////// tematická studie / thematic articles //////////////////////

PHILOSOPHICAL TOYS TODAY

Abstract: *The article introduces a thematic issue of the journal Theory of Science that attempts to revive the category of "philosophical toys" – objects and instruments designed for experimental scientific research that simultaneously played crucial role in the creation of the modern visual culture. It claims that to fully understand their nature and the kind of experience philosophical toys induce, it is necessary to situate their origins in eighteenth-century experimental science and aesthetics and proposes to approach them as perceptual and cognitive extensions.*

Keywords: *philosophical toys; scientific instruments; modern visual culture*

Filosofické hračky dnes

Abstrakt: *Studie uvádí tematické číslo časopisu Teorie vědy věnované aktualizaci koncepce „filosofických hraček" – předmětů a přístrojů určených k experimentálnímu vědeckému zkoumání, jež zároveň výrazně ovlivnily utváření moderní vizuální kultury. Abychom plně porozuměli povaze těchto přístrojů a typu zkušenosti, již sebou přinášejí, je třeba jejich původ situovat do experimentální vědy a estetiky osmnáctého století a chápat je jako percepční a kognitivní extenze.*

Klíčová slova: *filosofické hračky; vědecké přístroje; moderní vizuální kultura*

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The term "philosophical toy" was used in the first half of the nineteenth century to designate a specific family of artifacts with a dual ambition: to examine various phenomena experimentally and to provide popular amusement. They were mostly simplified or derivative versions of scientific instruments that spread among the lay public and became sought-after consumer goods, modern, awe-inspiring curiosities. This issue of *Theory of Science* seeks to analyze the specific position that philosophical toys occupied – at the boundaries of science, arts and popular culture, in between theory and practice, knowledge and amusement – and to describe cultural forms that populate these thresholds in today's culture.

In this introduction, I will attempt to capture the nature and functions of philosophical toys through a combination of perspectives of three contemporary authors from different fields, whom I find most inspiring for both the historical analysis of this phenomenon and its contemporary relevance. Triangulation of these perspectives will reveal some of the distortions they entail; I will try to address them in a seemingly paradoxical maneuver – by descending into the material culture of the science and aesthetics of the second half of the eighteenth century.

Nicholas Wade is a psychologist specializing in research of vision and visuality, both contemporary and historical. He is interested chiefly in optical philosophical toys and their role in the history of experimental physiology and psychology, as well as in their influence on the visual arts. Although Wade emphasizes the fact that unlike "philosophical instruments" (instruments of the natural philosophy of the seventeenth and eighteenth centuries that served the purposes of demonstration and experimental analysis) philosophical toys are meant to be also amusing and accessible to the broader public, his accounts are essentially limited to the development, use and interpretation of these contrivances within the scientific realm: they constitute a neglected chapter in the history of science. By "public" Wade typically means artists, namely painters, for whom questions of vision are also essential. His contribution rests primarily in his detailed account of philosophical toys (such as the kaleidoscope, thaumatrope, phenakistiscope, stroboscope, stereoscope, tachiscope...) and their roles in nineteenth-century scientific research on the perception of colors, space, depth, movement or time.[1]

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[1] Nicholas J. WADE, "Philosophical Instruments and Toys: Optical Devices Extending the Art of Seeing." *Journal of the History of the Neurosciences*, vol. 13, 2004, no. 1, pp. 102–124 and Nicholas J. WADE, "Toying with Science." *Perception*, vol. 33, 2004, no. 9, pp. 1025–1032.

A very similar set of devices is discussed by Jonathan Crary, a historian of art and visual culture. In his Foucaldian attempt at rewriting the traditional historiographies of art and media, Crary introduces a radical historical break, a discontinuity between the classical and modern regimes of vision, between the classical and modern spectator. The period of seventeenth and eighteenth centuries is characterized by the camera obscura as both a material device and a discursive figure: it is a concrete technical artifact and a dominant epistemological model (embraced by empiricists as well as rationalists) that defined the status and capabilities of a perceiving subject. The camera obscura model was based on a radical differentiation of the inside from the outside, on the separation of the dark interior of the human mind from the luminous outside world that penetrates inside through the aperture of the senses and so depicts its own image. The outside model and its inside copy correspond to each other, and it is the mechanism of the camera obscura and its physical principles that guarantee the objectivity of the projection. Experimental physiology developed in the early nineteenth century breaks with this model in an essential way when it begins to conceive of vision in terms of bodily and temporal processes. Goethe's or Purkinje's investigations of afterimages begin to delineate the conception of subjective vision, imagery produced by the human body that lacks any correlate in the outside world. It is the various optical apparatuses that according to Crary play crucial role in research and control of such visual experience. Thanks to them the referential illusion could have become the subject of popular entertainment as well. In the simplest form we can find it in a thaumatrope, a device that utilizes the persistence of vision: two different yet complementary images are painted on the front and reverse side of a paper disc (such as a bold head and a wig, a bird and a cage ...), which is attached to a stick or two pieces of rope and by twisting them fast enough the two images combine. This way anyone could realize that the resulting visual impression is not really what is in front of us, that the human senses generate optical illusions thanks to their "fallibility". Crary devotes most attention to the stereoscope, the "quintessentially nineteenth-century device" and the source of the most realistic effect in the mass culture of that time. The principle of stereoscopy is "based on a radical abstraction and reconstruction of optical experience",[2] it is the result of the separation and isolation of individual senses, their

[2] Jonathan CRARY, *Techniques of the Observer. On Vision and Modernity in the Nineteenth Century*. Cambridge, MA: MIT Press 1990, p. 9.

scientific analysis and targeted and controlled irritation by mechanical instruments.

