsiders (especially in the context of inter-group conflict)", while Gregory Stock (1993, 209) who popularized the idea of a growing global superorganism suggested as an almost inevitability a bioweapon to control fertility: "When birth-control vaccines are developed for humans, there is the obvious possibility that some contagious, flu-like infection might be created and released, rendering large numbers of people less able to conceive children." These examples are shocking because they question almost inalienable rights to live and to procreate. The mistake is to apply an organic analogy too quickly and uncritically (to use analogical reasoning with care, see Gentner and Jeziorski 1993).

Another pitfall of using LST is one of *reductionism*. In a fundamental way, each higher level living system has emerging properties that were lacking in the lower one. For example, the immune system is never dealt with systematically in LST, yet we know how important it is for living systems. Another example at a societal scale is the emergence of trade, markets and the economic system. There is actually no analog of monetary exchanges in biological systems. Such an emerging feature doesn't exist in biology, and yet monetary flows and economics are key to understand modern societies and globalization. At the planetary superorganism level, this leads to a humbling conclusion. Some new, unpredictable systems or dynamics are likely to emerge, and we should not try to ignore or downplay them, i.e. one should not restrict our modelling with the common multi-scale features of past biological evolution (note that Miller is aware of this criticism of reductionism and addresses it in J. G. Miller 1978, 1036–38).

In the context of the noosphere, LST is most useful when it's used as a *heuristic*, to understand where the strengths and weaknesses of this forming superorganism. The systematicity of LST can be exploited to formulate problems and potential solutions at a planetary scale. We can start to ask questions such as: In which order should humanity focus to develop the various subsystems? How much effort should be put to develop each subsystem versus integrating them? What are the planetary functions that are already well-developed? Under-developed? That are dysfunctional?

Two opposite examples are, on the one hand, the *timer* subsystem which is fully implemented on planet earth by global navigation satellite systems solutions (e.g. GPS, GLONASS, GALILEO). On the other hand, the planetary *decider* is largely non-existing as we don't have a global governance entity or control mechanism at a planetary scale.

One can also ask whether there is enough or too much redundancy in different subsystems. For example, does humanity really need three global navigation solutions? Or on the contrary, is this redundancy a sign of robustness, meaning that the planet can still have a *timer* function even if two of them would fail?

Many more questions can be articulated, such as how well the different functions and subsystems are integrated, also in a measurable manner. As Miller (1978, 90) writes:

> At each level the structural characteristics of the various subsystems or components can be analyzed. The performance variables of each subsystem can be measured, including their equilibratory ranges, variances, rates of transmission, lags, error rates, omission rates, matter-energy costs, efficiencies, and so forth. The input-output relationships, adjustment processes, feedback characteristics, growth and decay characteristics, degree of cohesiveness, and degree of integration, under many environmental conditions, can be studied.

Finally, the precise *definition* of each subsystem is of paramount importance, because our whole vision of planet Earth changes accordingly. Let us illustrate this point with the question of what we define as the *boundary* of the planetary superorganism. As in any systems modelling, the choice of the boundary (what delimits the inside from the outside) changes also the definition and relationship with the environment. The environment is by definition a place to gather resources and energy from, as well as a waste repository. So, if one focuses on humanity -as Teilhard certainly does-, one can legitimately exploit Earth's resources, while polluting and damaging the environment which consists of the geosphere and the biosphere. Of course at the time of Teilhard, there was little awareness and care about the issues related to the geosphere (e.g. climate change, air and water pollution). Still, it doesn't seems right...

Another example is the thorough examination of morality from an evolutionary and *human superorganism* point of view recently proposed by Aunger (2017). The boundary here is also on *humanity* so implicitly what is "good" is to develop humanity, not necessarily to take care of the geosphere or the biosphere. The framework is certainly insightful for descriptive ethics (understanding the evolutionary origin of our morality) but less so for prescriptive and proscriptive ethics (the "dos and "don't"), because past evolutionary strategies have no guarantee to be efficient in our unique evolutionary situation (Vidal and Heylighen 2021).

