From Catastrophe Theory to Psychic Complexity

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Abstract

This text offers a synthesis of catastrophe theory and its potential applications to psychopathology. Catastrophe theory offers a means of representing the complexity of the interacting dimensions bearing upon the psyche, thereby allowing us to advance toward its intelligibility.

Keywords

Catastrophe theory; Psychoanalysis; Cognitive science; Complexity theory

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Presentation

Catastrophe theory proposes a method for intelligibility, in the etymological sense of the term (*inter-ligere*: to bind things together). This method requires a preliminary distinction among several sets. The first set is that of observed phenomena — that is, the apparent states assumed by an object within a given domain of the real. We shall denote by **E** the set of observed states, actualized or potential, assumed by a system under study, denoted **S**. The second set, **C**, is that of the factors (control parameters) that govern modifications of the object. In classical reductionism, one postulates linear determinism:

$$\mathbf{C} \rightarrow \mathbf{E}$$

This reads: C determines (is the cause of) E. Variation in the control factors C determines variation in the states E of the object. For example, one raises the temperature (factor C) and water boils (state E); aspirin (factor C) reduces fever (state E); an antipsychotic dulls delusional thinking, testosterone triggers aggressive behavior, the frontal cortex pilots conduct, dopamine activates the "reward" system, and so on. It is possible to complicate this schema by the coaction of several control factors. One may also envisage the recursive feedback of E onto C, thereby establishing a circular causality. But the underlying principle, beyond the added complication of feedback regulation, always remains one of a $\mathbf{C} \rightarrow \mathbf{E}$ schema. Catastrophe theory complexifies this induction of C $\rightarrow$ E by inserting between these two sets a further set — that of singularities, **K** — that is, the set of singular values assumed by the control factors that determine the so-called catastrophic bifurcations of the states of E. These sets K may be points, as with the single value of water's boiling point. But where several independent control factors are present, these sets may be lines, surfaces, volumes, and even sets of multidimensional topology, of which we can only conceive local cross-sections. We thereby obtain a further deterministic schema:

$$\mathbf{C}\text{—}(\mathbf{K}) \rightarrow \mathbf{E}$$

Apparent phenomena are determined by control factors that are themselves categorized by bifurcation sets. Now, these bifurcation sets do not come from nowhere. They arise from the unfolding of mathematical singularities possessing an ontological reality, akin to the properties of the triangle, the circle, or the square. These mathematical singularities,

discovered by Thom, were named *catastrophes*. The term has been criticized for suggesting the idea of definitive destruction, whereas a catastrophe in René Thom's sense is a metaphor designating the genesis of discontinuities within a continuous flux. Catastrophes discretize continuous spaces by generating strata that separate out new sets. Remarkably, there exists only a small number of elementary catastrophes (seven), whose combination accounts for the diversity of morphologies observable within a given domain. It thereby becomes possible to classify observable phenomena on the basis of a reduced number of elements — a major epistemic gain. Yet this schema of intelligibility remains incomplete. It does not take into account the existence of the internal dynamics of system S that underlie the appearance of the states E. A dynamical system designates a process of temporal evolution in which the future depends, in a deterministic manner, upon the past, and thus ultimately upon the initial conditions of its genesis. Mathematically, a dynamical system is formalized as the investment of a velocity vector field upon a topological manifold, subject to an oriented gradient G.

Physically, a dynamical system may obey the laws of classical mechanics, as with a pendulum, or the planets of the solar system. The coordinates of a system (its degrees of freedom) evolve over time, and their values define its phase space. As the system evolves, its representative point in the n-dimensional phase space moves — the system traces an abstract trajectory through phase space. This notion of a dynamical system is applicable to every conceivable domain: chemical reactants, animal populations, stock market indices, the behavior of an organism, and so on. In other words, a dynamical system, regulated by control factors, is also subject to an internal evolution. Control factors regulate, influence, and modulate this evolutionary dynamic, while themselves being constrained by catastrophic sets that impose their strata of bifurcation, and thus catastrophic changes of state within the system. Finally, there exists one further element, which we shall call the **selective instance**, which may belong to other spaces of determination resulting either from the external effect of other dynamical systems, or from the election of a control factor as a critical factor. It may also remain unknown. This selective instance determines the choice of trajectory taken by the system.

