Keith Y. Patarroyo

Life is the combustion of love.
–Alex Grey, The Vast Expanse (1994)

Can we quantify the unquantifiable, compute the uncomputable, or capture the infinite with the finite? This seems to be the problem one faces when trying to develop a theory of creation. The creativity of the human mind or the creativity of nature seems to be far beyond any type of *understanding,* moreover many elements seem to hide even more when one tries to explore them. In a way, it is just like when you are not looking for *love* but it suddenly appears in front of you, elements of nature's creativity seem to marvelously manifest when you are not looking for them. Is this then a doomed mission? Can language even be used to express a glimpse into the process of creation inside the universe? Well, these words attempt to go beyond mere understanding and are doomed to provide an inadequate *feeling* for what I believe are the core elements involved in the process of creation. Perhaps this failed journey will be the catalyst to put some of these elements into *action* and manifest the process of creation itself.

Nature is at its core unpredictable, clearly, phenomena like fluid turbulence, the lifespan of an organism, or the future of technology are fundamentally irreducible. However, the key insight is that even if we have to follow the evolution of these systems step by step, they form structures at different *layers* or *slices* and we are able to *perceive*

these structures and give different *descriptions* of the phenomena. Turbulence seems endlessly complicated and fine-grained, but its energy spectrum follows statistical power laws. An organism varies greatly depending on the environment, but its size and lifespan are constrained by energy scaling laws. Lastly, technologies are built from millions of components, but they are themselves built from already known technologies. Slicing the phenomena of creation itself has generated incredibly generative theories like natural selection and cultural evolution, but it has also revealed elements that go beyond mere description and that manifest in higher forms of language where one gets a feel and perhaps can act upon creation itself.

In a fractal fashion, the theory of natural selection can itself be viewed through a variety of filters, each of which gives an insight into what the theory is really about. However, it is a mistake to believe that one insight captures it all, even if it appears so. We can interpret evolutionary theory from the biological individual perspective,[01] the geological perspective,[02] the ecosystemic perspective,[03] the hierarchical fitness landscape perspective,[04] as a second-order inheritance or lineage evolution,[05] or as an undirected novelty generation engine.[06] All of these insights are complementary frameworks to analyze the effects that one observes in natural selection. Fundamentally they pretend to explain what is *necessary* to transit from the *actual* to the *possible.*[07] At its core, natural selection is an explanation of a world in constant transformation.

The gist of each perspective's explanation could be summarized as: (biological individual) how did an individual's code change in order to satisfy an evolutionary pressure; (geological) how was the change of an element in the environment able to drive the change of a set of individuals to a new evolutionary equilibrium; (ecosystemic) how did a new evolutionary feature arise as a consequence of a series of new innovations in the ecosystem of a species; (hierarchical) how was a set of evolutionary features able to assemble into a stable building block to explore a new hierarchy of possibilities; (second-order) how evolution might also affect second-order biological properties, such as robustness, complexity, and evolvability, to anticipate the changes of

01 HUXLEY, Julian, "Evolution. The Modern Synthesis", in: *Evolution. The Modern Synthesis,* 1942.
02 SMITH, Eric & MOROWITZ, Harold J., *The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere,* Cambridge: Cambridge University Press, 2016.
03 KAUFFMAN, Stuart A., *The Origins of Order: Self-Organization and Selection in Evolution,* Oxford: Oxford University Press, 1993.
04 HILLIS, Daniel W., SYKES, Christopher, DYSON, George, "W Daniel Hillis—Nature—The Great Engineer", in: *Web of Stories,* October 2016.
05 KRAKAUER, David C., "Playing Go with Darwin", in: *Nautilus,* 2020, http://nautil.us/issue/94/evolving/playing-go-with-darwin/.
06 STANLEY, Kenneth O. & LEHMAN Joel, *Why greatness Cannot be Planned: The Myth of the Objective,* Cham: Springer, 2015.
07 PATARROYO, Keith Y., "Intelligence as Life", 2022.

an organism many generations in the future; (undirected evolutionary novelty) how can evolution find the solution to a complex problem space by exploring all kinds of unpromising solutions and almost by accident getting closer to a promising one.

