Version 4th of December 2015; invited paper submitted to: **Lo Sguardo. Rivista di filosofia**, Edizioni di Storia e Letteratura, Milan, scheduled for July 2016, special topic: Philosophy and Catastrophe

Wolfgang Wildgen

Intellectual revolutions in philosophy and art: continua and catastrophes

1 Introduction

Philosophy is a discipline which lies in a field beyond science and is in this respect comparable to art. Therefore the topic of continua and catastrophes is dealt in relation to both. The term catastrophe is with priority defined with reference to catastrophe theory, but for informal contexts standard cases of (natural) catastrophes are seen as good examples for the content of this notion. First major trends in the history of philosophy and the linguistic strategies used to treat problems of philosophy are sketched (Greek and Renaissance philosophy and modern Analytic philosophy are discussed in some detail). It is shown that catastrophe theory can offer conceptually relevant help for epistemology and philosophy; its evolutionary schemes are able to catch aspects of the dynamics in the field of philosophy. In a second part, major revolutions, i.e. dramatic changes in the history of art are analyzed. We deal with Leonardo da Vinci, William Turner, Henry Moore and Salvador Dali. In the case of Dali, a link to René Thom, the founder of catastrophe theory is established based on a meeting of Thom and Dali and several paintings of Dali which treat the topic of catastrophe in the sense of Thom. As a further completion cases of catastrophes (dramatic changes) in the field of music (intonation crises) and very summarily in language art are discussed.

1.1 Philosophy and art

Philosophy and art are two very different disciplines, it seems. Philosophy is traditionally understood as a highly argumentative, very systematic discipline. But Plato's dialogues, Bruno's Italian writings and even the writings of authors like Heidegger or Wittgenstein have a literary, often an artful design, and literature is a form of art. Nevertheless, art is rather considered as a topic of philosophy (under the label *esthetics*) than as the proper form of doing philosophy. In the twentieth century, mainly in the Vienna school and later in Analytic philosophy, the scientific character of philosophy was highlighted, although they never made use of an empirical or even experimental methodology. Other authors thought that philosophy had ceased to exist as a proper discipline and could be replaced by general theories, meta-theories, e.g. a theory of science or even a province of science (psychology,

cognitive science or other candidates for the throne of general ‘”wisdom”). After 1920, Ernst Cassirer designed a philosophy of culture, which he called a “philosophy of symbolic forms”. Art was one of these “symbolic forms”, science another one and the position of philosophy was not clear. Is it a “symbolic form” on par with art and science (language and myth)? Or is it some super- or meta-form, external to the other symbolic forms?

Historically, art was first linked to craftsmanship as in pottery, became a central part of religious and mythical artifacts such as temples, churches, sculptural or painted decorations and narrative displays. If Plato was skeptical towards art, because it did not always serve truth and the goal of ethical goodness, art-workers eventually became part of a philosophical discourse in the Renaissance period. Thus, Leonardo or Michelangelo may be considered as philosophers to a higher degree than many contemporary, religiously confined professors of philosophy. Literature and philosophy, theater and philosophy mixed in the publications of Giordano Bruno (cf. his dialogue “Ash-Wednesday Supper” and his comedy “Il Candelaio”; cf. Wildgen, 1998, 2011: 28-43). After Heidegger, who mixed traditional (mostly historically minded) arguments with poetic metaphors and idiosyncratic etymologies, many French philosophers from Sartre to Derrida travelled on the frontier-line between literature (style and imagination) and classical philosophy in the Cartesian or Kantian style. After World War I and until the mid-20th century there was a strong impact of intellectual revolutions in the art domain, such as Dada, surrealism and later the movement of flower-people (in music, life style and anarchistic or bio-mythical trends). These trends brought forward a kind of reflection on life, values in the social world and thus a kind of popular “philosophy” which rivaled with institutionalized philosophical teaching. Life itself appeared to be simultaneously an art, the “savoir vivre” in the French tradition, and a world-view, a philosophy; cf. the line of a philosophy of life (“Lebensphilosophie”), initiated by Karl Wilhelm Schlegel (1772-1829) further developed by Henri Bergson (1859–1941) and Husserl (1859-1938).

As a general maxim, one cannot treat art and philosophy as strictly separated domains, especially not after the transfer of many topics which had been classically treated in philosophy to separate disciplines. The “septem artes” taught in the medieval and pre-modern universities are now part of non-philosophical disciplines and at the heart of new faculties. The standards established in these disciplines did not really penetrate philosophy which remains not unlike the art-domain a territory of challenges, schools of thought sharing similar premises and tastes, charismatic individuals, politically motivated sub-cultures etc.

1.2 The meaning of catastrophes

The basic idea of this analysis of innovation in philosophy and art concerns the moments of change, the catastrophe scenarios. We assume that under this condition the major forces which underlie these fields of intellectual enterprise become visible and that the turmoil which often accompanies debates in philosophy and art can be cleared up.

Catastrophes in the non-mathematical sense are either the outcome of natural forces or of human (bad) decisions or mistakes dramatically reinforced by natural processes. In a book called “The big catastrophes” (Szatmari, 1928) nineteen “catastrophes” are described beginning with the earthquake in Lisbon (1755) until the inundation by the Missisipi (1927). Eight of them are natural catastrophes, the others combine human mistakes with very strong forces in nature: insufficient constructions which cannot resist the forces of a storm, small mistakes or acts of imprudence which start a huge fire, shipwrecks under difficult weather conditions, collisions of a ship and an iceberg etc. The general characteristic is that there is an underlying continuum of potential dangers which are not clearly visible: In the case of the earthquake and tsunami in Lisbon (1755), which brought about a skeptical debate in philosophy (cf. Voltaire’s critique of Leibniz idea that our world is the best world possible), the coming catastrophe was only announced by the behavior of animals and some very susceptible humans, but nobody cared about these signs of an imminent danger. The catastrophe tells us that there are small, non-perceptible causes which hide in the world we live in and which under certain conditions suddenly come to the forward and trigger tremendous effects. In chaos theory, the picture of the movement of a tiny butterfly whose wing-beat triggers a tornado is often used to describe this scenario. The epistemological problem lies in the fact that most humans tend to assume a small, well known list of forces and their effects, which can be calculated and thus controlled. The control has the simple logical format: If condition A is given then effect B occurs; therefore if one wants to avoid effect B one must guarantee that condition non-A is preserved. Causal effects follow a kind of syllogistic schema (they preserve truth, are linear and simple). In reality, forces have continuous values, their impact is governed by probabilistic laws (not only on the quantum-physical level), many forces of different nature may interact, cooperative effects, cyclic enforcements must be taken into account, etc.

A central feature in the context of catastrophes is stability and loss of stability. The logical “metaphor” of cause and effect presupposes a strong stability of all entities, i.e. small forces, which are mostly unknown and uncontrolled, vanish automatically by convergence and the analysis is not faulted if it neglects their impact. In the case of catastrophes (and a fortiori in the case of chaos), the state of the system diverges strongly, i.e. small forces are not nullified but cumulate, they can even trigger dramatic changes. In situations of instability or near critical points (singularities) even very small and imperceptible forces can trigger the breakdown of a stable state and bring about the transition towards a new state. Basic aspects of such a situation are modeled in catastrophe theory; other aspects are dealt with in the thermodynamic model of systems far from equilibrium by Prigogine. For deterministic systems generalized catastrophes, now called strange or chaos attractors, complete the

small list of elementary catastrophes which René Thom had proposed in 1972 as a basis for dynamic models in the natural and human sciences.

In the following I shall use the term *catastrophe* in the sense of catastrophe theory in case a scientific modeling is the major aim. In more informal contexts, sudden transitions which enforce dramatic changes and show the effect of hidden forces are also called catastrophes, even if nobody is killed and no natural cataclysm is involved. The two major categories of catastrophes alluded to in the report on historical cases remain relevant: unexpected effects of natural forces as in earthquakes, tsunamis or the uncontrolled expansion of fire or flood which override all the precautions taken by man.

2 Revolutions in philosophy on a macro-scale

At first sight, the history of philosophy seems to be rather erratic depending on religious, political and scientific developments and often on individual personalities (e.g. Socrates, Bruno, Descartes, Kant, Wittgenstein), but as soon as we consider philosophy and its development on a larger scale, where the individual contributions and their differences vanish, do we notice that the directions of change are rather few and that their dynamics are rather simple if not primitive. This encourages the application of very systematic and at the limit mathematical tools for the analysis of major changes, paradigm clashes, philosophical revolutions and phases of synthesis (stability)

ll shall first ask how philosophy reacted to a new generation of mathematical tools, which are beyond quantitative applications in the natural sciences and allow for qualitative modeling in the humanities (including philosophy).

2.1 Philosophy and (new) mathematics[1]

Mathematics have played since Plato's dialogue *Timaeus* a prominent role in philosophical thinking due to the simple fact that the search for very abstract and cognitively appealing principles in mathematics fits the basic philosophical motivation of unveiling the deepest enigmas in nature and man. There exists, therefore, a basic brother- and sisterhood between mathematics and philosophy. Nevertheless, it is immediately clear that the philosopher must resent mathematical structures as restrictive. His/her theoretical intuitions, his/her reflections on fundamental questions cannot accept the rigidity of mathematical concepts. But if this rigidity (or precision) is given up, another danger creeps up: uncontrolled speculation, or ideological framing of philosophical enterprises. The basic problem for all rational endeavors

[1] The first part of this contribution takes up some sections of a paper presented at the Twentieth World Congress of Philosophy (Boston: August 10, 1998), Round Table: *Catastrophe Theory Based Models of Meaning: Their Phenomenology, Ontology, and Importance for a Cognitive Semantics (u*npublished conference paper*)*.

in the realm of science is how to find a common language which allows us to assemble the experiences of a multitude of rational individuals. René Thom made the provocative statement:

> „One can say that the laws of physics do not describe the phenomena, they describe the laws which allow the comparison of the points of view of two observers.“[2]

The standard technique for the comparison of two points of view is discourse and its tool is language. In philosophy different types of „languages“ may help to establish a common ground for the integration of the „insights“ of individual philosophers or reflective individuals:

1. *Religion as common language*. After the victory of Christianity against antique religions and philosophies, the independence of philosophy from myth and religion in Greece was lost.[3] It was partially recovered in Renaissance philosophy (cf. on Giordano Bruno, Wildgen, 2011) but again lost in the 17th century. Western philosophy was therefore (at least until the French Revolution) framed by theology.
2. *Scholasticism*. Common intellectual traditions may function like a holy text. In this sense myths and rituals are replaced by ideological systems and by canonical scientific and philosophical texts. In the 16th century, this line was already criticized as scholasticism. Nevertheless, the 19th century witnessed again the establishment of a type of scholastic tradition: Neo-Kantianism, Marxism, and other schools.
3. *Political systems* (e.g., absolutism) or constitutions may frame philosophical thinking and allow an easy but limited communication between philosophers. This kind of very implicit censorship becomes visible in the shape of terminological and linguistic correctness, which excludes as impolite, crude, tasteless certain words, expressions or ways of arguing. In the field of faculties and departments at the university level, the frontier-lines of disciplines have the effect of excluding certain questions or methods and thus guarantee the perseverance of established ways of thinking and arguing (even if their lack of progress is obvious).