Catastrophe theory is thus deterministic, insofar as it proposes an explanation for the appearance of phenomena, and indeterministic, insofar as it does not, in most cases, predict the evolution of the system under consideration. Catastrophist models have been proposed across every conceivable domain, from meteorology to geology, by way of sociology and linguistics. They are transdisciplinary by their very nature, since the topological forms resulting from catastrophic bifurcations are independent of the nature of the substrates in which they occur. These models describe only the topology of emergent forms, not their metric (magnitude). They can reconstruct the number of spaces whose interactions determine their phenomenological appearance. From here, a methodological solution can be brought to bear on the problem of reconciling psychoanalysis with contemporary science. Each of these disciplines — psychoanalysis, cognitive science, neurophysiology, each legitimate in its own right — carries out a local cross-section within the complexity of the psyche, that is, within the complex, unrepresentable space of the flux of mental regulations, conscious and unconscious, categorized by bifurcation sets. Thus, psychoanalysis carries out a local cross-section within psychic complexity and has discovered the existence of the dynamic flux of the unconscious. In catastrophist terms, what Freud named the unconscious primary process is the free flux of fundamental biological prégnances[ˆ*] — sexuality and aggression — unfolding from catastrophic singularities and playing out within an n-dimensional space, devoid of time, which is then projected into the space of thought (three dimensions plus time), generating the secondary process (conscious, logical, subject to the law of non-contradiction). The death drive of Freud's final drive theory (1920) corresponds to the gradient tending toward a decrease in complexity, and stands opposed to sexuality (Eros), whose continuous thrust increases complexity. Psychoanalysis has thus approached as closely as possible the dynamical system itself (the unconscious drives) and attempted, with the conceptual means available to Freud, a description of its regulation (the topographies). Neuropsychology, for its part, refrains from seeking to understand the nature of this dynamic flux, and in-

stead describes a different local cross-section within the complexity of psychic life, by making explicit the control factors inherent in the neuronal implementation of the psyche's regulatory functions. Neurophysiology bears more directly on the scale of neuronal transmission. This level of description cannot, on its own, account for psychic phenomena, since it is confined to the establishment of control variables. These variables are categorized by bifurcation sets belonging to a different level of reality — one that cannot be grasped through experimentation or measurement, and that can only be rendered intelligible through a qualitative approach. Once we accept the idea that each discipline carries out local cross-sections within the complexity of the psyche, a new avenue opens up. Understanding psychic life as a whole no longer consists in identifying local causes — whether a neurotransmitter level, a psychological trauma, the intensity of a drive, the force of an agency, the functional state of an anatomical structure, or other supposedly determining factors — but rather in qualitatively describing the arrangement among the different interacting dimensions: the control factors, the flux of the dynamical system, and, ideally, the catastrophes that generate the bifurcation sets.

[*]: *Translator's note:* The French term *prégnance*, drawn from René Thom's semiophysics, is left untranslated here, as is customary in the English-language literature on Thom's work; it designates the primitive, salience-conferring quality by which certain forms exert an attractive or organizing force upon a perceiving or living system, prior to any symbolic elaboration.

Catastrophe theory brings no new facts to psychoanalysis. The existence of the unconscious, of infantile sexuality, of transference, of the dream as wish-fulfillment — these are facts, among many others, that constitute the foundation upon which psychoanalysis has deployed its theoretical conceptions. On this front, René Thom's models reveal no new facts likely to interest psychoanalysts. Nor does catastrophe theory bring any new metapsychological concepts, even though ingenious attempts have been made to import the concepts of *prégnance* and salience into psychoanalysis. What catastrophe theory contributes to psychoanalysis is the possibility of rendering intelligible the articulation among four major dimensions of psychoanalysis. These dimensions are implicit, subterranean — they have no entry of their own in the dictionaries and glossaries of psychoanalysis. And yet they are fundamental dimensions.