Within all these perspectives one naturally also finds a set of polarities. On the one hand, evolution seems very much *contingent,* the life we currently have seems to be a series of coincidences that are dependent on some historical factors that we cannot predict. On the other, it seems that evolutionary features are *inevitable,* they arise just when all the bare ingredients are on the table. For example, the amino acids in our genetic code are the easiest chemistry that can be formed with the carbon backbones coming from the reverse citric acid cycle.[08] This constant fight between inevitability and contingency is at the core of evolution and life. Moreover, it is also at the core of the different scientific approaches to life and evolution: on the one hand, physicists, chemists, and geologists are much more comfortable looking at the inevitable picture, since it easily fits into a deterministic framework; on the other, statisticians and biologists much prefer the contingent aspect, since it allows for more freedom by looking at a population view of evolution,[09] where its dynamics are modeled stochastically.

The possible resolutions of these polarities are a very productive set of ideas that allow us to consider new creative possibilities. For example, according to Peirce,[10] one is not to consider these two polarities as irreconcilable, but rather as stable elements of the process of *becoming.* While the contingent part focused on the freedom to look for solutions to evolutionary pressure, there is, in the background, maintenance of the becoming. In other words, nurturing the becoming is fundamental to keeping the key elements and finding a path in the possible to get stable features and satisfy the evolutionary pressure. After this process, this path looks like the only natural path, almost a property of the system, in other words, the result just *is.*[11] Another way to think about it is that the idea of causality appears in the process of becoming, but its mark is lost when observed from either polarity.

The process of becoming very much relates to the other pole of the creation of the universe, humanity. In this regard, it is also important to discuss the emerging theory of cultural evolution. The phenomena of the evolution of culture differ from the modern synthesis view of biological evolution in many ways. Here we focus on two fundamental elements, the first is that there are designers, and

08 PATARROYO, Keith Y., "Technology or Monetary System: What is the Key to Progress?—Part II: The Case for the Monetary System", in: *Medium,* 2021.

09 PENCE, C., *The Causal Structure of Natural Selection (Elements in the Philosophy of Biology),* Cambridge: Cambridge University Press, 2021.

10 PEIRCE, Charles S., "Evolutionary Love", in: *The Monist,* 1893, pp. 176–200.

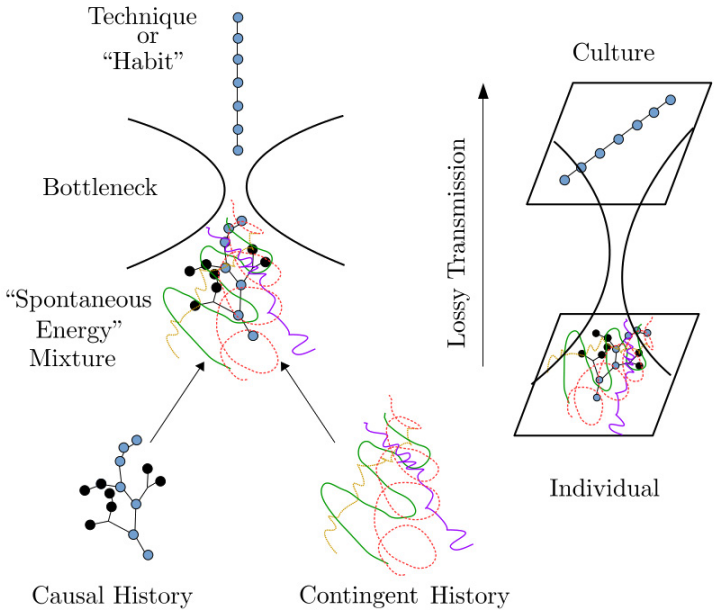
11 MACH, Ernst, *The Science of Mechanics: A Critical and Historical Account of its Development* (trans. MCCORMACK, Thomas J.), La Salle: Open Court, 1960 [1907], section: The Economy of Science.

the second is the fact that, unlike with biological species, there is no well-defined "biological" individual (biological replicators) in a cultural context. This last element makes culture much more fast-paced, since parts of the network of an idea are created and destroyed very quickly, whereas in biological evolution it takes a great number of resources for an animal to be born and its lifespan is much longer. Nevertheless, the real engine of creation is as mysterious in culture as in biological evolution. In fact, if we believe that creation in the universe has a common structure and that biology and humanity have been able to tap into this phenomenon, it is of fundamental importance to understand both at a deep level. This underlying weave is what I denote as the *Psyche of the Universe.*

If we realize that complexity, order, and knowledge in the universe are centralized at many different scales, we find that cultural evolution, biological evolution, and the organization of the universe share a similar structure. Our planet is highly complex in a mostly empty universe, there are few technologically advanced countries on Earth, and most of the complexity of a country lies within cities. In a similar way, while life can be found in the most obscure place on earth, this life is usually unicellular and its characteristics include autotrophy or reductive metabolisms. In fact, what we consider as a complex individual, that is a multicellular organism with heterotrophy or oxidative metabolism, is very much the exception. In a similar way in the cultural context, there are *nodes of great creativity,* usually hidden away from mainstream culture, where individual creators and company monopolies generate most of the complexity within society.