With these normative contexts of philosophical communication in mind, the restrictions imposed by mathematics appear as rather harmless. The basic advantage of a mathematical framing of philosophical thinking lies in the fact that mathematics develop rather freely and this process cannot be easily controlled by political or ideological forces. Thus the mathematical type of frame is probably the most rigid one, but it is politically/ideologically/-religiously neutral *and* it has a natural drive towards further development, which diminishes

[2] Thom (1978: 101): „On peut dire que les lois physiques ne décrivent pas des phénomènes, elles décrivent les lois qui permettent de comparer les visions de deux observateurs.“

[3] The conflict between philosophy and religion was also prominent in Greek philosophy. Socrates had been accused and sentenced for lack of religiousness and in the later academy and specifically in the neo-platonic school the interdependence between religion and philosophy was renewed.

the danger of scholasticism. A central feature of the evolution of mathematics is that the pace of evolution is (at least historically) much slower than the rapidly changing demands to which philosophical thinking has to respond.

These remarks motivate my basic assumptions:

- Philosophy should make use of developing mathematics, i.e., it should not wait for some final consolidation, but should experience the possibilities of new mathematics. They constitute possible languages into which new philosophical insights may be mapped (it does not create philosophical insights; it rather provides a proper place or architecture for them).
- As an immediate consequence the usage of mathematics in philosophy must evolve in time, i.e., no single tool should acquire a kind of scholastic authority (this seems to be the case for logics in Analytical Philosophy).

One very prominent type of new mathematics is catastrophe theory, which belongs to the domain to dynamic system theory. Catastrophe theory is basically the application of the classification theorem of Thom (proved by Mather in 1964). In the period since 1964 the field has further evolved. I will, therefore, include:

- Bifurcation theory (cf. Guckenheimer and Holmes, 1983)
- Theory of strange attractors and chaos theory (cf. Peitgen a.o., 1992)
- Stochastic dynamical systems as applied in synergetics (cf. Haken, 1983)

In its current state, the field may be organized around two basic topics:

- The typology of catastrophes (in deterministic systems) and the fractal character of iterated bifurcations leading to chaos.
- The stochastic attractors and the slaving effect of basic parameters in synergetics.

These basic dynamical structures explain the emergence of order in general and, therefore, create a framework, into which theoretical intuitions about possible laws or regularities in nature and mind may be integrated.

2.2 The counterpoint of evolutionary change: stability or rigidity (frozen state)

In the animal kingdom some species show stability for long periods (e.g. millions of years). This stability is not due to a lack of changing forces because the mutation rate in sexual species is independent from ecological changes or other forces, it is a chance factor. Stability is therefore due to the reduction, elimination of stochastic variations. The forces which damp the effect of stochastic changes, e.g. genetic mutation, are related to a kind of optimal adaptation to the ecological niche and the stability of the niche itself. Thus the oceans had similar conditions for fishes, dolphins and other inhabitants over long periods. Slow changes could be answered by a relocation of the population. In comparison to dolphins, the human

species evolved very quickly and is still changing at a quick rate. Nevertheless, compared to modern rates of change the Paleolithic species of man were bodily stable more than one million years (cf. the proto-species Homo erectus) and so were their cultural (mainly lithic) technologies. We must therefore consider the dynamics of stable states as a background of change.

A very simple model is given by the picture of a sink, a container, a lake which assembles the ambient water etc. Its formal analogue is a parabola, in one dimension; f (x)= x^2 , in two dimensions f(x,y)= x^2 + y^2 (elliptic paraboloid). If strong factors enforce a kind of hyperstability, in which even very strong fluctuations cannot trigger a jump to another attractor, one may consider a kind of goblet or narrow vase. In the kingdom of plants some have the shape of a sink in order to catch insects which they can digest. Some examples of objects and plants with a parabolic design are shown below.

Figure 1 Examples of design objects with a parabolic shape and an insect-eating plant (the insect cannot evade the natural goblet)

A simple dynamic analogue is the damped pendulum, which returns very quickly to its rest position. A classic example of a two dimensional attractor, i.e. a system which forces every point (object) in its environment into a closed, circular or elliptic orbit, is the movement of the earth around the sun. As long as variations of this movement due to minor impacts of asteroids, colliding with the earth and effects of other planets and the moon are damped by constant gravitational forces of the sun, the orbit is stable. If such variations exceed a certain size, e.g. if the earth collides with a planet of the size of mars, the earth will leave this orbit and strange things may happen (or if finally the sun changes its shape and dynamics). The baseline of all changes is therefore a situation in which all variations are damped and a seemingly steady state is realized.

In the case of music and visual art, we can observe long periods of stability and the necessity of strong forces (internal, external, often both together) in order to make paradigmatic changes occur. One strong factor in the stabilization of states is tradition and authority. Thus Greek philosophy was a feature of stability for Roman philosophy and art. After the fall of Rome, many of these traditions were lost in the West, but with the recovery of major works by Plato and Aristotle, they became almost indestructible authorities in scholastic philosophy.

2.3 The evolution of philosophy analyzed as the unfolding of a morphodynamic field

The following reflections refer to western philosophy in their examples; I guess similar gradients, catastrophes and fractal patterns will show up if we analyze other philosophies (Indian, Chinese, Japanese) and corresponding intellectual frames in non-written traditions (amero-Indian, Inuit, aboriginal cultures).

The traditional starting points of philosophy: Plato and Aristotle exhibit already two concurring syntheses based on the pre-Socratic tradition.[4] In synergetic terms, a synthesis is basically the reorganization of a set of partial systems in strong interaction by the choice of very few slaving parameters. For our purpose it is significant that we can distinguish three phases of this process:

1. A differentiated and distributed set of philosophical positions evolves. The interaction is rather low due to geographical heterogeneity (in the ethnically and linguistically subdivided mainland of Greece and in the Greek colonies around the Mediterranean and the Black Sea area).
2. A concentration in Athens due to political and (slightly later) cultural dominance. The slaving force may be located in the intellectual singularity of Socrates and the life-long development of his teaching in the work of Plato. The metastable character of the synthesis is shown by the work of Aristotle and the followers of Plato in the Academy. It is characteristic that the content of the philosophical teaching changed with every successor (at least in the first cycles); nevertheless the stability of the Platonic synthesis was inherited by the Hellenistic Academy, which was only destroyed in the campaign (529 after date) of emperor Justinian (482-565 AD) against pagan religions and philosophies. The Florentine Academy and the academies of the 15th and 16th century have revitalized this tradition.
3. The *disaggregation* of the Greek line of philosophy had many stages (transfer to Alexandria as center, influence on India, Persia and the Arab sciences). In the main line, the rise of Christian and later Islamic nations created a new synthesis based on the Bible and the Koran and, thereby, replaced the anti-mythic Greek philosophy by religious philosophies. Philosophy became „ancilla theologiae“ (the servant of theology). Several new syntheses fostered this role of philosophy:
   - The philosophy of Augustinus which was revived several times (e.g., by the Port-Royal Jansenists).

[4] Cf. Wildgen (1985b) for a description of this development.

- The philosophy of Thomas Aquinas (1225-1274), which became the official philosophy of the Roman church.
- A third line which tried to incorporate structures from the two concurrent monotheistic religions: Judaism and Islam was opened by Ramon Llull (1232-1315) but remained controversial (at the edge of heresy).

The strongest force in this evolution was surely the philosophy of Thomas Aquinas, which was able to govern philosophical thinking until Leibniz and even later in different forms of Christian Aristotelianism. All three philosophies had the ultimate aim of fostering Christian faith or even of demonstrating its superiority against the Judaic or Islamic traditions (vice-versa for the other text-religions).

4. The Renaissance philosophers like Marsilio Ficino (1433-1499) and later Giordano Bruno (1548-1600) successively broke the link between (Christian) religion and philosophy. Bruno tried to reconstruct some kind of basic Mosaic (Egyptian) religion as the ultimate metaphysical root of philosophy. This return to an independent philosophy was destroyed by Christian reforms (Calvinism, Lutheranism) and by the catholic counter-reform in the 16th and the 17th century. Finally, the philosophy of Enlightenment took up the advances of Renaissance philosophy. From now on the natural sciences and mathematics were taken as stable reference points for truth. This reference point became very strong after the acceptance of Newtonian physics by Condillac and Kant (in the middle and the end of the 18^{th} century).
5. The new creed of Enlightenment, which was motivated by the astonishing successes of modern science and the need for new frames of intellectual orientation (in the context of political and social reorganization) was slowly destroyed by a process we could call „disciplinary fragmentation“. The big theory (Newtonian physics) was broken from within as new paradigms evolved in physics and its role of orientation was overtaken by other disciplines like: biology (Darwinism, molecular genetics), chemistry, psychology, linguistics, etc. In dynamical terms we could call this stage, the fractal stage of modern philosophy.

This very rough picture of three millennia of philosophical evolution fits a dynamical schema in which specific parameters are able to slave and order the dynamics which in general have the tendency to diverge individually and thus to lead into chaos or noise. In terms of dynamical systems, stage (1) corresponds to spatially separated modes of a system.[5] Thus, the dominance of philosophical modes in certain geographical or cultural areas may be

[5] Compare the Belousov-Zhabotinsky-reaction, which shows periodically changing colors (red if the C_e^{3+} is produced at a high rate, blue if C_e^{4+} is produced). It eventually creates a stationary distribution with red (above) and blue (below).

explained by a temporally dominance of a philosophical position which eliminates (via social selection) all other modes. The most miraculous happenings are the big syntheses (stage 2), they ask for very specific conditions. The picture of a singularity in catastrophe theory may illustrate this point. In the elementary catastrophe called „butterfly“, we find a singular point leading to three modes. The basic equation is

(1) $V = x^6/6 + tx^4/4 + ux^3/3 + vx^2/2 + wx$

Partial differentiation (relative to the variable x, called internal variable) gives as the equations (2) and (3).