Thresholds and Interfaces

The first dimension is represented by the concept of **threshold**. A threshold is directly implicated in the foundational topographical distinction between conscious and unconscious. Something separates the locus of the unconscious from the locus of the conscious. Whether we name this "something" a barrier, a frontier, a limit, or an interface certainly introduces semantic differences, but in every case it remains a discontinuity between two spaces. Freud's first topography, which separates the conscious from the unconscious, thus posits a threshold. This threshold can split into two, leaving an intermediate space — the preconscious. It may also present the appearance of a continuous gradation. But at a given moment, the critical leap occurs: a representation is either conscious or unconscious. How are we to think the establishment of such a threshold — its nature, its function, its particular characteristics? Since the work of Paul Federn, this question has no longer been addressed directly within psychoanalysis. This notion of threshold is not confined to the conscious/unconscious distinction. Other thresholds exist. The distinction between a mental process and a somatic process is itself the effect of a threshold. The strength of the ego depends upon a network of frontiers and thresholds, of a quantitative or qualitative nature. Below these thresholds of security, the ego remains stable and operative; beyond them, it is threatened by the irruption, within itself, of traumatic elements, whether drive-related or event-related in nature. Where do these thresholds come from, how are they established? Why are they marked by such great inter-individual variation? Do other thresholds exist? These questions remain open.

Attraction

The second dimension is illustrated by the concept of **attraction**. The repressed draws conscious rep-

resentations toward itself. Past traumas are reactivated by present events. The subject's cathexes are shaped by unconscious phantasies that draw lived experiences toward themselves and modify them. Analysis unfolds along an evolving course in which childhood scenes draw mental associations toward themselves. The notion of attractor, even though it is not made explicit in the analytic literature, is nonetheless omnipresent there. The past attracts the present; the infantile attracts the actual; the sexual attracts the non-sexual; primitive man attracts contemporary man. The dynamic of analysis can be compared to the surface capture of elements of life, of thought, of object relations, drawing them (through an identity of perception) toward the deep, timeless, unconscious nuclei — in other words, toward attractors. What, in essence, is an attraction? Why does this dynamic of return — and thus of retroactive effect (*après-coup*), of memorial attraction — occur? How can we understand it in its essence, rather than treating it as a given process whose explanation can simply be dispensed with?

Structures

The third dimension is that of **structure**. Structuralism has gone out of fashion, but structures do indeed exist. They persist despite their disappearance from contemporary debate. They exist in linguistics, in anthropology — to name only fields where their validity is well attested — and they exist equally in psychoanalysis. One may harbor reservations about so-called Lacanian psychoanalysis. But one cannot deny Lacan the discovery of the four-term Oedipal structure (subject, father, mother, and death), which allows for structural displacements, together with the reinterpretation of castration as a symbolic operation permitting a structural circulation, of which the variety of analytic clinical practice gives ample account. This structure does not sum up the whole of Lacan's work — other structures have been described — but it is fundamental, since it articulates the subject's destiny with a pre-existing symbolic organization. Where does this structure come from? What is its function? What are its links with individual psychic functioning, and with anthropological structures?

Energy

The fourth dimension is that of **energy**. Freudian psychoanalysis makes profuse use of the notion of energy, following Freud's own metaphors, written at a time when energy — in its various forms, thermal, hydraulic, mechanical — constituted a central epistemic given. Psychic energy, mental energy, drive-pressure, repression, exhaustion, cathexis — metapsychology can hardly do without the notion of psychic energy. Is it a metaphor? Is it an objective given? What laws govern its energetic circulation? Is this energy oriented? What are its links with thresholds, with attractors, with structures?

More generally, then — and thus independently of any particular domain of reality — catastrophe theory proposes a cohesive articulation among these four dimensions. Catastrophe-theoretic models describe the origin and nature of the arrangements of thresholds separating disjoint spaces, whose centers, or poles, are attractors. These attractors coexist virtually, and their differential relations define structures, in the sense of Deleuze's differential structuralism. The full set of thresholds (strata), of attractors, and thus of structures, are generated by the unfolding of catastrophic singularities of mathematical essence, subject to an energetic gradient. Thresholds, attractors, structure, and energy are thereby brought together within a shared conception, allowing for a gain in intelligibility. This gain in intelligibility has a direct consequence: it offers the possibility of thinking Freudian metapsychology together with the contributions of neuroscience and cognitive science — without reduction, without degradation, without hypostasis, and without loss of reciprocal autonomy — but within an epistemologically coherent arrangement.