The idea of individual creators being a force of change is, while criticized, more acceptable in arts. However, in contemporary scientific culture, it is very much discarded. People say that science is done in collaboration, and that individuals are not the *catalyzers* of change. These two polarities are another source of conflict in the arts and the sciences. However, I don't see this as a fundamental contradiction. Once we take a layered view of cultural evolution, it will become clear that those great individuals are usually a source of great creation. Taking mathematics as an example: in the bottom layer, where we have very prolific individual creators (Grothendieck, Shelah, Erdős) there is great variation at a fast rate, however, it is the second layer (the mathematical community), even though it moves much slower, that is of greater "influence" than the bottom layer. While individuals might be recognized, the association between them and their creations is usually forgotten. The reason why they are not fully acknowledged is exactly the same as before, once they are completed, their creations

seem inevitable,[12] or in mathematical lingo, trivial. However, what happens here is that in the projection from the individual layer to the cultural layer much is lost, the ideas, the inspiration, the great network of connections, and intuitions of each individual mind (this is what Peirce denoted as “Spontaneous Energy”). What is transmitted to the cultural layer is the *technique* because that is what can be transmitted.[13]



The back-and-forth between cultural and biological evolution is extremely fruitful if one knows with *precision* what phenomena are analogous in the other realm. For instance, the ideas of biological evolution and ecology have been used in language evolution and cultural history.[14] Conversely, combinatorial evolution, a subcomponent of cultural evolution,[15] has been used as a possible mechanism of early life’s evolution. This led to the proposition that processes like horizontal gene transfer were instrumental in early cellular life. Moreover, models of early life like autocatalytic networks have been used to

12 KLOSINSKI, Leonard F. et al., *Is Mathematics Inevitable?: A Miscellany*, Washington, D.C.: Mathematical Association of America, 2008.
13 PATARROYO, Keith Y., “Von Neumann’s Final Dream: Mathematics is a Form of Life”, in preparation.
14 KESTEMONT, Mike et al., “Forgotten Books: The Application of Unseen Species Models to the Survival of Culture”, in: *Science,* 375(6582), 2022, pp. 765–769, https://forgotten-books.netlify.app/.
15 ARTHUR, W. Brian, *The Nature of Technology: What It Is and How It Evolves,* New York: Simon and Schuster, 2009.

model cultural evolution,[16] since in early life there was very likely no biological replicator, and just like in culture, network components are highly interconnected and cascading effects are much more common. In fact, some people regard this kind of evolution as Lamarckian, where the traits transmitted to the other pieces of the network are the ones acquired in the lifetime of a cultural trait.

Another very productive bridge lies between the idea of life, evolution, and non-equilibrium economics, as the idea of creative destruction was described by economist Joseph Schumpeter in his treatise on capitalism.[17] In fact, he very much believed that an economy is very much like a life form, creating itself out of itself. We can expand on this idea by thinking from a technological point of view, assuming that an economy produces mainly a set of assets, services, and technologies. Since new technologies are built from technologies already in use within an economy, we can conclude that new exports in fact create themselves out of themselves. This analogy can be pursued further, leading us to recognize *knowledge* as a fundamental quantity, and in turn, examine the details of how is it created, destroyed, stored, and what it can enable us to do.

To formalize the idea of knowledge, we'll take its definition from constructor theory,[18] where knowledge is a quantity of information that maintains itself over time and is able to catalyze a transformation.[19] At its core, it is the key element from which one could *in principle* generate a transformation. However, the specifics of the transformation are very much contingent. Fundamentally, knowledge can be stored in three different mediums: *materials, codified* knowledge, and *brains.*[20] For instance, if we have a message in a bottle, it is of fundamental importance that are we able to open the bottle, read the message and understand its meaning. There is knowledge stored in each of these layers, however; if the code is not understood, then the knowledge in the message cannot be instantiated.