(2) $V' = \delta V/\delta x = \quad x^5 + tx^3 + ux^2 + vx + w$

(3) $V'' = \delta^2 V/\delta x^2 \;=\; 5x^4 + 3tx^2 + 2ux + v$

The bifurcation point is defined by the zeroing of the first and the second partial derivative. $\delta V/\delta x = \delta^2 V/\delta x^2 = 0$ (cf. Wildgen, 1985a: 170). Figure 2 shows the bifurcation lines in the two dimensional space of external parameters (v, w); the other two parameters u and t have fixed values in a specific domain of values.

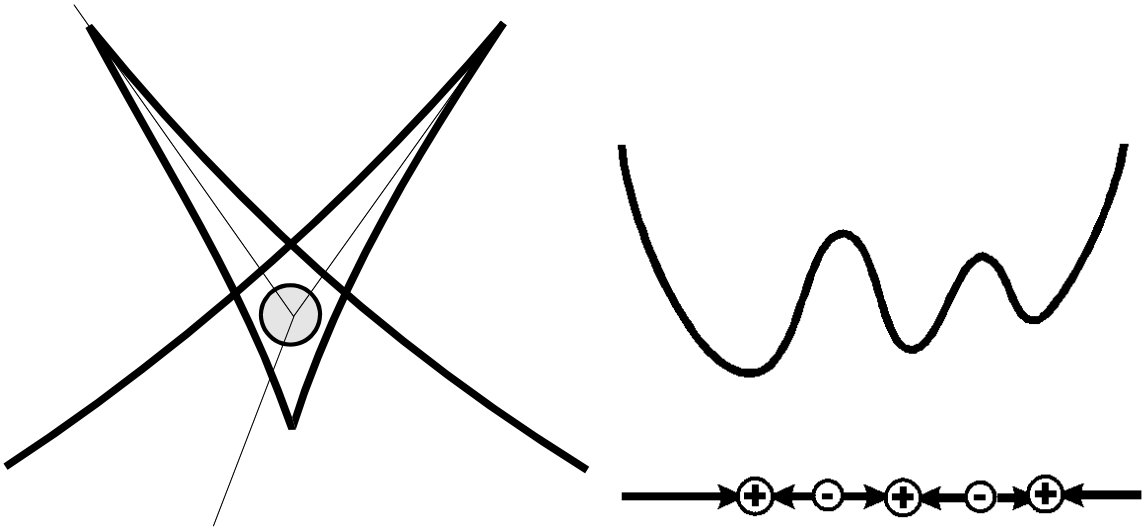


Figure 2: a) *The bifurcation space represented by a picture of (v, w) at specific points of the plane (u, t) and* ***b)*** *the potential function V (on x) and below the Dynkin-diagram of attractors, repellors and vector-flows*

The most complicated and compact picture is the one in the central area of Figure 2 (left). Here we find a singularity which can split-up into a system of two or three attractors (minima). Figure 3 shows the splitting in the neighborhood of the singularity.

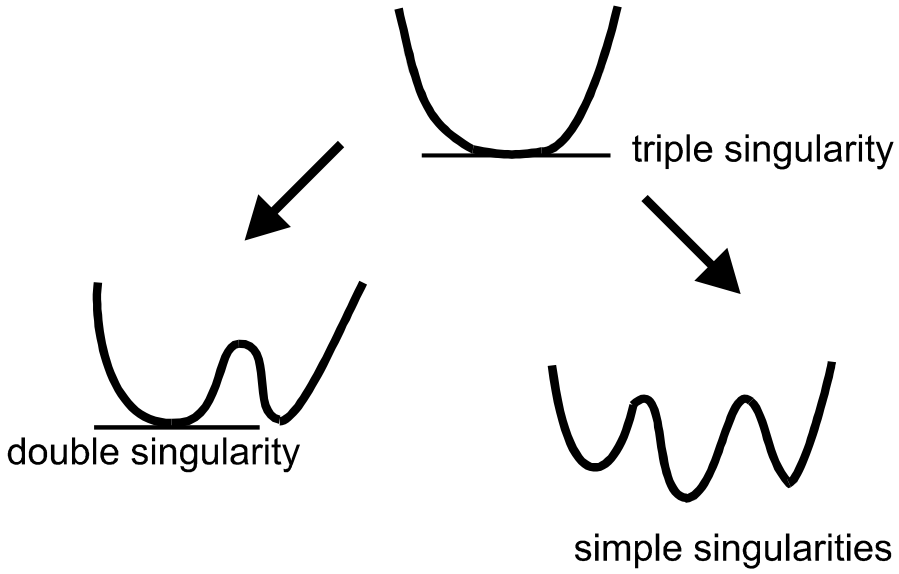


Figure 3: *Triple, double singularities and three simple (stable) minima (locally $V = x^2$) as consequences of the unfolding of the germ $V = x^6$.*

A big (temporary) philosophical synthesis could abolish the differences between three (in principle n) attractors (= philosophical positions) and create a very complex singularity. The basic prediction is that this synthesis will be unstable, and the interesting questions are:

- How long can such a solution persist (under which conditions)?
- What is the gain in the long run of such a synthesis?

I think that very specific historical, social, and intellectual conditions are necessary to give access to a philosophical synthesis (stage 2) and that the extremely low probability of such a singularity makes that its information is very high (if we apply basic intuitions of information theory).

The big points of synthesis, e.g., Plato, Aquinas, and Kant, are singular events and linked to singular personalities. In the singularity of a (philosophical) mind a particular balance between rather incoherent modes of philosophical explanation is created. This singularity cannot be explained by general mechanisms but one can find specific lines which form the organizing center of such a synthesis. In the case of Plato some amalgam of Pythagorean credo in mathematics and an oriental view of the soul which is independent of the individual body may have been such centers of organization. In many cases, the synthesis contains a balance between basically contradictory positions, e.g., rationalism and empiricism in Kant's synthesis. We shall come back to bimodality and underlying continua in the last section of this paper.

The chaotic nature of „normal" evolutions in the domain of philosophy may be due to an iterative, self-similar process of mapping. This can occur in the transition from one school to the next one or in a partial mapping between parallel and concurrent schools. Such a

„mapping“ by the reformulation of traditional positions, by their citation, comment etc., is always open to deformations (simultaneously on different parameters) and, therefore, open to chaotic dynamics (cf. Peitgen et alii, 1992 on the copying machine dynamics). Dynamically the self-reference or auto-similarity of a philosophical system is a phenomenon which may be observed in any intellectual system transmitted from generation to generation. It applies a general mechanism of cultural transmission and shows the stability/instability of cultural traditions.

In order to analyze the formal features of such a process we may throw a look at the logistic mapping in dynamical systems theory.[6]

(1) $y \rightarrow kx\,(1-x)$ (logistic mapping)

The iteration takes y as the new value of x and thus produces an infinite series of new values of y (in time t):

(2) $x_{t+1} = kx_t\,(1-x_t)$

The parameter k controls the stability of the mapping. If k = 2 we get a steady state after 7 steps of iteration. If k = 3 the steady state is replaced by two alternative states, this constitutes a bifurcation. Between k = 3 and k = 4 chaos appears (and disappears) by period-doubling (chaos breaks down to periodicity and reappears, etc.). Figure 4 shows the Feigenbaum-tree of an iteration of this type.

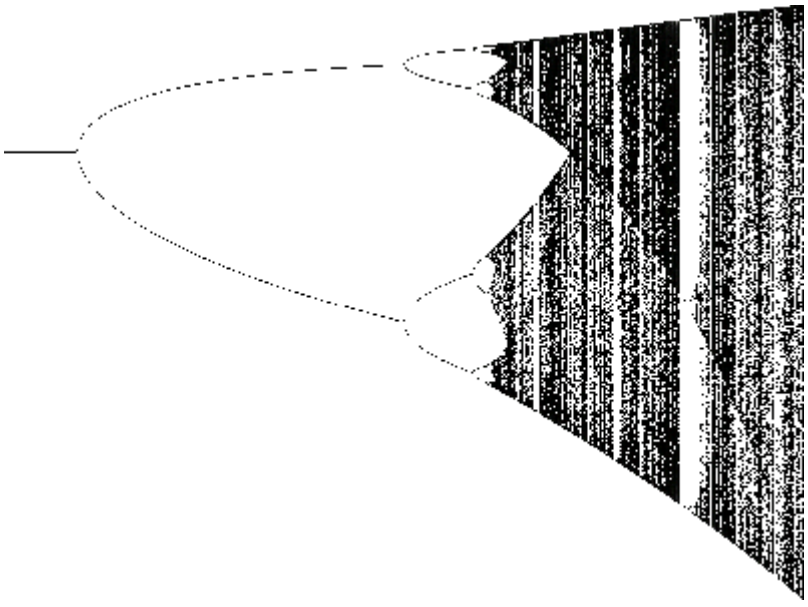


Figure 4: *Bifurcation diagram of the logistic mapping (for different values of k).*

The transfer to my argument on the evolution of philosophy exploits a structural analogy. The relevance of this analogy is based on the fact that the characteristics of the logistic mapping

[6] Cf. Wildgen and Plath (2005) for a more explicit introduction into chaos theory and its application to semiotics and linguistics

have been shown to constitute a formal schema applicable in many different domains. In the following this schema and not the formula itself will be applied.

In the history of western philosophy Plato and Aristotle reflect already a late period of self-similar mapping (since ca. 600 BC). The first stages of bifurcation are inaccessible. What may be observed are zones of stability in the domain of chaos, i.e. the small bands of stability (cf. Figure 4) correspond to periods of philosophical synthesis. In many cases they have period 2. Thus, Platonism and Aristotelianism, rationalism and empiricism are subsystems with period 2. As the philosophical evolution is spatially distributed, different branches can occur simultaneously (in different cultural areas or in different persons).

The forces which could control such a synthesis are not part of the schema. They could be of two kinds: First, the forces could be intrinsic to the human mind/brain. Thus, the brain shows effects of convergence and binding involving long-ranging coordination (e.g. in the 40 Hz level) and segregation related to subsystem specialized with a divergent dynamics. These basic mental process-types could explain the rival tendencies of synthesis and diffraction in cultural/intellectual traditions. Secondly, social dynamics may either enhance segregation in intellectual rivalry, in relation to the exploitation of social resources like public attention and access to pupils and followers or enhance cooperation and convergence via coalitions which bring together a group of social agents who would otherwise be too weak to achieve public acceptance and cultural success. The two levels, the mental and the social, may be linked by a coordination cycle of the type exemplified by Turvey (2004) and also assumed in “Social Morphogenesis”, cf. Porpora (2013). If coordination, synthesis breaks down, a kind of rather general catastrophe occurs. If diffraction goes on without limit, all positions imaginable and their terminological variants are stochastically run through such that no halting point appears and the philosophical enterprise fails totally; it becomes insignificant for the community of philosophers. An important guarantee of intellectual stability lies in the use of language and its adaptation to the practices of philosophical thought and discourse.