A New Conceptual Imaginary

Catastrophe theory renders intelligible the unfolding of complex spaces, stratified by multiple interfaces separating local regions organized around attractors, whose competitive relations with other attractors generate a structural functioning. Catastrophe theory allows us to conceive of the existence of a multidimensional reality — unimaginable in the strict

sense of imagination, since it exceeds the faculties of our understanding, to borrow Kant's term, which is constrained by the three dimensions of space and by time. This space is the space within which biological life unfolds. It is not uniform, for it contains mathematical singularities that can be conceived either as Platonic essences informing reality, or equally as mathematical seeds inherent to reality itself. Within this space, life unfolds and assumes forms resulting from the dynamic and morphological constraints stemming from these singularities, in combination with the necessities of adaptation and natural selection. The evolution of living organisms, along our own phylogenetic lineage, is marked by a progressive cephalization and the appearance of cognitive functions. These functions are forms of regulation of the catastrophic dynamics induced by adaptation. Ancient phases constitute attractors, toward and away from which the lines of evolution converge and diverge. The animal — and subsequently the human — psyche is constituted by the full set of cognitive functions, including self-consciousness, which have, in part, achieved autonomy from their somatic substrate. Only in part, however: for while the psyche constitutes a holistic entity, substances capable of modifying the biological substrate can equally modify psychic activity. We are thus dealing with a holistic system protected by a network of critical, dynamic thresholds, which can be subverted, destroyed, or reinforced. In the case of the human species, and for reasons that remain phylogenetically imprecise, the development of the sexual function undergoes a marked discontinuity, expressed in the latency period separating infantile sexuality — an observable fact — from pubertal sexuality, itself the prelude to adult sexuality. The result is a particular psychic destiny of sexuality, marked by the existence of repression — that is, the establishment of a stratum of bifurcation within psychic space, separating the conscious from the repressed unconscious. Psychoanalysis explores and conceptualizes this unconscious space, within which the sexual drive has achieved its own autonomy, and whose unfolding is the source both of psychopathological manifestations — though not of the whole of psychopathology — and of phenomena of cultural and social sublimation.

This unconscious space, the originary locus of object relations and object-cathexes, is not the whole of psychic space. It coexists with cognitive functions whose aim is adaptive, and whose raison d'être is the regulation of the organism. These functions can certainly be subverted, diverted, or inhibited by an unconscious cathexis — clinical practice offers constant examples of this. But the description of these functions — the object of cognitive science — and of their physiological implementation — the object of neuroscience — can be neither reduced to "adaptive functions of the ego," a move that would exempt us from seeking to understand them, nor dismissed as lying outside the analytic field altogether. For contemporary clinical practice — that of autism, of schizophrenia, of bipolar disorders, of depression — shows that reality has scant regard for territorial claims. Reality is, by its very essence, complex, and only a mode of thought willing to assume that complexity stands any chance of approaching its true description.

References

Virole, B. (1995). *Sciences cognitives et psychanalyse*. Nancy: Presses Universitaires de Nancy. ISBN 2-86480-797-7.

Virole, B. (2011). *La complexité de soi*. Paris: Charielle Éditions. ISBN 978-2-9528925-5-1.

Virole, B. (2019). *Catastrophes de l'inconscient*. Paris: Éditions Baguera. ISBN 978-2-902591-01-5.

Translator's note: This is a scientific English translation of the French original by Benoît Virole. Terms drawn from René Thom's catastrophe theory and semiophysics (catastrophe, bifurcation set, control factor, unfolding, singularity) follow standard English usage in the mathematical and philosophical literature on Thom's work. The term prégnance *has been left untranslated, following the convention of the English-language secondary literature, since no single English word captures its full technical sense. Psychoanalytic vocabulary (the topographies, cathexis, drive, repression, the primary/secondary process) follows established English usage.*