The implicit appearance of causality in this formulation of knowledge implies strongly that time may play a more fundamental role in the foundations of physics.[21] Moreover, the observation that knowledge is overall increasing over time[22] may become a fundamental

16 GABORA, Liane & STEEL, Mike, "An Evolutionary Process Without Variation and Selection", in: *Journal of the Royal Society Interface,* 2021, http://doi.org/10.1098/rsif.2021.0334.

17 SCHUMPETER, Joseph A., *Capitalism, Socialism and Democracy*, Abingdon: Routledge, 2010.

18 DEUTSCH, David, "Constructor Theory", in: *Synthese,* 190, 2013, pp. 4331–4359, https://doi.org/10.1007/s11229-013-0279-z.

19 Note that in this definition, there is a clear arrow on the idea that knowledge causes a transformation, therefore causation is implicit in this formulation. But it is in the transformation where the arrow really appears.

20 HAUSMANN, Ricardo, HIDALGO, Cesar A., BUSTOS, Sebastián, COSCIA, Michele, SIMOES, Alexander & Yıldırım, Muhammed A., *The Atlas of Economic Complexity: Mapping Paths to Prosperity,* Cambridge: MIT Press, 2013.

21 MARSHALL, Stuart M. et al., "Identifying Molecules as Biosignatures with Assembly Theory and Mass Spectrometry", in: *Nature communications,* 12(1), 2021, pp. 1–9.

22 HIDALGO, Cesar, *Why Information Grows: The Evolution of Order, from Atoms to Economies,* New York: Basic Books, 2015.

element in the description of time's directionality. In this regard, as thermodynamics is deeply related to time's arrow, we see a connection between thermodynamics and knowledge. Furthermore, we can be inspired by the history of thermodynamics and the fact that it was first developed by working with heat engines during the industrial revolution. In an analogous way, we can start developing a thermodynamic theory of knowledge by studying knowledge engines in the information age.[23] With this in mind, we may search for an analogy for heat engines and the fundamental thermodynamic quantities such as work, heat, temperature, and energy. As a first guess, the knowledge engines could be humans or whole planets and the fundamental quantities associated with this new sort of engine would perhaps be knowledge, intuition, and information. We can go further and perhaps ask about its laws, where we might be inspired by the first and second laws, whose formulations[24] say that the energy of a system can only be changed by changing the energy of another system by the same amount and a heat engine cannot generate work at a single temperature. Analogously, we can conjecture that there are knowledge engines that can make knowledge "ignite" and in every process of transmission of knowledge with engines capable of different states of "burning" or "combustion" some amount of intuition is lost.

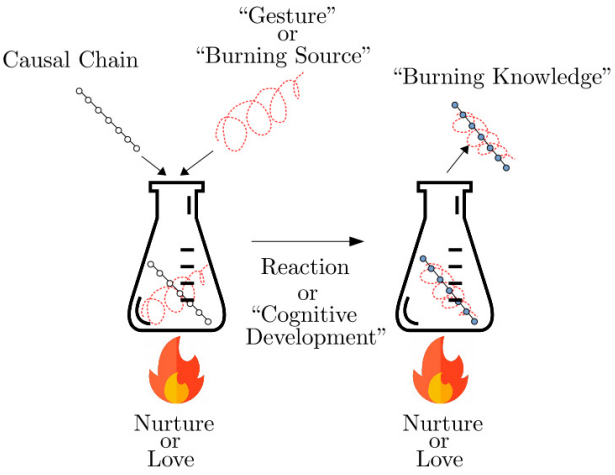
What do we mean by "ignition", "burning" and transmission of knowledge? Interestingly enough, knowledge in "burnt-out" form is exactly what remains in the process of lossy transmission of creative output from the individual layer to the cultural layer. Therefore, burnt-out knowledge alone lacks exactly what is needed to construct or understand a transformation. Note that there are two fundamental processes that we allude to here, *creation* and *instantiation.* At the moment knowledge is first created, it appears in a "burning"[25] form, however much is lost in the way of transmission or storage, this spontaneous burning is gone, the burning knowledge becomes burnt-out knowledge, and this loss is very much what we need for burnt-out knowledge to instantiate or "ignite", thereby catalyzing a transformation. In a way, the idea of reverse engineering or bio-inspiration is precisely this; if we have a piece of burnt-out knowledge stored in a material or a symbolic way, how can we instantiate it, or in other words,

23 STREVENS, Michael, *The Knowledge Machine: How Irrationality Created Modern Science*, New York: Liveright Publishing, 2020.