In my view, the boundary of the noosphere should aim to become a *planetary superorganism*, i.e. not only a human superorganism, but the planet as a whole, including the geosphere, the biosphere, humanity and the technosphere. This implies for example that fossil fuels are not anymore a free supply of energy from the environment, but simply a limited reserve inside the planet's *storage* subsystem. Looking at Earth from space, at a very coarse level, the noosphere as a planetary superorganism is likely to become more and more an integrated living system once it takes as energy input the Sun, and rejects waste out of its gravitational bound into space -space junk is still an issue! In this way, our planet would become more and more an efficient open system thermodynamically speaking -another common denominator of all living things.

The importance of being able to see the noosphere from space can be highlighted using the hierarchical framework of Salthe (1985). A given system at a focal level is always constrained both with lower-level constraints from the system below, and higher-level constraints from the level above. How does it apply to the noosphere? On a first approximation, the immediate lower-level are the nation-states and the higher-level is planet Earth in its solar-system context.

Another common critique of LST is that the framework remains rather static, and therefore focused on the anatomy of living systems. As Corning (1983, 71) remarked, "Miller's encyclopedic effort is a kind of Gray's *Anatomy* of cybernetic systems". This suggest that other complementary evolutionary and cybernetic modelling would be useful. Schwaninger (2006) compared LST to Beer's viable system model (e.g. Beer 1984) and writes: "Miller unmistakably bases his argument more strongly upon General Systems Theory, emphasising openness, inputs and outputs. Beer, on the other hand, argues primarily from the Cybernetics point of view, dwelling principally upon the management of complexity by means of control, i.e. (feedforward-based) steering and (feedback-driven) regulation." Schawninger concludes that both framework are complementary as they focus on different features of systems.

This discussion largely misses the view that the noosphere is first and foremost an evolutionary *transition* or transformation. Let us see now how LST could be complemented by recent insights in major evolutionary transition theories.

Noosphere as a Major Evolutionary Transition

Major evolutionary transitions (METs) depict the few moments in the history of life where radical novelty and change has happened. These include the origin of life itself, eukaryote cells, multicellular organisms, sexual reproduction, cultural transmission, mental modelling, and, as a growing number of evolutionary scientists are recognizing and debating, the emergence of a kind of planetary superorganism (e.g. Maynard Smith and Szathmáry 1995; Stearns 2007; Calcott, Sterelny, and Szathmáry 2011; Stewart 2020).

The core challenge to make a MET succeed is to solve the cooperation barrier (Stewart 2000). This involves centrally the emergence of a new metasystem that can deploy control mechanism that can suppress free-riding, and promote cooperative processes (Turchin 1977). Obviously, the specific implementation of such control mechanisms varies with each transitions (RNA is not going to regulate cultural transmission). Once the cooperation barrier is solved, division of labor can start, and matter-energy distribution (the *distributor* in LST) and information flows (*channel and net* in LST) need to be present to coordinate the differentiated parts. All this must happen with little or no conflicts.

Thinking in terms of METs is a promising way to probe and understand the broader meaning of globalization. For example, West et al. (2015) identified the following eight big questions:

> i) What conditions favor the formation of cooperative groups?
> ii) What conditions maintain cooperation during group transformation?
> iii) What conditions favor division of labor?
> iv) What conditions favor communication that coordinates co-operation at the group level?
> v) What conditions lead to negligible conflict within groups?
> vi) What conditions favor mutual dependence?
> vii) How are new conflicts of interest suppressed in groups that have already made a major transition?
> viii) What conditions favor the breakdown of major transitions?

If we want to apply these questions to the noosphere, the group in question is composed of the nation states and other international actors. This line of thinking creates a biologically inspired framework for developing international relations.

One may argue that the noosphere transition is unique in the sense that there are not other noospheres to provide competition and selection mechanisms. Two avenues of research to tackle this issue are to explore virtually, with computer simulations, alternative global futures, and thus make the competition happen only virtually (see e.g. Helbing et al. 2012). Another approach would be to create a “vertical market” opening a trade and competition of various governance mechanisms, especially within nations. Stewart (2000) explains:

> In a vertical market, it would not be the goods and services traded in economic markets that would be produced and sold. Instead, the vertical market would trade in regulations, market frameworks, systems of education, laws, taxes, law enforcement systems, and programs that build better communities. Any component of governance could be developed and sold in a vertical market.