Film historian and theorist Tom Gunning published several brilliant studies about (again, particularly optical) philosophical toys. I regard these studies as the most inspiring contributions to the topic so far, because they actually situate the toys within the realm of popular culture (Crary's account follows mainly shifts in the conceptualization of vision in the works of intellectual elites, philosophical toys being their secondary illustrations) and also regard them as a constitutive moment of modern and contemporary media culture, a tendency still present and effective that intersects with and supplements other visual forms and conventions. The starting point for Gunning's interest in these proto-cinematographic devices is his radical reassessment of early cinema, expressed in the conception of "the cinema of attraction" from 1986. Until then, the historiography and theory of film were dominated by a narrative understanding of film that was unable to adequately grasp its early phase (until about 1906), which was taken to be a groping, undeveloped, primitive film form still in search of its true media-specific narrative nature. However, according to Gunning, the cinema of attraction is guided by very different principles, it is based on making images seen, harnessing visibility and exhibiting both the filmic illusion and the film technology. He sees early cinema "less as a way of telling stories than as a way of presenting a series of views to an audience, fascinating because of their illusory power [...] and exoticism."[3] It is necessary to point out that this exhibitionist impulse does not evaporate from cinema even after the classical, narrative form takes over; it rather becomes a kind of submerged stream that feeds avant-garde film and often surfaces into mainstream cinema, just like today in the form of special effects or so-called 3D, 4D, and 5D cinema. Later, Gunning searches for these aspects of film understood in terms of a fair attraction or a parlor trick in the popular visual culture of the nineteenth century. Philosophical toys and their "technological images" based on the manipulation of human perception through mechanical devices give rise to the modern image culture, at once profoundly technological and perceptual. Thanks to its simplicity, thaumatrope serves as Gunning's first and foremost example of this new phenomenon:

[3] Tom GUNNING, "The Cinema of Attraction: Early Film, Its Spectator and the Avant-Garde." *Wide Angle*, vol. 8, 1986, no. 3–4, p. 64 (63–70).

> We see this image not simply as a representation of something, but as an event, a process, an almost theatrical turn in which the image behaves in an unexpected manner, calling attention to its own production, making its appearance into a performance of image-ness, of becoming visual, of *appearing*.[4]

Similarly, later devices such as the phenakistiscope – a rotating disc with a series of movement phases – "do not represent motion, they produce it."[5] While producing visual illusions, philosophical toys, according to Gunning, at the same time demonstrate the process that generates them and make it possible for us to understand how our senses function and how they interact with the environment: they provide us with "rational entertainment." Gunning adopts Crary's historiographical model, situates the moment of emergence of the modern visual culture in the 1820s and exemplifies it with the thaumatrope. I am convinced we must look deeper than that.

Gotthold Ephraim Lessing wrote his short but remarkable fragment "That more than five senses are possible for human beings" at the very close of his life, most likely in 1780. In several paragraphs, he outlines a conception of human development from simple forms to complex and advanced ones: human sensory apparatus is not fixed once and for all but evolves towards greater refinement and complexity. Our present stage of five senses was achieved through combinatorics of individual ones: "If nature nowhere makes a leap, the soul will also have progressed through all the lower stages before it reached the stage at which it is at present. It will first have had each of these senses singly, then all ten combinations of two, all ten combinations of three, and all five combinations of four before it acquired all five together."[6] The present combination is not, however, the final stage of development: senses determine the limits of the soul's representations, they are their order and measure and the way the soul is conjoined with matter – the senses are themselves material. Matter, however, is not monolithic; it contains homo-

[4] Tom GUNNING, "Hand and Eye: Excavating a New Technology of the Image in the Victorian Era." *Victorian Studies*, vol. 54, 2012, no. 3, p. 510 (495–516).
[5] Tom GUNNING, "The Play between Still and Moving Images: Nineteenth-Century *Philosophical Toys* and Their Discourse." In: RØSSAAK, E. (ed.), *Between Stillness and Motion. Film, Photography, Algorithms*. Amsterdam: Amsterdam University Press 2011, p. 38 (27–43).
[6] Gotthold Ephraim LESSING, "That More than Five Senses Are Possible for Human Beings." *Philosophical and Theological Writings*. Cambridge: Cambridge University Press 2005, p. 180 (180–183).

geneous elements or masses that correspond to particular senses.[7] Because we know that there are more than five homogeneous matters (although we cannot know for sure how many there are in the world altogether), we can assume more senses are possible:

> Thus, just as the sense of sight corresponds to the homogeneous mass through which bodies attain a condition of visibility (i.e. light), so also is it certain that particular senses can and will correspond, e.g., to electrical matter or magnetic matter, senses through which we shall immediately recognize whether bodies are in an electrical or magnetic state. We can at present attain this knowledge only by conducting experiments.[8]

Lessing illustrates his thesis with the classic motive of sensory impairment: if we lacked vision, for example, we would not be able to form any conception of it. After gaining sight, a "whole new world will suddenly emerge for us, full of the most splendid phenomena." In the same way, we are aware (thanks to scientific research) of the existence of electrical or magnetic powers but we cannot perceive them because we haven't developed special senses for them yet. Human perception is dependent upon psychophysical constitution, which is not invariable.

Of course, Lessing does not speak in terms of purely biological evolution; his system is "the oldest of all philosophical systems," the system of the soul's pre-existence and of metempsychosis. The idea of a process in which an immortal soul migrates into new complex beings was very popular in Lessing's times and he himself developed it further in some of his other, later texts. Aside from a rich tradition of metempsychosis speculation, Lessing was most likely inspired by Charles Bonnet's theory of palingenesis.[9]

Bonnet was one of the first authors to use the term evolution, although in a different manner than it is known to us from the nineteenth century. His Leibnizian approach to evolution was marked by a belief in preformation, according to which every living being encapsulates in itself a primordial seed, an unchanging miniature replica of itself that is activated at fertilization and

[7] In this regard, Lessing draws on the traditional assigning of particular senses to different elements and simultaneously radicalizes his earlier and more famous notion of a "suitable relation" between signs, their referents and modes of perception that will be discussed below.
[8] LESSING, "That More than Five Senses Are Possible." p. 181.
[9] Such is the contention of H. B. Nisbet in his introduction to LESSING, *Philosophical and Theological Writings*, p. 14. The influence of Lessing's close friend Condillac and his discussion of the senses in the 1754 *Treatise on the Sensations* needs to be acknowledged as well; however, it is the progressive development found in Bonnet that provides the relevant framework.

develops into new identical organisms. At the creation of earth, all future generations of living beings were embodied in these primordial germs and the breeding of new creatures is essentially the production of endless series of copies of a given species. Preformationism excludes change or variation in the later evolutionary sense. It is not, however, an entirely static system. In his *Philosophical Palingenesis* from 1769, Bonnet delineates an image of catastrophic revolutions that radically alter living conditions on Earth and lead to new rebirths. The physical bodies of organisms are destroyed during these periodical catastrophes, but their germs survive and are born again into new worlds. These new worlds bring about different living conditions from the preceding ones, which is the reason why organisms acquire new forms corresponding to these new environments. "I conceive that the germs of all organized beings were originally constructed or calculated with a determinate correlation with the diverse revolutions which our globe was to undergo."[10] Catastrophic revolutions are predetermined just like the forms of the living are and they allow organisms to evolve towards greater biological complexity and higher spiritual perfection.