2.4 The dynamics of philosophical discourse

Philosophical texts from the Greek tradition on have in general three kinds of textual organization.

(1) They are *aphoristic.* The aphoristic discourse of the pre-Socratics is partially due to lost traditions and to short citations or comments recovered in later periods. In the case of Heraclitus (c. 535 – c. 475 BCE), philosophical research has assumed that his writings had originally the form of short locutions (gnomes). His aphoristic style was later imitated by other philosophical authors in order to avoid the impression of a rigidly fixed canon of knowledge.

(2) They are *literary* (or exoteric). Plato's dialogues are similar to scenes played on stage (They point to real or fictive dialogues with Socrates.). This style imitates the oral style preferred by Plato's teacher Socrates; it was in the sequel adapted in its written form for larger non specialized audiences. In scholasticism and humanism, philosophical dialogues mirror the highly formalized debates which were part of the curriculum of students in the faculties of the medieval and pre-modern universities.

(3) They are *systematic* (esoteric). Aristotle's lectures establish the ideal of this very compact style. The logical or axiomatic style was a further development in the same line. Its standard format was established by Descartes and Pascal in the 17th century (a philosophy „more geometrico") and logically specified by Whitehead and Russel (1910).

All three types of philosophical discourse and many mixtures coexist today and they have an impact on the content-level of philosophy (or are adapted to it).

A recent style of philosophy has been shaped by scientists working in mathematically elaborated disciplines and treating question of philosophy. Thus, Prigogine (dissipative systems), Mandelbrot (fractal geometry of nature), Thom (morphodynamics and semio-physics), Haken (synergetics) have contributed to intellectual enterprises, whose goal is a new philosophy of nature and man. In this move they produced a semi-formal type of scientific discourse which sometimes comes near to literary discourse.[7]

The different philosophical styles mentioned may be ordered along a scale:

1. The *systematic* (or mathematical/logical) style presupposes an artificial language with fixed rules. By this choice it enforces a kind of (artificial) semiotic stability corresponding to the ideal of eternal laws and well established truth. Nevertheless, semiotic stability (by a conventional choice of rules) is not causally linked to the stability of the knowledge expressed in this language. We could call this enterprise the search for stable knowledge via a stable language (a precursor of this style in medieval times was Ramon Llull).
2. The *literary* (dialogue) style is ideally meant for readers/hearers just equipped with common sense, but it may be adapted to rather formal laws of argumentation (as in the scholastic dispute). In this case it loses its exoteric character. Many innovators like Bruno and Galileo chose this style in specific phases of their career. In the same move they decided to write in their national language and thus to liberalize the stylistic conventions of philosophical discourse. The spontaneous, almost oral style of philosophy (in the tradition of Socrates) can be found in private correspondence

[7] In the case of René Thom, his style was fascinating in its intrepidness but almost inaccessible for scientists (because it was too imaginative/speculative) and for people trained in the humanities (because its mathematical part was unintelligible for them).

between philosophers (in the case of Leibniz his correspondence contains major parts of his philosophy).

In general, the literary style with its dramatic (sometimes comic or satiric) components transports its message on different levels: common sense intuition, current imagery, comic and satiric means, and aesthetic values, etc. The cooperative effect of these different stylistic devices is very communicative and tuned to the complex mental world of normal audiences.

3. The *aphoristic* style which has puzzled so many readers of Wittgenstein's „Philosophical Investigations" is basically chaotic, insofar as it prefers to move around a central topic and thus to negate the existence of a (final) solution. In terms of dynamical systems we could say that it moves on a limit cycle (its center is a repellor) or even on a strange attractor. This avoids the impression of a rigid canon of knowledge and allows the reader to travel in his own mental world just under the impulse of a sequence of aphoristic statements. This style also negates the „ceremonial" character of many philosophical disputes and foregrounds the reflexive process of thinking (and the image of a relaxed philosopher).

The first philosophical style is a static sign-construction comparable to a public *architecture* which is meant to evoke admiration in the citizens; the second style is like a stage-play or like a trial in court. The third style takes the audience along in a „journey" of philosophical thinking.

The different styles of philosophical discourse mirror different views of the relation between the (intellectual) society and the (intellectual) individual.

- The systematic style creates (seemingly) permanent structures (almost the myth of an independent philosophical reason; *philosophia perennis*).
- The discursive style mirrors the struggle of opinions in the institutions, basically the fight for dominance and power in an ideal community of philosophers (cf. Plato's utopia of the state).
- The aphoristic style shows the philosopher as an (ideally isolated) individual arguing with himself (or with his doubt as in the case of Descartes).

The heroic individualism of Giordano Bruno is characteristic for the last attitude, and even Descartes, who was so methodical in his scientific writings points to the isolation in which he first conceived his new philosophy (in the introduction to his: Discours de la méthode, 1637).

In reality every philosopher is involved in all three styles:

- if he aims at the establishment of *his* own philosophy (a system, a school),

- if he tries to persuade his audience and argue against his opponents and
- if he struggles with the flow of his reflexive thought.

The basic schemata of order, conflict and chaos coexist in every single philosophy, but they do not show up simultaneously in every philosophical text.

2.5 Philosophical structuralism and catastrophes

The last sections have dealt philosophy as a kind of social phenomenon analyzed in its unfolding in historical time (from Heraclitus to Wittgenstein). In our discussion of different "linguistic" styles of philosophy we mentioned the exoteric style introduced in Aristotle's systematic treatments (prefigured in the very theoretical dialogue "Timaoios" by Plato). As Aristotle was also the father of logics and his syllogistic schemata were used to argue philosophically, logics in his sense was also the backbone of philosophy and this remained the case during the Middle Ages and Modernity. Modern structuralism as applied philosophically in Analytic philosophy is still based on logics, now in the new style of formal logics (with many variants from two valued predicate calculus to many valued or probabilistic logics, intensional or situation-logics in the style of Montague (1974) and Barwise and Perry (1983). Peirce had favored relational logics and proposed a graphical logics and Curry advanced a type of combinatorial logics (cf. Desclés, 2004). I cannot enter this field of discussion, but shall point out that already Leibniz had proposed a logic of (technological) invention based on geometry rather than logics and that Jean Petitot (2004, chapter 1 and 2011) argues on the basis of Kant and Husserl for a morphological structuralism using catastrophe theory and other formal tools of differential topology rather than the usual Aristotelean and neo-scholastic schemata of logics.

In the following sub-chapter 3 I shall discuss in detail revolutions (catastrophic transitions) in the visual arts and the mathematical innovations which occurred in parallel or prefigured major changes. In this context I shall also give examples of new conceptualizations in the esthetics of visual art based on geometrical, topological and dynamical formal tools in order to show that these are not only relevant for a kind of meta-theory dealing with the unfolding of philosophical and esthetic paradigms, but can complete or in some case replace traditional schemata based on logics or structural methods inspired by formal logics. In sub-chapter 4 I shall consider in less detail major revolutions in the domain of music and literature in the course of the 20th century and the relevance of dynamic concepts in the foundation of musical and literary theory.

3 Revolutions in visual art and the underlying space of visual esthetics

In visual semiotics (cf. Wildgen, 2013) and visual esthetics, changes in orientation or esthetic revolutions may depend on contingent factor such as political and religious revolutions; in this case they should be analyzed in the specific context. There are, however, instances where the general intellectual climate may have been influenced by political changes but where the major forces are esthetic ones. In these cases, the sudden and violent changes (catastrophes) are able to demonstrate the underlying dimensions of art-work and esthetic decisions. This perspective will be selected in the following sections. Moreover, mathematical traditions and new developments are not only decisive in the sciences and in philosophy, as we have shown in the first part, they concern also the arts. Therefore, we shall again discuss the question: How does mathematics (and what kind of mathematics) influence major changes in the esthetic perspective and orientation in the arts, mainly in the visual arts. The focus on the visual arts favors those mathematical disciplines which deal with space and time, i.e. geometry, analysis, topology, differential topology and dynamic systems theory.

3.1 The visual arts and (new) mathematics

Since antiquity mathematics was not only used for physics and astronomy, it was also applied to the arts and crafts, such as Greek mathematics of proportion and symmetry applied to music and to constituent parts (cf. columns, doors, windows) and the décor in architecture. Classical examples are the role of rational numbers (1/2, 1/3 etc.) and of irrationals numbers like the square root of 2.[8] The most prominent case is the “golden proportion”, which stood for perfect beauty. In Renaissance time the art of proportion was taken up by artists and geometry was used in order to construct a realistic perspective, which is able to simulate the view of a three-dimensional scenario with the means of a two-dimensional picture. The complete mathematical treatment was only given in projective geometry (early nineteenth century). During the 16th century elementary proportions and constructions with circle and ruler were the basis of the so-called “practical geometry” which was also applied in Leonardo’s and Dürer’s treatises on art and measure. The first examples in the following sections refer to this type of mathematics predating modern algebra, algebraic geometry, analysis and topology. The second half of the nineteenth century witnessed a strong interaction between new mathematics (applied in the natural sciences) and visual art. Philosophically this development was due to the rise of neo-Kantian

[8] They show up when the rule of Pythagoras is applied to a right-angled triangle with the legs (cathetus) of length 1, the root of two = 1,414213562…, or in the calculation of the pentagon where the root of 5 appears. It is also a constituent part of the *golden ratio*.

philosophy and esthetics, to psychological and neurophysiologic research on vision and to modern mathematics, such as non-Euclidian geometry, n-dimensional space and topology. The epistemological publications by Henri Poincaré (1854-1912) had a major impact on art before and after 1900; its consequences may be seen in cubism, futurism and later in surrealism. There is, however, a major difference between the impact of mathematics in the sciences (e.g. in physics and technology) and in the arts. Werner (2002: 84ff) considers the impact of mathematics in the arts as the construction of a “myth” in the sense of Barthes’ “every day myth”, i.e. secondary sign-structures which concentrate important contents of a larger cultural tradition or development into a rather compact “concept”, such as the myth of the steam machine, the atom, the computer etc. Thus, the specific contents of a mathematical theory, its internal logics and consistency, become secondary. What is considered or focused is rather a general view of the ambient world which is changed, modified, renewed in the context of the mathematical or scientific theory. Thus spaces with more than three dimensions, which may be visualized by combining several projections into lower dimensional spaces motivated the collages by Max Ernst, the “maquettes” of Man Ray (cf. Werner: 2002: chapter 3) and cubistic decompositions by Pablo Picasso and later Paul Klee. But the products of these artists are in no sense applied mathematics, they rather use the exercise in new ways of imagining space and spatial configurations given by the developments of mathematics in order to create a new visual tradition. Insofar the general public did not participate in the development of new mathematics and their way of imagining abstract spaces, the public also rejected these developments in art. A very dramatic rejection occurred with the reaction of the Nazi-regime in Germany in the thirties (and parallel reactions in the United States and in Russia). The clash between general public (and state organizations) and modern art is insofar strange, because the scientific and technological impact of new mathematics was rather straightforward and many of these regimes were positive about modern scientific developments and the enhanced possibilities of a new technology (e.g. for military purposes as in the case of the atomic bomb). The reaction to new mathematics in the art thus announced a more general cultural change, which was, however, not perceived or understood by the general public and political leaders. The impact of mathematics at the end of the nineteenth century cannot explain, however, the very strong movement towards abstraction in the visual arts. Probably it had only been a first impulse along with other factors and its importance was lost in the first decades of the twentieth century. An exception is perhaps the discourse of Salvador Dali with the mathematician René Thom and the chemist/physicist Ilya Prigogine in the seventies of the last century, which I shall discuss in the last section of this part.