24 These are the Clausius statement of the First Law and the Kelvin statement of the Second Law.

25 Burning knowledge is not necessarily knowledge stored in brains. Humans can memorize burnt-out knowledge; for instance, I can memorize a multiplication algorithm and perform the calculation as precisely as a mechanical calculator does, but if I forget the algorithm or the calculator is destroyed, the algorithm is lost forever. In the case I understand the idea behind the algorithm, I can recover it by remembering a compressing gesture (SAINT-OURS, Alexis de, "Les sourires de l'être", in: *TLE,* 22, 2005) even if I have forgotten about the details; in other words I'm able to re-create knowledge from its burning source plus a causal chain (POINCARÉ, Henri, "Mathematical Creation", in: *The Monist,* 20(3), pp. 321–335). Therefore, a brain is a knowledge engine capable of two different states of combustion or burning.

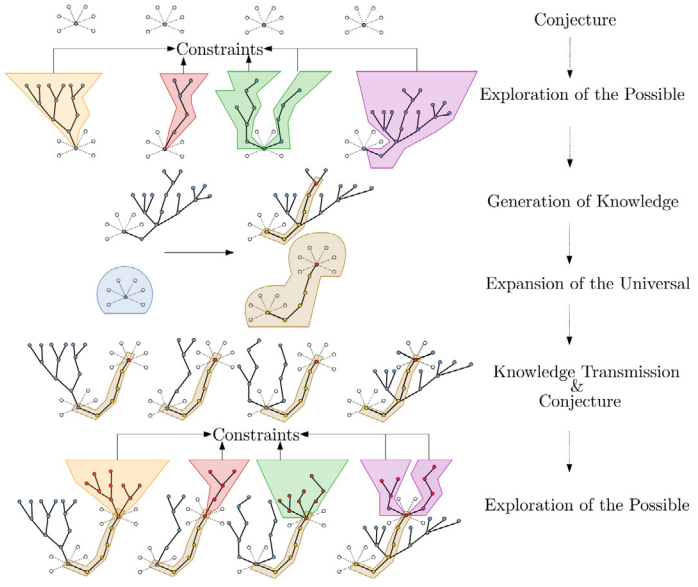
learn the transformation that this knowledge catalyzes? That is what makes this burnt-out knowledge "burn", the process of learning a transformation. But how can one create this burning knowledge and how can we ignite burnt-out knowledge? Perhaps just like in thermodynamics, we don't need a mechanism to formulate a useful "macroscopic" theory, however deep experience in the operation of knowledge engines is of fundamental importance to make sense of the theory.[26]



We can find a qualitative understanding of knowledge engines in the psychology of creativity, where four elements are of fundamental importance. These are what could be described as passion, love, freedom, and discipline. They can be joined into three categories: *Emotion, Thought,* and *Action.*[27] These three elements are what Grothendieck calls the three poles of human experience. In creative pursuits, Thought is not a primary player, it is secondary, it organizes the structure before and after the creation has been made. More importantly, Emotion contains the elements of passion, love, and freedom; in each of these elements, individuals need to go beyond their head and follow their heart. In this process, they should be free to explore all types of possibilities and follow their heart to all sorts of different places, never be constrained by their own limitations. Finally, this process should be repeated passionately very often, every single day, or even every single hour, the creator generates and generates, never expecting any kind of result, but doing it simply for the love of the craft.

26 This image has been designed using resources from Flaticon.com: Fire by Freepik, https://www.flaticon.com/free-icon/fire_785116/, and Erlenmeyer by Samlakodad, https://www.flaticon.com/premium-icon/erlenmeyer_3676252/.
27 GROTHENDIECK, A., "The New Universal Church", 1971.