Bonnet's temporalizing of the chain of being does not involve the gradual transformation from simple to complex forms but proceeds rather by discontinuous leaps, a general shifting of all living beings and their hierarchical arrangements. During these phases, living beings constitute a continuous series, an uninterrupted chain of being that develops through sequential revolutions of time:

> The series of events, however, is quite distinct from these spatial configurations, each of which describes the taxonomic continuity in its own way; the series of events is discontinuous, and different in each of its episodes; but, as a whole, it can be drawn only as a simple line, which is that of time itself (and which can be conceived as straight, broken, or circular). In its concrete form, and in the depth that is proper to it, nature resides wholly between the fabric of the *taxinomia* and the line of revolutions.[11]

Late eighteenth-century natural history historicizes nature by integrating a consecutive series with the continuity of living beings: "evolution" is still both a scientific and a theological term. It has to be reconciled with the be-

[10] Quoted in Arthur O. LOVEJOY, *The Great Chain of Being. A Study of the History of an Idea*. Cambridge, MA: Harvard University Press 1936, p. 285.
[11] Michel FOUCAULT, *The Order of Things. An Archaeology of the Human Sciences*. London – New York: Routledge 2002, p. 163.

lief in the immortality of the soul and preformation. The inner hierarchical structure is not affected by time; time is not the principle of the evolution of organisms and their organization in the sense of later evolutionism and transformism. For Bonnet, evolution is the unfolding of a pre-programmed course that determines the nature of organisms, their mutual relationships, as well as revolutions of the environment they inhabit.

Lessing's fragment falls within this evolutionary framework, the development of the senses is understood as a combination of individual senses and their aggregates, not as their gradual perfection. However, his examples of existing matter (electrical or magnetic), which cannot be immediately perceived yet, must bring us to a halt. We gain knowledge of them by conducting experiments. It is due to scientific experiments that invisible processes, powers and matters become manifest in various effects – and we can register these effects with our senses or detect them with diverse (mostly measuring) instruments. The discoveries of electrical, magnetic or galvanic phenomena in the eighteenth century were still closely connected to the belief of God's presence in the world and they inspired radical changes in the understanding of the relationship between the body and soul or matter and spirit, when they replaced the traditional medieval metaphysics of light: "Magnetism and electricity emerged as the most palpable manifestation of the hidden presence of divine power in the world and its objects – as the concealed power that creates life, movement and warmth; that permeates the entire universe ..."[12]

Joseph Priestley, the author of a seminal survey of historical and contemporary electrical research from 1767, emphasizes the role causality plays in human cognition:

> One of the most intimate of all associations in the human mind is that of *cause* and *effect*. They suggest one another with the utmost readiness upon all occasions; so that it is almost impossible to contemplate the one, without having some idea of, or forming some conjecture about the other. In viewing the works of nature, we necessarily become first acquainted with appearances or effects.[13]

Appearances and effects are extremely diverse; therefore, it is necessary to search for analogies among them and so explain them by a small number of

[12] Ernst BENZ, *The Theology of Electricity. On the Encounter and Explanation of Theology and Science in the 17th and 18th Centuries*. Allison Park: Pickwick Publications 1989, p. 2.
[13] Joseph PRIESTLEY, *The History and Present State of Electricity, with Original Experiments*. Vol. II. London 1775, p. 11.

causes. An effect can become a true scientific phenomenon when it ceases to be only a particular event and becomes a regular and regulated one instead: it has to be made to appear every time under given circumstances and only then becomes a stabilized, observable phenomenon. Searching for analogies between appearances and producing them under identical and controlled conditions are the ways in which one establishes relationships between the large number and variety of visible effects and the few simple invisible causes. This principle is particularly distinct when studying electricity:

> Indeed, no other part of the whole compass of philosophy affords so fine a scene for ingenious speculation. Here the imagination may have full play, in conceiving of the manner in which an invisible agent produces an almost infinite variety of visible effects. As the agent is invisible, every philosopher is at liberty to make it whatever he pleases, and ascribe to it such properties and powers as are most convenient for his purpose. And, indeed, if he can frame this theory so as really to suit all the facts, it has all the evidence of truth that the nature of things can admit.[14]

The first experiments, which most commonly produced static electricity by friction, explained it in terms of gravitation, as a kind of attraction or repulsion intrinsic in specific bodies. "But when electricity began to show itself in a greater variety of appearances, and to make itself sensible to the smell, the sight, the touch, and the hearing: when bodies were not only attracted and repelled, but made to emit strong sparks of fire, attended with a considerable noise, a painful sensation, and a strong phosphoreal smell; electricians were obliged to make their systems more complex, in proportion as the facts were so."[15] In the last decades of the eighteenth century, electrical phenomena became even more complex when animal electricity was added to the register. Investigations of the nature and specificity of animal electricity and its similarity to static electricity produced artificially in laboratories (as we know them primarily from the Galvani–Volta dispute) were simultaneously an arena for speculations about the roles of analogy and metaphor in scientific research.[16]

[14] *Ibid*., p. 16.
[15] *Ibid*., p. 18.
[16] *Cf.* Marcello PERA, *The Ambiguous Frog. The Galvani-Volta Controversy on Animal Electricity*. Princeton: Princeton University Press 1992 and Laura OTIS, "The Metaphoric Circuit: Organic and Technological Communication in the Nineteenth Century." *Journal of the History of Ideas*, vol. 63, 2002, no. 1, pp. 105–128.