I shall summarize some results of my analysis of paintings by Leonardo da Vinci (cf. Wildgen, 2010 and 2013) in the following section and then proceed to the analysis of other

examples linked to innovations in visual art by William Turner later which was used as a landmark by impressionists like Claude Monet, sculptural innovations by Henry Moore and finally the “surrealist revolution”, which led to a interesting contact of Salvador Dali with René Thom, the founder of catastrophe theory and its applications in the humanities.

3.2 Elements of event, action and sudden change (catastrophe) in Leonardo’s paintings

Leonardo’s theoretical orientation is documented in the writings transmitted though his manuscripts and in his treatise “Libro di Pittura”. Two major concerns can be emphasized: the geometrical construction of the topics applying the laws of perspective stressed by Bruneleschi (1377-1446) and Leon Battista Alberti (1404-1472), and indirect representation of motion, dynamic constellations as signs of the mental and emotional processes involved (the artist prefers to paint living characters instead of “wood figures”)[9] which is further elaborated to a semantic vector-field which is able to create a visual narrative (cf. Wildgen, 2005 and 2010). In relation to the geometry of the painting, we can say that in his mural painting “Last Supper” Leonardo tries to organize his composition as an instant in a process which shows the origin of the force, the immediate effects and the multiple structures created by the percussions of the force, which is in and comes from Jesus. As the emotional and intellectual effects of the central force are the main topic of the painting, Leonardo reorganizes the geometry of the scene, in order to arrive at an optimal representation of the percussions in body-postures, gestures and facial expressions.

The semiotic revolution in Leonardo’s painting prefigures the scientific revolution announced in Copernicus’ *De revolutionibus orbium* (1543) and brought to the summit in the work of Galileo and Kepler. Together with other intellectual and religious changes they remodel the common knowledge, the world-view of educated people in the sixteenth century and of Western civilization in the centuries which follow. I shall give a short analysis of another painting by Leonardo, the thematic composition in Leonardo’s paintings of St. Anne.

[9] « "Il bono pittore ha a dipingere due cose principali, cioè l'omo e il concetto della mente sua. Il primo è facile, il secondo difficile, perchè s'ha a figurare con gesti e movimenti della membra; ». Cf. Pedretti, 1995: §180 (p. 219).

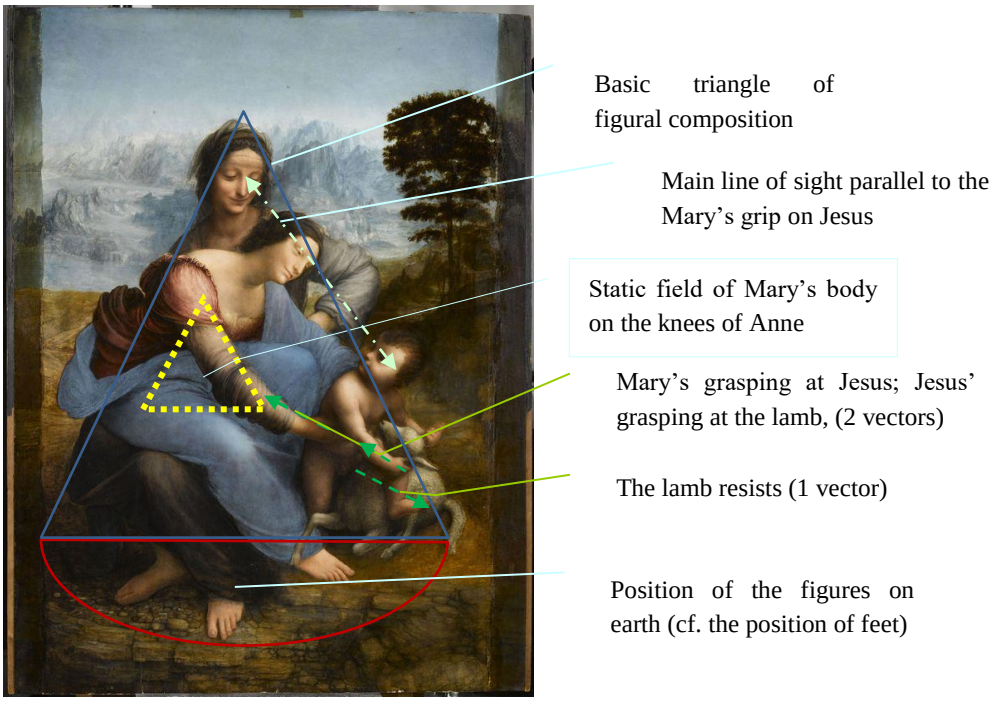


Figure 5 Leonardo da Vinci: St. Anne with Mary, Jesus and the lamb (1509/10; Paris, Louvre)

The painting contains a rich geometric and dynamic structure (weights, bar centers, force-vectors, [10] gaze-directions, etc.). A purely static representation would be insufficient for both the pictorial and the narrative aims of the painting. Furthermore, this piece is typical for Leonardo's art which consistently exemplifies the concept of *dynamic valence*. [11]

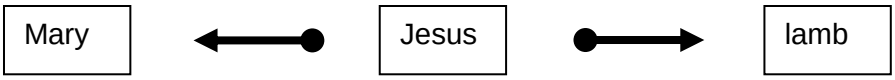
In the case of this painting, we have on the surface a quaternary constellation: Anne — Mary — Jesus — lamb. If one considers the force fields and actions, one notices that a basic interaction links: Mary — Jesus —the lamb.

- Mary *pulls on* Jesus
- Jesus *pulls on* the lamb
- The lamb *resists*
- Jesus *resists* being pulled away from the lamb

[10] A specific consequence of the mathematical conceptualization of dynamics is the calculus of vectors introduced by William Rowan Hamilton (1805-1865). In Fig. 5 three force-vectors and one sight vector are given. In a catastrophe theoretical frame, one would rather consider vector-fields with attractors (minima) and repellors (maxima); cf. Figure 2.

[11] Peirce was the first to propose a general scheme on this level of abstraction. His monads, dyads and triads are considered as dynamical wholes (in Leibniz' sense) not reducible by simple composition. However, they may be and often are degenerated. i.e., not complete, not saturated, with defects. The concept of syntactic valence occupies a central place in the grammar of Tesnière (1959) and was the starting point of René Thom's conjectures on topological and dynamical laws in human language (cf. Thom, 1975; elaborated in Wildgen, 1982, 1985a).

There is a conflict between Mary who tries to prevent Jesus from seizing the lamb and Jesus who notices this (he looks back to her) but resists against her action. This triad constitutes a force field, which dominates the message of the painting. A first schematic representation introduces two vector-fields with attractors:



The constellation of forces between Mary – Christ – the lamb corresponds to the basic archetype of transfer in Figure 6 The archetype is derived by considering a path in the catastrophe set of the butterfly: germ $V = x^6$; cf. section 2.3). In the center of the catastrophe set three attractors (=minima) coexist and the change occurs along a path in this zone; for technical details cf. Wildgen, 1982 and 1985a.

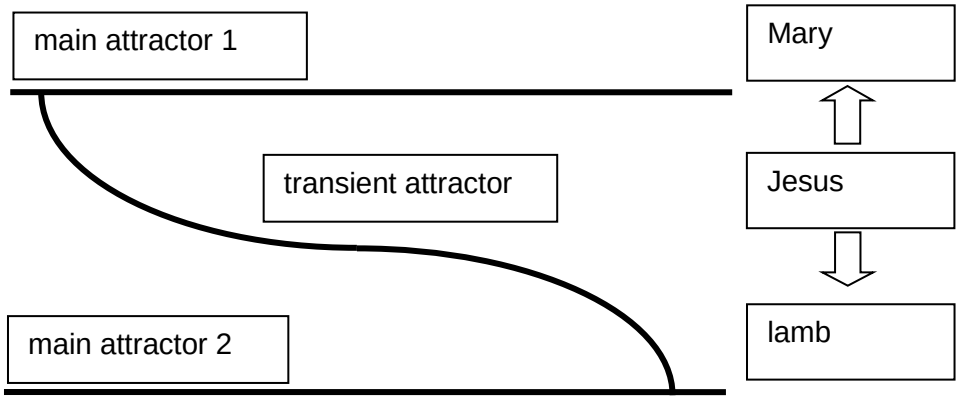


Figure 6: The dynamical archetype of transfer (giving) and a fiber on it (with attributed contents).

As the archetype does not describe all the interactions in the pictorial composition, one has to add two complications:

- Anne supports/anchors the whole event (physically and genealogically), she is a fourth attractor which sustains the event happening on her knees. This anchoring is visible in the position of the feet and the central triangle of gravitational stability in Figure 5
- The manner of “transfer” is further elaborated in the painting and could be described in a sentence like: *Mary tries to prevent Jesus from seizing the lamb*. This complex sentence goes beyond the elementary schema shown in Figure 6.

The innovation by Leonardo does not break with the tradition of his Renaissance- precursors (cf. the development of the topic of the Last Supper before and after Leonardo in Wildgen, 2010 and 2013), it is rather the climax of this development, which will be imitated in the following centuries. It is followed by the mannerist period and baroque art. Such a climax is a singularity in the sense of catastrophe theory. As such it has a very strong impact on later

developments although it is itself unstable and induces rapid changes which show up already in the late work of Michelangelo, and more radically on that of Tintoretto and Arcimboldo (cf. Wildgen, 2013: 107-111).

3.3 The "perceptual catastrophe" in the art of William Turner and Claude Monet

William Turner (1775-1851) is an outstanding figure in British landscape painting mainly because he broke with this tradition and prefigured the revolution of French impressionists, mainly the work of Claude Monet (1840-1926). In a painting of the Castle of Chillon at the lake of Geneva from 1809 (British Museum), a precise representation with persons in the foreground, buildings, the lakeshore and mountains is given; it is shown in Figure 7 .