Note that I mentioned *love,* this is of fundamental importance because here I'm referring to what Peirce denoted as *evolutionary love,* by which, he meant the way one nurtures an idea that is growing to be a creation. This is, in fact, the connecting fabric between necessity and contingency in his ideas of a Lamarckian evolutionary theory. He proposes that "habits" or, in our case knowledge, embedded in materials, is the default state of most objects in the universe, and it is by providing them with this fire, with love, that they go beyond habit to a new state of mind. For this one needs the freedom to explore different possibilities, and then love to nurture an idea in order for it to grow once it is conceived. The burnt-out knowledge seems like a simple memory of this process and stills need to be set afire when it has been extinguished by some process. According to Peirce and as we have alluded to before the process of setting something afire is analogous to the process of learning, because once the fire is extinguished one should re-start the process of cognitive development just like one must re-grow muscles each time one stops going to the gym. Moreover, by creating new knowledge and liberating matter from this habitual state, we are increasing the set of what is possible in the universe and expanding the scope of the universal.[28]



28 The idea that the universe is expanding its capacity for creation is an idea considered by Peirce, but is also being reconsidered today in the quest to find the origin of Life. In this quest some are starting to believe that the early universe had a lower creation capability than today's universe.

This is a description at the level of human psychology, but can we create a model that captures these very ideas, perhaps even in an emergent way? Well, the idea that thought alone can capture the two other elements of human nature is perhaps a little naive. In fact, just as they usually say in religious and mystical circles, once you have experienced it, *it is real!* No matter the explanation. Therefore, what Brower[29] denotes as transcendent truth is the very idea that these mystical elements experienced by a human should not be analyzed but rather left as such. By trying to capture them with pure thought, we are transmitting from the bottom layer to the culture layer. All the spontaneous burning is gone if we analyze this with pure Thought. So, is there a way out of this impasse? Can we ever grasp the psyche of the universe in our hands? Well, I think this suggests that a true experience of the creative force should be enacted in the world, and it also proposes that the theory and the practice of creation should be unified. However, this does not suffice, this unification should be nurtured by love in a process of development. It is only at this stage that we will have considered the full scope of human nature[30] and the psyche of the universe will be transmitted beyond our planet Earth and us humans.

Embracing the messiness of creation also allows us to reach a new set of possibilities. Instead of looking at mathematics, science, or art as a set of techniques, we embrace the full creative power of these disciplines as new forms of *universality.*[31] In this way, we conceive higher forms of language that compose beyond sequentiality and rather react like chemical compounds creating new bonds and an explosion of potentiality. In this dangerous process of jumping to the new, we may find nodes of great creativity in marginal areas,[32] where we might be able to unleash new transits to areas of contemporary culture and thereby expand the set of what we think is possible. This constant creation of potentiality reflects the way life bootstraps itself out of itself, which means that by this process we are making the universe more and more alive.

By taking this panvitalist perspective we aim to complement a program of sheaficiation[33] of culture where we avoid dividing the world and look at it as fundamentally mixed. In that way, just like in an environment of creation, that is raw, unpolished, and highly constrained, things emerge because of these constraints, not in spite of them. Therefore, at each stage of constraint generation, the capacity of the

29 BROUWER, Luitzen E. J., "Life, Art, and Mysticism", in: *Notre Dame Journal of Formal Logic,* 37,(3), 1996, pp. 389–429.
30 THIEL, Peter, "The Straussian Moment", in: HAMERTON-KELLY, Robert (ed.), *Politics and Apocalypse,* East Lansing: Michigan State University Press, 2007, pp. 189–218.
31 The New Centre for Research & Practice, "Why Zalamea Matters: Philosophy, Media, and Culture", *Youtube,* 2015, https://www.youtube.com/watch?v=X7AEfpOh4NQ.
32 This is in fact the objective of Project Galápagos, which attempts to capture the key elements of the creation of the human mind and of the planet Earth, and to enact them in the material world while providing them with nurture or Love.
33 ZALAMEA, F., *Synthetic Philosophy of Contemporary Mathematics,* Cambridge: MIT Press, 2012.

universal increases. Just like that, we will be taking on the quest that Grothendieck left for those who *"regard the enhancement of Life, in all its richness and variety, as being the supreme value".*[34]

Keith Y. Patarroyo is a research engineer working on artificial life, digital chemistry, and unconventional computation. He is the Principal Investigator at the Gálapagos Project and currently works as a developer in Chemify and as an engineer at the Cronin Group from the University of Glasgow. He is also a Research Affiliate of the Wolfram Physics Project and is very interested in the foundations of mathematics and creativity. These days he is often found online at Goedel Parallax on Clubhouse.

34 GROTHENDIECK, A., "The New Universal Church", 1971.