One other way that may help unleash international cooperation more systematically would be to apply core design principles from Wilson Ostrom and Cox (2013) at multiple human scales, up to nation states, to progressively transform planet Earth into a cooperative unit with a functional global governance.

Again, focusing on human groups and human institutions, one can quickly forget the critical importance of also managing the geosphere and the biosphere. To address this, I propose to extend the Gaïa hypothesis (J. E. Lovelock and Margulis 1974) to *Anthropogaïa*, this time including the feedback loops necessary to regulate the geosphere and the biosphere (see Fig. 2). Anthropogaïa is a neologism combining humans (*anthropos*) with the goddess Gaïa. The half-human half-goddess ambition is to attempt to manage and regulate both the biosphere and the geosphere. Such successful management at the planetary level should control the essential variables of the geosphere, biosphere and noosphere, so they can sustain each others in the long term, as well as enabling them to continue to evolve.

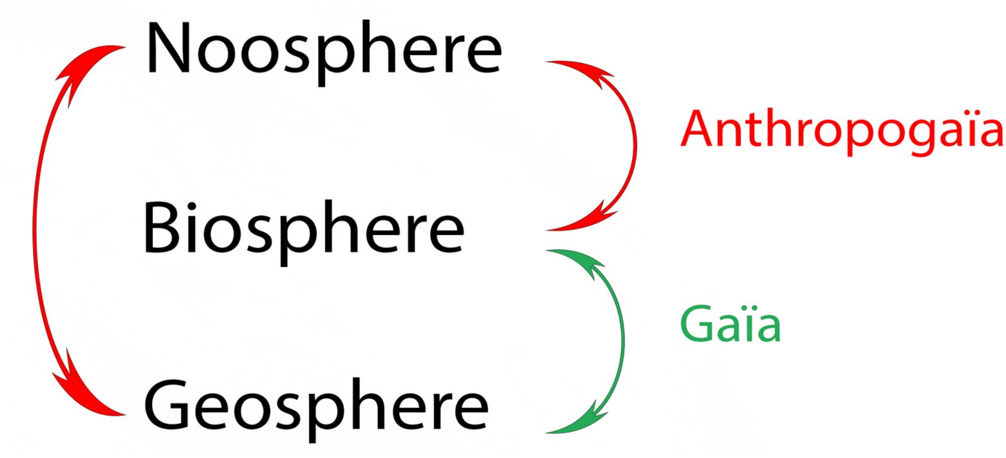

Fig 2. The Gaïa hypothesis unveiled the fundamental feedback loops existing between the geosphere and the biosphere (in green). Anthropogaïa highlights the interactions between the noosphere with the geosphere and biosphere (in red).

Attempting to steer a planetary MET is an unprecedented and immense challenge, almost a godlike challenge, as the word anthropogaïa suggests. But it's not impossible, and the theories and frameworks of METs outlined here do provide starting points.

We can also think about the situation from another angle: we have the rare chance and opportunity to be caught inside a MET. We can measure and document it, see it happening in front of our eyes. By studying it, we might gain critical insights to better understand not only the noosphere transition, but also past and future METs.

Noosphere as a Planetary Emergence

What happens once the MET has happened? This is a much more speculative topic. Teilhard wrote about the future of the noosphere: "it is at that ultimate point of centration which renders it cosmically unique, that is to say, apparently incapable of any further synthesis, that the Noosphere will have become charged to the fullest extent with psychic energies to impel it forward in yet another advance..." But which advance? Teilhard developed the *omega point* theory as an answer that includes an integration of science and religion (see Teilhard de Chardin 1959b). I propose to focus on three other emergent features: planetary *consciousness*, planetary *heart* and a planet seeking *other noospheres*.