Figure 7 Castle of Chillon at the lake of Geneva from 1809 (British Museum)

In a watercolor painting from 1841 the same lake of Geneva in depicted in a very vague fashion.

Figure 8: Geneva: The mole, the lake and the Savoy Hills, 1841 (cf. Wilton, 1982: 63, Nr. 89).

In the second painting (cf. above) one can still recognize mountains, the shore of the lake, the water surface (blue), ships, and possibly people, but the symphony of colors, the transitions between surfaces and indirectly the emotional values become dominant. In the perspective of ecological psychology (cf. Gibson, 1960/1982: 344) the second picture refers to a different stimulus space. It makes the stimulus recede and therefore gives more weight to sensation and perception. Anyway, the picture is always a “surrogate” of reality and thus communicates intentional information given by the producer (the painter) to some addressee. In this message, very different values or aspects of the individual result of sensation, perception and cognitive analysis may be selected and transmitted with preference. In his deliberate selection of atmospheric cues and unusual viewing conditions, Turner predated the later developments of “impressionists”. Claude Monet, who was an admirer of Turner’s work, added the variability of appearances in his series of 25 hay pack paintings, 1890-91. Other series concerned: the *Mornings on the* Seine*,* Poplars*,* Rouen Cathedral*, the* Houses of Parliament*,* and *the* Water Lilies*.* The Charring Cross Bridge in London in the fog was the topic of 37 paintings, all taken from the balcony of the Savoy Hotel.

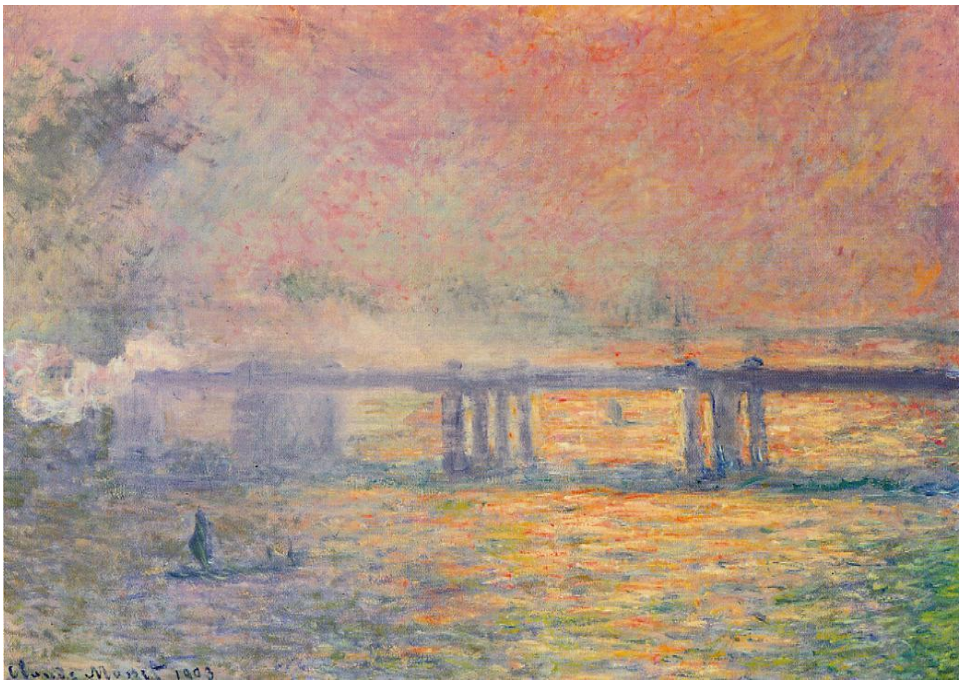


Figure 9 Claude Monet, Charing Cross Bridge, London, 1903, Saint Louis Art Museum

The catastrophic transition concerns the accepted view (until today encountered in many naïve art “experts”) that a painting has primarily to give a “true” and moreover a standard picture of the world we live in; a landscape painting must like a postcard or touristic advertisement show its appearance under standard conditions (not in fog, in rain or under very specific conditions). The departure from this quasi-silent convention by Turner was understood as a provocation; some critics called him a lime-painter. In the case of Monet, the series points to the variability of the appearances of one and the same object (haystack, bridge over the Tames etc.). In premodern paintings, the artist first chooses or constructs a frozen “surrogate” of reality, comparable to a literary description in a novel. The paintings by Turner and Monet reduce the link to an (implicit) text, focus on the visual message, and acknowledge the visual variability of the object in question. In abstract paintings (after 1913) even the binding by external stimuli and referential links is abandoned. In the sense of Gibson (1971/1982: 278f) the double nature of visual information in pictures: the information about a depicted reality and the information about the painting as a visual object are separated, only the second “reality” is left and the observer has to concentrate on this aspect and be satisfied by it. In terms of dynamical systems, the classical image is a metastable coordination between two concurring images. In abstract paintings one of them is discarded; in impressionistic paintings the artist stops halfway with a preference for the visual information of the picture as object in itself. The fundamental ambiguity of pictures is thus resolved by reduction of the referential illusion; cf. for dynamic models of ambiguity Wildgen (1995).

The next section will follow the line of stimulus reduction and abstraction, which became dominant in expressionism and cubism. The work of Picasso could be a good example but I choose the sculptures of Henry Moore.

3.4 Morphological continua and (catastrophic) transitions in Henry Moore's sculptures

Henry Moore (1898-1986) became famous for his large sculptures, many of which resemble human bodies, but some of which lack any referential support. In Figure 10 two sculptures by Henry Moore, one with the topic "reclining figure" (cf. Wildgen, 2004: 191-194 and 2013: 162-168) and one without descriptive content are shown.

Figure 10: Henry Moore. "Reclining Figure Nr. 5", sited in the grounds of Kenwood House, London, Bronze (1963-64); http://www.andrewdunnphoto.com/ and "Oval with Points", in Henry Moore Sculpture park Perry Green, Hertfordshire. https://de.wikipedia.org/wiki/Henry_Moore_Sculpture_Perry_Green

The torso of a human body with extremities (arms or legs?) cut off is completed by a separated piece alluding to legs and clothing. Henry Moore's sculpture "Oval with Points" shows an oval object with a hole scarcely separated by two points. The reduction may be compared to the transition between geometrical (metrical) to topological spaces, i.e. to the mathematical generalizations triggered by the innovations of Bernhard Riemann (1826-1866), Felix Hausdorff (1868.1942) and their application to physics. Of special importance is the separation of a spatial domain into two, three or more pieces and holes or handles in such spaces (cf. a torus and a ball with handles in Figure 11). The discontinuities, singularities (points), separations into parts and the cutting or pruning are catastrophe phenomena on a continuum.

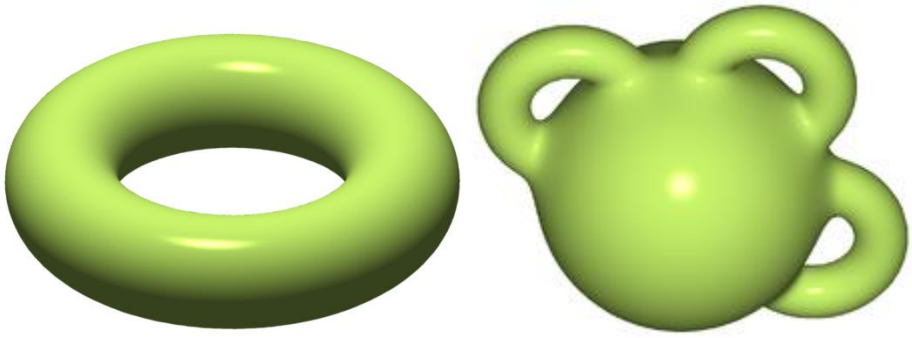


Figure 11 Torus as the archetype of an object with a hole and a more complicated object (sphere) with handles

The two-piece reclining figure shows a hole in the right part, whereas in the sculpture “Oval with Points” the hole is the central feature; the points are singularities. In general the figures underwent a transformation from perceived bodies and objects to abstract, topologically less detailed but also less coherent constructions. The shape of the cavity or hole is complementary to the shape of the full body and both contribute to the esthetic perception of the object.[12]

In terms of morphodynamics, one may imagine a kind of inverse morphogenesis. The highly diversified body shape due to cascades of cell differentiations and specialization of body parts is reduced step by step in the artist’s imagination with the aim to return to very simple natural forms which Henry Moore found in nature as shapes of bones or stones. They were a kind of “objets trouvés”, i.e. of r*eady mades* in the sense of Marcel Duchamp (1887-1968). The underlying catastrophe is one of bifurcation and morphogenetic channeling in the sense of Conrad Hal Waddington (1905-1975) and his hypothesis of evolutionary development (EvoDevo).

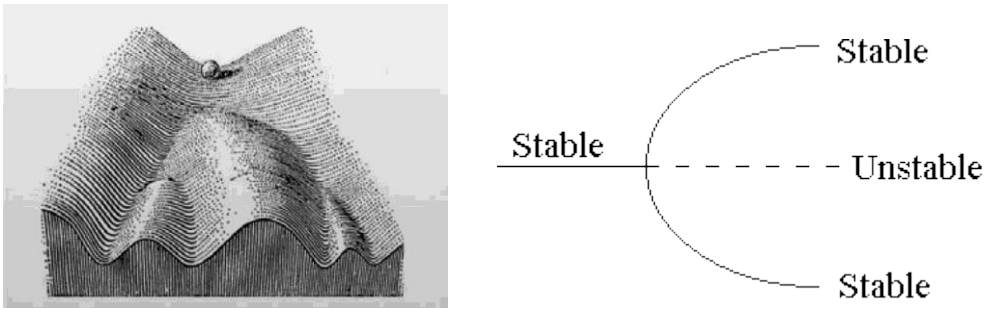


Figure 12 Epigenetic landscape and bifurcation of a stable state

The transition between a real reclining woman and one of Moore’s sculptures is dramatic, quasi a “catastrophe of imagination”. Its basis is not knowledge about evolution and

[12] These effects are also exploited by Salvador Dali in his painting: *The triangular hour* (L’heure triangulaire, 1933).

morphogenesis[13] but the experience of growth and deformation in our ambient world. Thus the transformation of a newborn child (or even an embryo) into a school child and an adult on one side and deformations due to developmental mistakes and illness (accident) establish a basic space of variation. Under specific visual conditions, camouflage, partial obstruction further deformations may be perceived and remembered. This space of variation is the ground on which the imagination of the artist and that of his clients may meet. Nevertheless, the departure from standard conditions of perception creates a catastrophic impact and a sudden rise of the information value (because such perceptions are rare and have a very low probability). This is the basis of the esthetic surplus value of the piece of art.