Take the example of the electric shock that can be delivered by a torpedo fish or an electric eel. In the Renaissance, it was still an inexplicable, occult phenomenon. In early modern times, it became the subject of more focused research and acquired mechanical explanation. Thanks to the invention of the Leyden jar in 1745, a condenser able to store static electricity, one could perceive some similarity between the two effects and consider the torpedo shock as electrical. Electricity, however, permeated the organic realm much more intensively once it began to be understood as a possible medium of communication in the nerves and when the emerging neurophysiology was still closely connected with physical and technical research. Even though explicit parallels between organic and technological systems would become commonplace in the next century, the preconditions for their intersections and interfacing (both conceptual and technical) emerged in Luigi Galvani's lab, on a table full of wires, condensers and dissected frog legs, which he himself regarded as the finest existing electrometer. Scientific apparatus and the instrumental arrangements do not just serve the purpose of displaying the nature and functions of the subject matter; they also help to formulate the conceptual models and metaphors used to interpret these phenomena.[17]

> The core element of modern electrophysiology, beyond the more or less technical terms and concepts it makes use of, consists of the fact that the membrane of nerve and of muscle fibers is actually a "machine," which produces and utilizes the electricity necessary to encode and transmit information to the excitable tissues.[18]

The nature of electricity is revealed through its effects and the phenomena produced must be stabilized in certain ways so they can be compared one to another. One way is to measure them. A different method was discovered in 1777 by Georg Christoph Lichetnberg, who found by chance another sensitive "tissue" that could be affected by electricity. While working with his electrophore, Lichtenberg noticed how resin dust would settle in its base forms into peculiar patterns and he started to examine this more systematically: radial or circular patterns were thought to be the result of positive or negative electrical fluids. Lichtenberg compared them to macroscopic images – stars, milky ways, suns – or to the images brought forth by the frost on window-panes and referred to them as "projections." He was also able to

[17] See Tomáš DVOŘÁK, "Scientific Instruments and Epistemology Engines." *Theory of Science*, vol. 34, 2012, no. 4, pp. 529–540.
[18] Marco PICCOLINO – Marco Bresadola, *Shocking Frogs. Galvani, Volta, and the Electric Origins of Neuroscience*. Oxford: Oxford University Press 2013, p. 320.

preserve them by spreading an adhesive substance on a sheet of black paper, thus discovering the principle of xerography.

The electrophore generated an electrical charge and served as an auxiliary instrument for charging a Leyden jar – Lichtenberg decided to build a much larger version (with a diameter of over 2 meters, his older model's diameter being around 45 centimeters) because "executing experiments with larger instruments is tantamount to observing the exhibited phenomena under a microscope: what went unnoticed beforehand to the most acute eye even with greatest scrutiny, can no longer remain forever unnoticed even by the sloppiest and most inconsiderate observer with the dullest sense once it is enlarged in this manner."[19] Thanks to this substantial magnification of the power to visualize an electrical charge (Lichtenberg was able to produce 40-centimeter-long sparks), the electrophore became a much more sensitive instrument of detection and display that allowed even for "drawing" patterns or letters: a new kind of secret language allowed nature to make itself manifest. At the time, electrostatic figures captured the attention of the public as analogies of atmospheric charges, thunderbolts harnessed and domesticated. Smaller versions of Lichtenberg's instrument were soon on sale, philosophical toys that were meant to demonstrate and explain the emergence of frost patterns. The principles behind these invisible processes were still unknown but thanks to the instrument they could be made visible, and release a lasting image of their transient state, a pregnant moment of their potentiality: "In the frozen state of a single image, the world is expressed as a specific state of tension."[20] Lichtenberg's figures are nature's explosive gestures, indexical images that allow nature's hidden forces to surface by means of the apparatus and to translate the haptic sensation of electric shock into a visual one. They are simultaneously beautiful and true ciphers, not yet fully understood but nevertheless able to insert certain degree of certainty into theoretical confusion and controversies. These sonograms of modernity inaugurate an era of mediation that are characterized by the dialectical tension between movement and stillness and would develop into the forensic imagination we indulge in today.

It might seem surprising that Lichtenberg did not pursue a more thorough explanation of his figures or attempt to situate them within the system

[19] Quoted in: Davis BAIRD – Alfred NORDMANN, "Facts-Well-Put." *The British Journal for the Philosophy of Science*, vol. 45, 1994, no. 1, p. 46 (37–77).

[20] Siegfried ZIELINSKI, "Show and Hide: Projection as a Media Strategy Located between Proof of Truth and Illusionising." In: ZIELINSKI, S. – WAGNERMAIER, S. M. (eds.), *Variantology 1. On Deep Time Relations of Arts, Sciences and Technologies*. Köln: Walther König 2005, p. 97 (81–100).

of knowledge of the time. It was as if they could speak for themselves. Such an approach resonates with his other scientific and literary work: Lichtenberg favored experiment over theory as well as aphorism over novel. His method of presentation was based on a graphic and immediately effective apparition, shocking rather than contemplative. His anti-systematic approach led to the demonstration of knowledge in a condensed and concentrated form, not in a gradual and detailed interpretation or theoretical explication.[21]

When Lichtenberg introduced his electrostatic figures to the public in 1778 and when two years later Galvani began his series of experiments with dissected frogs, exposing them to static or atmospheric electricity, they contributed yet another fascinating images to the rich repertoire of electrical imagination of the eighteenth century.[22] This imagination was not the exclusive property of scientists, rather the opposite: ingeniously elaborated and spectacular demonstrations of electrical phenomena accompanied scientific lectures but also attracted customers to instrument shops, and became fashionable parlor tricks and domestic amusement and were discussed in the periodical press as sensational events.

> [N]atural philosophers could use their control over active powers to construct a *theatre* with all the appeal and all the dangers that implied. The theatrical image, as an analogy for the world which was to be investigated, was common. The Linnaean disciples wrote of "the theatre of this life" and of the naturalist as "the eye and spirit of the Earth, attentive to gaze with astonishment upon the economy of the Creator". They emphasized that "one finds in Man two properties of which all other animals are deprived: *astonishment* and *language*."[23]

[21] The relationship between Lichtenberg's scientific and literary work is discussed in Jürgen TEICHMANN, "Georg Christoph Lichtenberg: Experimental Physics from the Spirit of Aphorism." *Nuova Voltiana. Studies on Volta and his Times*, vol. 5, 2003, pp. 15–30 and Jeremy ADLER, "Klikatá čára. Vizuální narativní metoda: Sterne, Lichtenberg, Novalis." *Kritický sborník*, vol. 19, 1999/2000, pp. 65–82.