The idea that the noosphere is leading to a planetary consciousness has been explored mostly by new age thinkers such as Argüelles (2011). However, a more theoretically grounded approach is to use modern models of consciousness such as information integration, adaptive resonance, and global workspace and to apply them to the noosphere, especially to the information dynamics circulating on the web and on social media (Beigi and Heylighen 2021). However, it is worth reminding ourselves that we don't even have the equivalent of thermoregulation for planet Earth -i.e. we are still unable to stabilize global warming and climate change. By contrast, in all warm-blooded animals, thermoregulation is a basic and fundamental control mechanism. My point is that we should attempt to develop and secure the analog of an autonomous nervous system before hoping to jump to complex cognitive functions. Of course some functions may be developed in parallel, but survival ones should take priority.

Teilhard (1959a, 172) hinted at the possibility that the noosphere will find its heart: “May it not be that tomorrow, through the logical and biological deepening of the movement drawing it together, it will find *its heart*, without which the ultimate wholeness of its powers of unification can never be fully achieved?” This is actually deeply consistent with the history of the word “noos”, which sits in the heart in Homer (IL.3.63), which is the "mind of the heart" in eastern orthodoxy, and, in ancient China, the heart is the centre of human cognition. This emergence may result from secure and enduring cooperation at a planetary scale, and we might see early indications of it emerging in the global decline of violence (Pinker 2011). Another speculative way towards the noosphere as a heart is the proposal that the noosphere is developing a kind of omnibenevolence, as part of planetary versions of divine attributes: “*omniscience* (knowing everything needed to solve our problems), *omnipresence* (being available anywhere anytime), *omnipotence* (being able to provide any product or service in the most efficient way) and *omnibenevolence* (aiming at the greatest happiness for the greatest number)” (Heylighen 2015).

We suggested earlier that the noosphere as a planetary superorganism would become a truly living system when it could be observed as such from space. This emergence of the noosphere in the galaxy might arise when Earth becomes whole, an entity with its own individuality. The noosphere’s inputs and outputs would then become more and more tied to the galaxy and other putative noospheres. For example, the noosphere would manage and pay attention to its energy input -solar, but also to the 5 to 300 tons of matter entering the atmosphere every day (Plane 2012). In terms of information, it would make tremendous efforts to capture information -knowing more about the galaxy and the universe, and possibly intercepting intelligent communicative signals (i.e. amplifying astrobiology and its search for biosignature and technosignatures). Even if we would be the first noosphere, in terms of outputs, there would be a growing motivation to reproduce, via terraforming (e.g. Elon Musk’s project of Mars colonization) or via sending probes or lifeforms thorough the galaxy (e.g. Breakthrough starshot program or directed panspermia). The noosphere might also want to signal its presence, a currently small and controversial endeavour called Messaging to Extraterrestrial Intelligence (METI, e.g. Vakoch 2016). As eloquently expressed by Jill Tarter (2009), even if the search fails, it would have given a way to see all humans as Earthlings, and to see Earth as one. I hypothesize that the recently emerging science of astrobiology and globalization are amplifying each others.

Conclusion

Living systems theory provides a robust foundation to define and think about the noosphere. We saw that the noosphere can have at least the following four meanings. If we consider it as a planetary superorganism, it has to do with all processes involving matter, energy and information on Earth. If one wants to focus on the mind (*noos*) aspect, we can restrict it to all information processing happening in humans and their technologies. We saw that the most critical and challenging issue is how to transition towards the noosphere, and this aspect can be approach with evolutionary science as a planetary *major evolutionary transition*, as a unique planetary transformation. The noosphere is also often accompanied by future visions of what could our planet become, and what kind of features could emerge in the near future. We outlined three speculative futures: the emergence of a planetary consciousness, a planetary heart, and a growing will to make or join new noospheres in the galaxy.

Our planetary challenges are immense. The vision of the noosphere may be critical to navigate successfully through them. Ultimately, defining the noosphere is not only a conceptual or descriptive problem. It is increasingly becoming an international and global challenge of deciding how to bring forth a planetary superorganism or how to manage the first planetary major evolutionary transition. Despite all the difficulties and challenges ahead, I share Vernadsky's hope: "I look forward with great optimism. I think that we are experiencing not only an historical change, but a planetary one as well. We live in a transition to the noosphere."

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