3.5 The surrealist revolution and Dali's encounter with catastrophe theory

André Breton (1896-1966) and his followers considered surrealism as a revolution as the titles of major journals show: "La Révolution surréaliste" (1924-1929) and "Le Surréalisme au service de la révolution" (1930-1933).[14] Surrealism was not only applied to visual art (painting, sculpture, installations, and film) but also to literature and had repercussions in sociology and philosophy. The general tendency of surrealism beyond an exuberant diversity of positions and enterprises is its opposition to dominant and publicly recognized standards and institutions. In Bataille's terms, the heterogeneous, the excluded, the taboo is the major concern of surrealistic enterprises. In mathematical (topological) terms the pictorial space in surrealism is often a piecemeal of representational subspaces (cf. the technique of collage introduced by Max Ernst, 1891-1976) or astonishing transitions between visual subspaces.

Salvador Dali (1904-1989) considered himself as the incarnation of surrealism.[15] An immediate link to catastrophes is given by the fact that Dali received René Thom in his home in 1978 at the time when catastrophe theory which had been developed and disseminated by Thom and Zeeman and was at its climax. Dali's turn to mathematics occurred in parallel with his return to Catholicism and sacred art, and his fascination by the topic of atomic, nuclear power after World War II. In Dali's version of the Last Supper (cf. for the historical evolution of this topic Wildgen, 2010 and 2013) the rectangular table is standing under the "roof" of a

[13] Morphogenetic principles have been used as a kind of metatheory in sociology to describe the interaction between agency and culture (social structure). In the arts, individual, creative aspects dominate and trigger the emergence of new cultural values and social relations; cf. Porpora (2013).

[14] The surrealist movement had been prepared by the movement called Dada which started in Zürich 1916, changed to Paris in 1920 and spread over the world (New York, Russia, Japan). Some of the proponents of surrealism (e.g. André Breton, 1896-1966) transferred the surrealist movement on the path to the United States (1941-1946) and influenced younger American artists (e.g. Jackson Pollock). The anarchist tendency of surrealism was later taken up by the Beat generation (beatniks) and Psycadelicart (I thank my son Quirin for this information).

platonic solid, the dodecahedron, and this spatial archetype, which is the only platonic solid with pentagons as its sides, reappears as major element in the painting “At the search of the fourth dimension” (1979).

Figure 13 Salvador Dali “Last Supper” (1955) and “At the search of the fourth dimension” (1979)

The series of ideal (regular) polygons (equilateral triangle, square, pentagon, hexagon etc.) and ideal polyhedrons (only five, the so called platonic solids) has a dynamic and topological equivalent in the elementary catastrophes, cf. Slodowy (1988). Insofar it was only consequential that Dali met René Thom, the famous topologist and Fields medal winner. The regular geometries and stable unfoldings are a kind of last residue of stability in a world of constant change, steady transitions and chaos luring anywhere. As Thom had established a link not only to morphogenesis but also to plate tectonic in geology and geography his and Dali’s imagination came near to one another. In fact, their conversation in Dali’s home was fruitful insofar as Dali produced a series of paintings on catastrophes. In one of them, his last painting called “Swallowtail” Dali cites different elements of Thom’s theory: a section of the elementary catastrophe called cusp (unfolding of the unstable dynamic system $V= x^4$) and of the swallowtail (unfolding of the unstable dynamic system $V= x^5$).

[15] He was excluded from the surrealist movement in a trial in 1934, but considered himself as the true heir of this tradition.

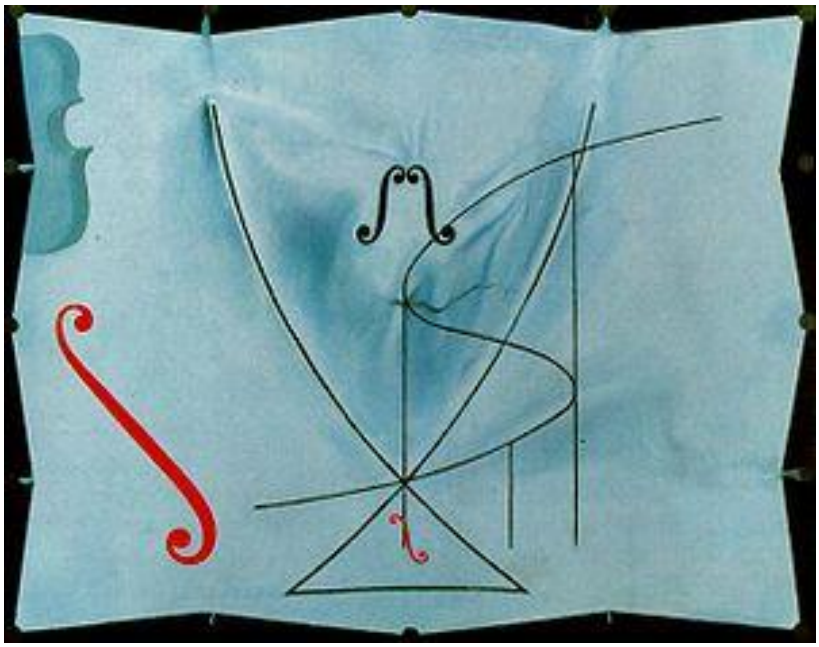


Figure 14 The Swallowtail, 1983

Descharnes and Néret (1989:219) show a photo where the old Dali poses besides this painting. It is an enigma how this painting fits into the life-work of Dali. Is it just a reflection of his admiration for René Thom and for modern science in general, or does it tell us something about Dali's relation to catastrophes, hidden dangers which may suddenly trigger the catastrophe? Great catastrophes have a double nature: first a preparation which is only apprehended by few, very sensitive persons or animals and second the cataclysm which involves many persons and objects. As such it is the symbol of danger and instability and Dali was in all his life very anxious and sensible about imminent dangers.

4 Some remarks on revolutions in the domain of music and literature

4.1 Remarkable (catastrophic) revolutions in the history of music

The evolutionary place of music in relation to language is still controversially discussed. Did language exploit earlier developments in the origin of music (as Rousseau explains), is there a common root (musico-language) or was musical competence enhanced by advances in linguistic competence and could only later separate from the dominance of language (singing) as it became mainly instrumental music? If one considers the archaeological evidence, visual and musical artistic performance is well documented since the late Paleolithic, i.e. since 40.000 years B.P. (See the earliest musical instruments found in caves of Southern Germany, mainly in Swabia, and the rock engravings and the earliest art of cave paintings in France and Spain).

In their historical origins, both visual art and music share the consideration of ratios and proportions (in the Pythagorean tradition) and are thus linked to Plato's Pythagorean thinking in his dialogue called "Timaeus". Indirectly they refer both to his philosophy of nature. The Platonic scale can be realized in the proportions of architecture, i.e. visually, and in musical scales. In this sense, visual harmony corresponds to musical harmony, at least in the framework of Greek mathematics. There are two domains of intersection: first the (visual, manual) construction and mastery of musical instruments and the device and use of musical notations (writing).

Revolutions, changes, i.e. radical and rather quick changes, in music may have different sources and be due to different kinds of forces;

- On the material side the construction and use of musical instruments can trigger systematic changes in the aesthetic standards and performances of music. Thus the separation of vocal music and instrumental music, mainly the autonomy of instrumental music triggered dramatic changes in the European tradition.[16] The opposition of vocal music (singing, choir) versus instrumental music seems to be a basic force in the evolution of musical forms (cf. Assafjew, 1976: 191ff.). A secondary consequence is the impulse of instrumental music for the construction and evolution of musical instruments, e.g. the construction of violins and in modern time electronic devices. These technologies reduce the dependency of musical forms on human motor-processes, e.g. breath extension and arm or finger dependent motion (in the case of a violin or a piano).
- The notation of music at different historical stages enhanced a higher complexity of musical constructions, using cyclic structures, techniques of counterpoint, musical citations etc. In most cases the complexity of new constructions is supported by the use of well known materials encountered in folk-traditions of singing or dance (cf. ibidem, 199ff). If these roots are ignored, musical constructions risk becoming incomprehensible to a larger public. This was the fate of many experimental types of music in the 20th century (a similar effect may be observed in the case of abstract visual art).
- Musical theory and its impact on musical performances is a further force in innovation. Thus the "Well-Tempered Clavier" or twelve-tone music were changes in the theoretical bases of music which had a revolutionary impact on practiced music.

[16] The isolation of vocal music, e.g. in the Orthodox Church music, did not lead to similar changes. The dominance of vocal music in religious offices held in the national language had also a strong effect in the area of Lutheran Reform in Germany. Simultaneously the importance of the organ in Lutheran offices enabled the Music of Johann Sebastian Bach (1685-1750) and his theoretical innovations (cf. the art of the fugue).

The classical musical scales based on seven steps or other systems with more steps in Indian and Chinese music have an influence on the form of preferred music and hearing competence in the audience. Rhythmic patterns may also be modeled by theoretical considerations beyond the simple imitation of culturally present examples.

A basic factor in musical innovation concerns the constant force based on improvisation and variation/elaboration in the domain of musical performances. Its limits are defined by the human ear and musical memory and their capacity to recognize and appreciate musical patterns. Radical changes in the history of music were called “intonation crises” by Assafjew (1884-1949).[17] “Intonation” in Assafjew’s terms means the transition of some kind of musical idea (concept, emotion, motivation etc.) to its manifestation by musical forms. Some of these forms may become worn out, weak and without expressivity and new forms have to be invented. Assafjew calls radical changes in intonation “intonation crises”. His historical examples concentrate on the period between the Renaissance and the early 20th century (until 1917). He did neither consider the effect of Jazz on European music nor the developments of 12-tone music (Arnold Schönberg) and General serialism (Karl Heinz Stockhausen). Schönberg’s 12 tone music abolished the distinction between the major /minor tunes; the tonic /dominant /subdominant and the notions of consonance and dissonance. The latter were replaced by nearer and farer consonances. In the case of Schönberg, a basic innovation or change in the intonation type triggered an avalanche of further changes and the invention of new devices and techniques of musical composition in order to achieve a complexity of musical expression comparable to earlier forms of “intonation”. The radical innovation itself (and its success) encouraged further innovations in John Cage’s music and in many kinds of “new music” (punctual music, statistic music, electronic compositions etc.).