[22] It is worth noting that both these discoveries, as well as many others at the time, are regarded as having occurred "by chance." This interpretation stemmed from the lack of theoretical explanations for them and from the understanding of an experiment as a test of a theoretical hypothesis, which denies any kind of epistemological gain on the side of instrumental arrangement. In fact, similar discoveries occur only thanks to experimental systems that are not simply tools for generating answers but rather materialize questions and produce material entities along with concepts and theories; see Hans-Jörg RHEINBERGER, *Toward a History of Epistemic Things. Synthesizing Proteins in the Test Tube.* Stanford: Stanford University Press 1997.

[23] Simon SCHAFFER, "Natural Philosophy and Public Spectacle in the Eighteenth Century." *History of Science*, vol. 21, 1983, no. 1, p. 14 (1–43). The role of instrument makers and

In scientific experiments, the controlled production of a phenomenon and wonder went hand in hand; eighteenth-century science did not know the future differentiations between professionals and amateurs, academic institutions and market, work and amusement. It was in the next century, when science was "purified" of popular, entertaining, commercial – in short, non-scientific – activities, and this process of purification was a way of legitimizing its new social role and status.[24] Epistemological dramas that were performed in the theatres of nature of the eighteenth century were, above all, entertaining and educational visual spectacles. They accounted for the different regime of visuality that was assigned to the period by authors like Foucault or Jacob: for Foucault, theatre is the model of Renaissance visuality and it is substituted in the Classical period by the table and the catalogue; according to Jacob, the eighteenth century is defined by a search for "visible structure", "reducing a living being to its visible aspect and translating its shape, size, colour and movement into words."[25] Both authors focused primarily on natural history; it is true that public demonstrations were dominated by the physical and mechanical sciences, but alongside light, electricity, magnetism and various automata, minerals, plants, corpses and monsters were also put on display. The way they were exhibited was very different from the Renaissance regime of curiosity, because it became a public and commercialized enterprise. Instead of totally displacing theatricality, we should look for moments where both modes of observation overlap and supplement one another while avoiding their subsumption under some monolithic and normative framework: in every period, we can find a number of coexisting heterogeneous scientific cultures with frayed edges. On the one hand, they allow for and inspire mutual exchanges of concepts and metaphors, the sharing of methods of research and instrumental equipment, the creation of analogies between disparate phenomena and hints of universal systems; on the other they also produce moments of cognitive dissonance and provoke discursive, disciplinary or institutional battles.

itinerant lecturers in both the presentation and research of electricity is discussed in Oliver HOCHADEL, "A Shock to the Public: Itinerant Lecturers and Instrument Makers as Practitioners of Electricity in the German Enlightenment (1740–1800)." *Nuova Voltiana. Studies on Volta and his Times*, vol. 5, 2003, pp. 53–67.

[24] See Bernadette BENSAUDE-VINCENT – Christine BLONDEL (eds.), *Science and Spectacle in the European Enlightenment*. Aldershot: Ashgate 2008.

[25] François JACOB, *The Logic of Life. A History of Heredity*. New York: Pantheon Books 1973, p. 45.

Making the invisible visible or rather making the imperceptible perceptible by some sort of mediation is one of the concerns shared across many different fields and disciplines. It was within aesthetics that questions of mediation were posed in the most pronounced and profound ways, especially in the works of Lessing. His *Laocoön* from 1766 is a critique of the classical doctrine of *ut pictura poesis*, an understanding of painting as mute poetry and poetry as a speaking picture. Lessing proceeds from the different ways identical situation is rendered in these media: Vergil's epic poem *Aeneid* and the ancient sculptural group *Laocoön and His Sons* from the first century BC. Laocoön was a Trojan priest, punished for attempting to expose the ruse of the Trojan Horse (according to the most common interpretation). Poseidon sent sea snakes to kill him and his sons and the group of the three suffering figures with snakes wrapped around and suffocating them is taken to be the prototypical icon of human agony. Lessing is puzzled by the expression in Loacoön's face – unlike the poetic rendition, the sculpture does not portray the most extreme moment of pain and suffering because that would have been a violation of the classical ideal of beauty. The artistic medium therefore determines to a certain extent what can be represented and how. We should note, however, that a strong normative claim is present here; in fact it is not the very material limits of individual media, as many interpreters of Lessing the semiotician claim, but rather a required form of expression. Technically speaking, the sculpture could represent the situation in a different way as well but then it wouldn't fulfill Lessing's preferred conventions and ideals. In the same way, the critique of *ut pictura poesis* is directed against excessive descriptiveness and staticness of poetry; "good" poetry should follow its medium-specific principles.

There were many discussions of the relationships between artistic media before Lessing, his originality, however, lies in the reduction of this difference to the fundamental distinction between temporal and spatial principles. The succession of time is the sphere of the poet and space is that of the painter:

> In the first place I presume it will scarcely admit of dispute that the imitations of painting are effected by means entirely different from those of poetry; the former employing figures and colors in space, and the latter articulate sounds in time. Now, as it is evident that the signs employed must bear a suitable relation to the things represented, it follows that those signs which are arranged in juxta-position with each other, can only express co-existent objects, or an object whose parts are co-existent, while those signs which are consecutive, can

> only express things which, either of themselves, or in their component parts, are consecutive.[26]

Lessing further distinguishes between primary and secondary or direct and indirect expression: painting can represent actions by intimation, by means of bodies, and poetry may also delineate bodies by means of actions. Thus expressing juxtaposition by poetry or consecutiveness by painting is not impossible, it is only more complicated and strenuous and demands more effort from the recipient. The crucial criterion here is, simply, the effectiveness of generating a full and vigorous illusion. In the ideal situation we even stop perceiving the means that bring it to life:

> The poet seeks to render the ideas which he awakens within us so vivid, that we may instantly fancy we perceive the real and sensible impressions of the objects they refer to; and, in that moment of illusion, we cease to be conscious of his words, that is to say, of the means by which he produces his effect.[27]

If poetry is specifically temporal, it produces its own specific temporality: in that moment of acceleration necessary to generate the desired deception, it breaks up with the pace of human perception, falls below the threshold of consciousness and becomes a machine for producing special effects. When Lessing talks about actions and their consecutiveness, he does not refer only to some general conception of time or movement but rather to human action and the effort, activity, work it entails.

> Those combined effects which the eye perceives at a glance, [the poet] is obliged to enumerate in tedious detail, and it not unfrequently happens that by the time we arrive at the last of his traits, we have already forgotten the first. Nevertheless, it is from these successive traits alone that we can form any conception of the whole. To the eye, the parts contemplated remain constantly present, and may be recurred to over and over again; on the contrary, when the ear is the channel of perception, the parts described are lost, if they are not preserved in the memory. And even supposing them to be all correctly remembered, – what an effort, what an exertion would it require to revive their impressions all in the

[26] Gotthold Ephraim LESSING, *Laocoon; or the Limits of Poetry and Painting.* London: J. Ridgway & Sons 1836, p. 150.
[27] *Ibid*., p. 165. The English translation uses the word "instantly" instead of speed or rapidity, which would more precisely translate "die Geschwindigkeit" – thanks to the speed of sensory impressions we believe we perceive the real objects.

> same order and with the same distinctness, and to think them over again with even moderate rapidity, so as to form a tolerable idea of the whole![28]

The effort, exertion and time needed have to be passed on to the mechanism that produces the synthesis for us. Leibniz was pondering the idea that eyes of sufficient acuity might read all the relations in space and time within the "present;" that idea is realized here, although on a much smaller scale, in the appropriately structured artifact and its coordination with the human sensorium: artworks are phantasmagorical projections, we are not aware of the processes that generate illusions because they take place below the threshold of our consciousness.

Lessing's reflections are most fruitful when they focus on possible violations of laid down principles (such as the treatment of indirect, "unsuitable" modes of expression). These moments also uncover the most problematic of his assumptions and his normative requirements. Producing an effective illusion is predicated on two levels of abstraction: the first step is based on the very differentiation between painting and poetry and their respective inner principles, coexistence and sequentiality, space and time. The second one results from what media with such a bias – according to their material limits – may choose to represent from the space-time continuum.

> The painter can only employ, in his compositions of co-existing bodies, one single moment of the action, and he must therefore select, as far as possible, that which is at once expressive of the past, and pregnant with the future.
> In like manner the poet, in his consecutive imitations, can employ but one single attribute of bodies, and must therefore select that which awakens the most sensible image of the body under that particular aspect which he has chosen to represent.[29]

The reality effects postulated by the emerging science of aesthetics are based on the sequential isolation of these elements and their resulting combination. In this respect, Lessing proceeds in union with the methods of natural sciences of the time. "Observation," writes Foucault, "from the seventeenth century onward, is a perceptible knowledge furnished with a series of systematically negative conditions." It advances via reduction and selection of phenomena that can be further analyzed and made generally acceptable: "The area of visibility in which observation is able to assume its powers is

[28] *Ibid*., pp. 166–7.
[29] *Ibid*., p. 152.

thus only what is left after these exclusions [...] This area, much more than the receptivity and attention at last being granted to things themselves, defines natural history's condition of possibility, and the appearance of its screened objects: lines, surfaces, forms, reliefs." Foucault hurries to emphasize that optical instruments such as a microscope fall within such regime of visuality as well: "it was the same complex of negative conditions that limited the realm of experience and made the use of optical instruments possible."[30]

The main difference lies in the fact that the aesthetic sphere is interested in the creation of artifacts that produce anticipated effects. This difference is, however, only a misrepresentation based on our contemporary perspective: we tend to view various spheres of knowledge and experience separately as subject matters of individual fields and under the influence of traditional historiography of science understand the history of knowledge mainly as the history of ideas and theories. In fact, experimental science and aesthetics share many fundamental concerns: recall Lichtenberg figures in case of which any separation of truth and beauty is impossible and pointless. They are not a reflection or a representation but rather a discharge, which would quickly become the prime concern of Romanticism. Romantic aesthetics would treat it first of all in psychological terms, as the excessive pressure of the author's emotions, and thus suppressing its bonds with the ways the world appears in scientific experiments. The more Romanticism wanted to bring forward a critique or an alternative to the experience of rationalization and industrialization, the more it lost the ability to understand this new expressive form in its wholeness and complexity. The "mirror" and the "lamp", the metaphors analyzed by Abrams as the dominant models of mind and creative processes in the Classical period and in Romanticism,[31] are always simultaneously material technologies, cognitive extensions that are located outside of the human body but define it and its abilities and partake in their development. Any conception of a bare human subject and its inner vision is but a strained abstraction. The lamp of Romanticism is an electric lamp and it was electrified decades before Kant or Coleridge. The pivotal aspect of modern explosive aesthetics is then found in Lessing.

> If *apparition* illuminates and touches, the image is the paradoxical effort to transfix this most evanescent instant. In art something momentary transcends; objectivation makes the artwork into an instant. Pertinent here is Benjamin's

[30] FOUCAULT, *The Order of Things*, pp. 144–5.
[31] Meyer Howard ABRAMS, *The Mirror and the Lamp. Romantic Theory and the Critical Tradition*. Oxford: Oxford University Press 1953.

> formulation of a dialectic at a standstill, which he developed in the context of his conception of a dialectical image. If, as images, artworks are the persistence of the transient, they are concentrated in appearance as something momentary. To experience art means to become conscious of its immanent process as an instant at a standstill; this may perhaps have nourished the central concept of Lessing's aesthetics, that of the "pregnant moment."[32]

Lessing formulates his conception of the pregnant moment in the beginning of his essay, long before the rigid differentiation of time-based and space-based media and modes of perception appears. It emerges when he discusses the problem of Laocoön's facial expression, the question of why the sculpture does not portray the most extreme state of the priest's pain and suffering. It is not just a matter of aesthetic conventions. If the visual arts are to choose one particular moment for depiction, they must select the appropriate one:

> If it be true that the artist can adopt from the face of ever-varying nature only so much of her mutable effects as will belong to one single moment, and the painter, in particular, can seize this single moment only under one solitary point of view; – if it be true also that his works are intended, not to be merely glanced at, but to be long and repeatedly examined; – then it is clear that the great difficulty will be to select such a moment and such a point of view as shall be sufficiently pregnant with meaning. Nothing however can possess this important qualification but that which leaves free scope to the imagination. The sight and the fancy must be permitted reciprocally to add to each other's enjoyment.[33]

Here, the later claim for maximal effectiveness is somewhat denied: it is not a matter of overlooking the image at once, seeing it in one instant, but rather a question of creating an interface in which the viewer is animated by the image and the image animated by the viewer. The last sentence of the excerpt is translated very loosely. It really reads: "The more we see, the more we must be able to imagine; and the more we add in our imagination, the more we must believe we see." In condensed form, Lessing captures the basic principle of the emergence of the illusion, the linking of human sensorium and its extensions that form their coordinated complicity: a specific kind of technical imagination. In the pregnant moment being appears in its process of becoming something, it is both static and dynamic and thus addresses our