4.2 Are there catastrophic changes (revolutions) in the history of literature, i.e. in language art?

In the domain of art based on language, i.e. in poetry, prose/novel and drama, revolutions are perhaps less evident because beyond the human ear and the human capacity to speak further restrictions, mainly the linguistic system (phonology, lexicon, grammar) establish a rather stable background which cannot be changed radically and in a short period of time,

[17] The theory of musical intonation had been introduced by Boleslaw Jaworski (1877-1942) based on the linguistic notion of intonation used in phonetics. In language, differences of relative stress or frequency (tone) can have many different functions: lexical/semantic differences as in tone languages, contrast and stress differences with syntactic or pragmatic function, etc. The space of such differences and values is much richer in music. In the case of singing, musical and phonetic tone contours must be matched and may be in conflict with each other.

without a dramatic loss of intersubjective intelligibility.[18] In concrete poetry and in Dada texts, the visual and acoustic form of text was considered as a separate domain of art manifestation. As a consequence, specific relations to visual art (in visual poetry) and to music (in sound poems) were established, laws of phonology, lexicon and syntax were at least locally neglected. This change did, however, not reach the larger public and remained an isolated domain. If one listens to a Dada or concrete poetry, it does (almost) not matter in what language it was written: this is comparable to popular music; the audience may enjoy it although it does not understand the song text in foreign languages (in Germany mainly lyrics are in English, Italian, or French).

Revolutionary changes in the language arts concern in majority the domain of text and discourse. In the domain of text, different mental spaces (in the sense of Brandt, 2015) beyond the ambient experiental space are put forward in inner dialogue, dream, the image space of children or mentally ill persons etc. This development mirrors the dominance of the referential or narrative mode in language art. The reference domains beyond ambient space and time can be easily transferred to the past (historical novels), the future (science fiction) to fantasy spaces, to absurd or labyrinth-like mental spaces etc. This means that the catastrophic transition concerns primarily the mental space used as reference domain. As a secondary consequence the lexical, syntactic and discursive techniques have to be adapted to the new task of moving (together with the audience) in such new and strange spaces of imagination. On could call this a “crisis of figural imagination” parallel to Assafjew’s notion of “intonation crisis”.

4.3 Conclusion on revolutions (catastrophes) in art

Innovations in art are more than temporary changes in taste or dominance shifts in the rivalry of schools. They contain at their heart a “problem” and its “solution” by the artist. This has been shown in the case of Leonardo, where the arrangement and the postures in the “Last Supper” contribute to the visualization of the dynamics inherent in the narrative episode represented in the mural. In the series of works dedicated to the triad: Anne, Mary, Jesus, a dynamic configuration with attractors, repellors, forces, weights and counterpoises is visually organized together with a system of sight- and action-vectors. The case studies on Turner and Moore showed the process of symbolic abstraction in landscape painting (Turner) and

[18] Learning a new language is at least for adults a rather difficult endeavor. This barrier seems to be less harsh in visual and musical communication. A basic difference between language on one side and visual art and music on the other concerns the relevance of every day speech (writing) for language and the fact that language art has to start from this very rich and socially accepted basis. Although in music folk or pop music is consumed by a large public, they don’t practice it massively. Music and visual art are always the product of a highly specialized and professional subgroup of society (cf. Wellmer, 2009: chapter II, 38f.).

figural sculpture (Moore) and the directions of their gradual development in the oeuvre of the artists.[19] In the case of surrealism a quasi-political revolution involving programs and establishing leaders and parties of artists can be observed. This shows on one side that its appearance is linked to political events, e.g. the first world war and the destruction of traditional values in its sequel, the strong impact of social struggles, e.g. between fascist and communists movements, anarchistic and Stalinist parties in the Spanish civil war. Nevertheless these political movements were only responsible for a general motivation for change, a search for new values and the negation of traditional value systems including esthetic values and philosophical positions.

In the domain of music and language art, similar catastrophic (abrupt) changes can be observed. In the domain of music the rise and finally the dominance of instrumental music gave rise to the important paradigms of European music after the Renaissance. The theoretical revolutions of 12-tone music, general serialism and followers led to a fundamental reorganization of the classical paradigm of tonal music. In the case of literature (language art) the case of Dada and concrete poetry is considered and major differences between language art based on common language and the visual arts or music practiced by a specialized sub-society are pointed out.

In a last and concluding chapter I would like to ask if a more fundamental parameter is underlying those abrupt changes (catastrophes), i.e. if the logical schemes operating with oppositions (contraries), negation and affirmation are sufficient. This question cannot be resolved by replacing two valued (Aristotelian) logics by three-value logics. We must reconsider the role of continuity underlying all affirmations, negations, oppositions, complementarities etc.

5 Continua underlying intellectual developments, beyond discrete logics

In the mainstream histories of science and art oppositions and shifts between alternative views and priorities are the dominant patterns of comparison. This may be due to a traditional, logically based dialectics of: true ÷ false in two-valued logics which have been generalized to discursive polarities such as: time ÷ space, wave ÷ particle, energy ÷ matter, realist ÷ idealist, holistic ÷ local, good ÷ bad etc. In this perspective a bipolar shift occurs from position A to B, where A and B are contraries and no intermediate is allowed (cf. the

[19] Further semiotic aspects of the art of Leonardo da Vinci have been treated in Wildgen (2005: directions of gaze and gestures); the iconography of the Last Supper was the topic of a chapter in a book on the semiotics of art (in French; Wildgen 2004b). Innovation in art has been analyzed in the context of innovation in language and in science as a chapter of my book on the Evolution of human language (Wildgen, 2004c).

"*tertium non datur"* as basic axiom in two valued logics). Kelso and Engstrøm (2006) argue in favor of "complementary pairs", i.e. the opposition is in many /all cases not exclusive; both of the seemingly alternative choices can be valid. A central topic in their epistemology concerns cooperation. In many systems, the cue is not the opposition between elements or subsystems but the coordination, communication between parts, the emergence of binding phenomena which enable self-organization with the goal of higher performance and better survival. Basically, coordination is also the key to our understanding of sign use and language. To separate, to distinguish is one intellectual operation valid for specific purposes, but unifying, binding, is an even more important one and in many circumstances even an unavoidable operation. A precondition for such complementarities or better for the emergence of in-between solutions, transitions and self-organization towards higher performance, is a level of continuity behind the apparent oppositions. The question therefore is: What are the continua behind truth and falseness, realism and idealism, good and bad in esthetic judgments. In the first section I have shown how bipolar or tripolar fields emerge in a continuum with reference to the elementary catastrophes called: *cusp* (germ: $V = x^4$) and butterfly (germ $V = x^6$). But what does the underlying continuum mean? How can we interpret the internal variable x and the quick dynamics which governs the shift, the transition, the catastrophe?

In philosophy, we may start from two infinitely remote, epistemologically untouchable positions. The individual Ego (beyond his/her socialization, beyond gender, beyond learning processes) as the individual genetically prefigured **Self** on one side and objectivity as such (beyond human perception and comprehension) the classical "Ding an sich" (**Object** in itself) discussed by Emanuel Kant. These opposed poles are epistemologically inaccessible, but we find a continuum of positions between them. This continuum may be exemplified by mentioning several sub-fields which show up in epistemological discourse:

- Earliest perceptions of the individual (in the womb, immediately after birth etc.),
- First categorical judgments, precursors of language specific classifications,
- Linguistically mediated judgments,
- Observational data in empirical science,
- Hypotheses and theories in the sciences.
- Unified theories in scientific fields, such as a theory of everything in physics and cosmological models (e.g. the big bang model)
- Metaphysical speculations as those found in religious contexts.

This list is not exhaustive , another position may exist between any of the terms mentioned. Therefore, if we choose two different positions on the scale, they may appear to be in a kind of dual opposition; in reality they are only different and at a specific distance on the

continuous scale and we can always find an intermediate position which diminishes the distance and contains features of both.

In art, the two poles of (esthetically) *good* and *bad* are also elusive, inaccessible and they depend on the above discussed scale of Self versus Object, insofar as art has always an anchor in individual taste, feeling, subjective reaction and cannot be completely or even in major concerns be objectified. “De gustibus not est disputandum” was the neo-Latin dictum: *Don’t discuss on taste!*[20] Nevertheless, humans constantly do so and cannot avoid doing so. The problem is that the points of reference of good and bad in esthetics are floating dependent on many contingent factors. In a coherent community, where specific esthetic standards of taste have been fixed, everybody may adhere to a specific judgment with the result that all participants not belonging to this community are rejected as tasteless.

Art is, however, as many specialist of esthetics would agree, more than just taste and although the values attributed to artwork may change over time and be dependent on geographical and political contexts, there seems to be a stable kernel of “good” art and a separating line to “bad”, insufficient, unskilled … artwork. The basic factors of general esthetics may be the two dimensions proposed by René Thom in his theory of “prégnance” (biological relevance) and “saillance” (perceptual salience). The second factor may be accessed via the psychology of art; cf. the work of Arnheim who translated the psychology of Gestalt of his masters (Wertheimer, Koffka) into an esthetics of visual art (cf. Verstegen, 2005 and as a summary Wildgen, 2013: chapter 1.1.4). The first factor may in majority be responsible for cultural differences, because in different social, political and economic contexts the biological/social/economic (survival) value or the criteria of success can be very different. One major factor is the place which artwork and artists occupy in a specific society and how much space /freedom is conceded to artists. In critical periods, the whole domain of art (and playful use of human capabilities) may collapse. Such cultural catastrophes are also catastrophes in the usual, non technical reading. The end of the Roman Empire in Western Europe was such a cultural catastrophe, the arrival of Europeans in the Americas was a cultural catastrophe for the amero-indian populations, and the Nazi-regime was a cultural catastrophe in Germany etc. After the catastrophe, new developments may emerge with some delay, such that the catastrophe, if it is not a total one (e.g. the extinction of a nation or of mankind), allows for a renewal which activates on one side the basic human capacities for culture and esthetics and on the other side puts together the few remains of the former cultural level. Thus the Italian Renaissance and humanism were able to recover many lost

[20]It is probably derived from neo-scholastic philosophy: „De gustibus et coloribus non est disputandum ». A non-authentic anecdote says that Julius Cesar presented with asparagus in butter instead of olive oil in Milan, spoke the sentence “De gustibus non est disputandum” in order to mediate the Roman disgust of butter in the kitchen, which was considered as barbarian.

elements of the Egyptian, Greek, and Roman culture (via Byzantium and the Arabic traditions present in Spain) and to reconstruct parts of the lost heritage. With these stimulations, new developments based on the drives inherent in European (Italian, Spanish, French, and German etc.) cultures could take place. The classical picture of this after-catastrophe scenario is the Phoenix rising from his ashes. It is documented since very early civilizations (Egyptian etc.).

Figure 15 Miniature of the phoenix in the Aberdeen Bestiary (Library of Aberdeen University, probably 12th century)[21]

[21] Wikicommons, cf. https://en.wikipedia.org/wiki/File:Phoenix_detail_from_Aberdeen_Bestiary.jpg

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