[32] Theodor W. ADORNO, *Aesthetic Theory*. Minneapolis: University of Minnesota Press, p. 84.
[33] LESSING, *Laocoon*, pp. 28–9.

affective and cognitive processes that simultaneously trust it and let themselves be deceived. Different layers of our minds and bodies participate in this paradoxical tangle of trust, seeing and imagination: the human being is divided into segments that in different ways and in different measures respond to specifically structured stimuli. The doctrine of the separation of the senses is a precondition of the establishment of aesthetics as developed by Lessing or Diderot. The major texts of Enlightenment theory are imminently interested in the capacities and limits of medial transmission and sensory apparatus – that is why various forms of sensory deprivation play such a crucial role in these discussions. Through them, restrictions can be delineated and combinatory possibilities envisioned. It is not a matter of a perfection of the senses but rather of a prosthetic overwriting of their capacities and capabilities, a whole new architecture in which corporeality is provisionally and partially synchronized with various supplements and assistive technologies. This coordinated rearrangement has a specific dynamic that is most pertinently developed in Moses Mendelssohn's reaction to Lessing's *Laocoön*.

Following Jean-Baptiste Dubos, Mendelssohn asks why looking at sorrow, pain and misery can bring us pleasure and satisfaction. Bullfights, racks, insane asylums, bloody scaffoldings for execution, these are his examples of things we would prefer not to feel than to feel – peculiar mixtures of appreciation and rejection. Deficiencies and evils are immediately undesirable but in mediated form can be good and pleasant. If we perceive them, for example, in the form of artworks, our "secret consciousness" (ein heimliches Bewusstsein) reminds us that we have only an imitation before our eyes and thus moderates the strength of the objective disgust:

> It is true, the soul's sentient knowledge and capacities to desire are deceived by art and the imagination is so swept away that at times we forget every sign that it is an imitation and fancy that we truly see nature. But this magic lasts only as long as it is necessary to give our conception of the object the proper vitality and fire. In order to have the most pleasure, we have accustomed ourselves to diverting attention from everything that could disturb the deception and directing attention only at what sustains it. However, as soon as the relation to the object begins to become unpleasant, a thousand factors remind us that we are looking at a mere imitation.[34]

[34] Moses MENDELSSOHN, "Rhapsody or Additions to the Letters on Sentiments." In: *Philosophical Writings*. Cambridge: Cambridge University Press 1997, p. 138 (131–168).

In the interest of maximum pleasure the soul plays a specific energetic game in which the controlled experience of immersion, of loosing oneself in the projected world, temporarily dominates, only to be turned off once a critical state is reached. Mendelssohn anticipates Coleridge's concept of the "willing suspension of disbelief" but frames it in a much more sophisticated fashion. In his account, the concept of attention understood in terms of practice and acquired habit is crucial. Not everyone enjoys dramatic tragedies. We have to be accustomed to such experience, for which "a certain refinement is required." Whoever is not accustomed to it feels bored or experiences a conflict – sometimes annoying, sometimes ridiculous – between his reason and his imagination.

For Mendelssohn, the problem of pleasure from sorrowful spectacles is an ethical rather than an aesthetic problem. He recalls Plato's concept of virtue and the difference between speculative and pragmatic knowledge. If virtue is a certain kind of knowledge, it can be learned and acquired by repeatedly practicing skills and habits. It is not a theoretical, verbalizable knowledge, a knowledge we can be aware of, but exactly the opposite: our capabilities are transformed into proficiency only when we cease to be conscious of them. They have to stream through our blood, get under our skin, become automatic, become habitual. The principle of such automation is, again, speed:

> For what causes consciousness to stop? The quickness with which concepts succeed one another. Thus, although the degree of our knowledge is lessened by the lack of consciousness, the quantity of effective impulses remains the same in this case. For what is lost in the degree of knowledge is gained in the shortness of the time or in the quickness.[35]

The effectiveness of representation depends on three factors: 1) the degree of the perfection of the representation; 2) the degree of our knowledge; 3) the speed with which we ponder matters. The less time we need to consider the perfection presented to us, the more pleasant our intuitive knowledge is, and the more passionately we desire to enjoy it. The speed of our intuitive insight compensates for the fact that we are not fully aware of it. "This explains how, without thinking about it, we can perform a number of habitual actions which in the beginning required deliberations and reflection. What array of automatic movements are part of speaking and writing? How slowly and deliberately they proceed in the beginning and how quickly they follow

[35] MENDELSSOHN, "Rhapsody," p. 163.

upon one another, often unconscious to ourselves, once we have achieved a proficiency in this regard."[36] Mendelssohn further analyzes the process of automation with the examples of a pianist or a typesetter; it does not just apply to mechanical activities but also fundamentally concerns the modes of perception and cognition mediated by artifacts and the formation of the human subject in modernity as such. Unlike the more or less isolated moments of aesthetic experience in Lessing, Mendelssohn conceives of these intervals and situations as components of the gradual constitution and reconstitution of human nature.

> Virtue is, to be sure, a science and can be learned; but if it is be carried out, then it demands not merely scientific conviction, but also artful practice and proficiency. Indeed, anyone who grapples with the highest stage of ethical perfection and strives for the blessed condition of bringing the subordinate powers of the soul into a perfect harmony with the superior powers of the soul, must do this with the laws of nature just as the artist must do so with the rules of his art. He must continue practicing until, in the course of the exercise, he is no longer conscious of his rules, in other words, until his principles have turned into inclinations and his virtue appears to be more natural instinct than reason.[37]

The planes of instinct, intuition or habit are formed by different rules and principles than rational and theoretically expressed convictions are; because they are saturated with material practices and techniques and have to deal with their affordances and relatively autonomous development. If we want to conceptualize the transformation of experience and to historicize forms of perception and cognition, we cannot make do with just the development of philosophical, scientific or aesthetic systems. On the contrary, we need to descend onto levels traditionally regarded as low and subordinate. Just like Walter Benjamin did with his concept of distraction, which essentially refers to habit realized through tactile reception: "For the tasks which face the human apparatus of perception at historical turning points cannot be performed solely by optical means – that is, by way of contemplation. They are mastered gradually – taking their cue from tactile reception – through habit."[38]

[36] *Ibid*.
[37] *Ibid*., p. 166.
[38] Walter BENJAMIN, "The Work of Art in the Age of Its Technological Reproducibility." In: *Selected Writings*. Vol. 4, 1938–1940. Cambridge, MA – London: The Belknap Press of Harvard University Press 2003, p. 268.

In the first paragraph of his seminal essay, Benjamin alludes to the multiplicity and diversity of logics and temporalities of technical and organic segments that continuously combine one with another and rearrange and get used to themselves: lithography, invented by Senefelder in 1796,[39] made it possible to reproduce images in much larger numbers and at a much quicker pace, thus providing an illustrated accompaniment to everyday life. A few decades later, lithography was surpassed by photography, which for the first time "freed the hand from the most important artistic tasks in the process of pictorial reproduction – tasks that now devolved solely upon the eye looking into a lens. And since the eye perceives more swiftly than the hand can draw, the process of pictorial reproduction was enormously accelerated, so that it could now keep pace with speech. A cinematographer shooting a scene in the studio captures the images at the speed of an actor's speech."[40] Manual labor, skilled gestures, machines and instruments, speech, sight, hearing, touch, technical images, sound recordings – apparatus and organs combine and group together in changing clusters and constellations that give rise to historically specific cultural techniques and practices; these provisional arrangements are simultaneously determined by political and economical preferences of the time.

The accounts of philosophical toys mentioned in the introduction agree that one of their characteristic aspects is the disclosure of the processes simultaneously examined and experienced: "A crucial feature of these optical devices of the 1830s and 1840s is the undisguised nature of their operational structure and the form of subjection they entail."[41] Gunning develops this point most thoroughly, in my opinion as a consequence of his effort to debunk the myth of early cinema's passive and helpless audience.[42] The spectators of philosophical toys are entertained yet at the same time actively participate in the process and rationally engage in a quasi-scientific experimental instruction. Scientific curiosity is thus made public and transferred to lay consumers: "in contrast to the traditional magic trick, whose illusion remains mysterious because the secret is kept close by the prestidigitator,

[39] Senefelder developed lithography while searching for a cheaper and more effective way of distributing his dramatic works; see Alois SENEFELDER, *The Invention of Lithography*. New York: The Fuchs & Lang Manufacturing Company 1911.
[40] BENJAMIN, "The Work of Art," p. 253.
[41] CRARY, *Techniques of the Observer*, p. 132.
[42] See Tom GUNNING, "An Aesthetic of Astonishment: Early Film and the (In)Credulous Spectator." *Art and Text*, vol. 34, 1989, pp. 31–45.

the philosophical toy is a tool of demonstration and demystification [...] The philosophical toy sought to demystify magical effects and unveil the secrets of perception and technology to the masses."[43] I think that this is an overly idealistic interpretation of the technological imagination, which cannot hold up even in reference to the simplest possible devices such as the thaumatrope was.

Gunning vigorously opposes the traditional view that the composite image of the thaumatrope derives from a "fallacy" of the human eye – similar arguments of such deficiency or weakness of human senses surround discussions of later animation devices or cinema: it is because the eye is not capable of perceiving rapid change that we actually see the virtual image instead of a series of still images. Referring to sensory insufficiency, according to Gunning, reveals a prejudice towards perception as a static process. We should rather embrace its mobile possibilities and praise our senses' ability to participate in the creation of similar phenomena. Gunning attempts to resolve this dilemma by embracing a phenomenological standpoint, which, in effect, seems to be more of an evasive maneuver:

> My position is obviously phenomenological; that is, I maintain that perceptions need not be dissolved into their physiological process (I am not against doing this – if we are studying physiology rather than moving images). But my task here is to describe our perception as we experience it. The riddle of the perception of the moving image lies in the fact that no one can explain it purely physiologically and the physiological explanations are still debated. In other words, we have a true challenge to explanation here.[44]

Indeed, we still do not fully understand all the subtleties of the physiological process of perception; so what exactly is it that the viewer of a philosophical toy is instructed about? What kinds of secrets are unveiled, what operational structures are demonstrated? None really. No one can explain this process in purely physiological terms simply because it is not a purely physiological process. If we take seriously Gunning's claim that human perception undergoes a fundamental transformation based on a deep coordination of the perceptual and the technological, we also have to acknowledge the fact that the technological is a relatively autonomous and largely unknown territory – though this in no way precludes us having an intimate relationship with it. We can see without fully understanding our senses and we can also

[43] GUNNING, "Hand and Eye," pp. 503, 509.
[44] GUNNING, "The Play between Still and Moving Images," p. 39.

see mediated, virtual images without fully understanding the principles of their genesis. We are happy to delegate time and labor needed for perceptual and cognitive tasks on technological processes that take place below our consciousness or beyond the confines of our bodies. The phenomenological description is obviously a legitimate one, but I believe that the crucial lesson philosophical toys provide us with is the glimpse they offer of the appearance of a very intricate and volatile cohabitation that can be most productively addressed within the framework of extended cognition. This concept seeks to overcome the residual Cartesianism in our understanding of human cognition that draws a dividing line between the "thinking thing" and the "extended thing", criticizes traditional mentalist and propositional conceptions of knowledge, and argues for the inclusion of the material environment into cognitive and perceptual processes and activities. This is not to say only that artifacts, instruments or media somehow amplify human cognition, but rather that the dividing line between human and non-human is redrawn with respect to what constitutes a cognitive process. Such a process then cannot be limited to the human brain or human body since material objects in the environment function as parts of our mind or sensory apparatus and together constitute coupled systems and assemblages that need to be acknowledged on their own if we are to adequately understand our knowledge-making processes. Neural, bodily, material and social resources need to be addressed simultaneously since material artifacts establish an external connection between our motor, visuo-spatial, and conceptual systems, thus creating dynamic experimental spaces within which knowledge and perception is processed and constituted. If we delegate certain tasks to technological agents, we need to acknowledge the fact that we are not able to fully control and often even understand them in a reflexive and rational manner:

> It is a profoundly erroneous truism, repeated by all copy-books and by eminent people when they are making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them.[45]

[45] Alfred North WHITEHEAD, *An Introduction to Mathematics*. New York: Henry Holt & Co. 1911, p. 61.