Inventing Cinema

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1. The Why and How of Machines

Abstract
This chapter first establishes the fundamental definitions necessary to the construction of the approach: technique and technology, machine and dispositif. It discusses Foucault, Simondon, Crary, and Albera/Tortajada in the process. It then argues that there is a fundamental link between machines, images, and movement within the history of culture. It analyses the apparatuses invented by Filippo Brunelleschi during the Renaissance, before exploring the depiction of machines from the Renaissance to industrial drawing. Given these relations, this chapter argues that machines should be considered as archives, materializing the history of performance gestures, and of the system they have been a part of. A detailed analysis of the camera obscura and its historical variants, connecting the histories of art, of spectacles and of science, exemplifies the approach.

Keywords: Machine, technology, dispositif, Gilbert Simondon, camera obscura, media epistemology

Today's proliferation of media, their base and equipment, has given urgency to the need to theorize the issues they raise and, consequently, have brought about the return to film theory and to media theory more generally of a vocabulary borrowed from a description of what Gilbert Simondon called ‘technical objects’: devices; instruments; machines; technologies; techniques; dispositifs. Because of the structural importance of these terms to the approach taken in this volume, it is important that we establish distinctions between them.


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A Few Definitions

Technique/Technology

Historically, ‘technology’ is a term initially used to describe a field of study that began in English- and German-speaking milieux, first by Christian Wolff in 1728 in his *Preliminary Discourse on Philosophy in General*, in which he invented the concept in its modern sense. His work had no concrete consequences, but was adopted more successfully as a simultaneously theoretical and pedagogical project by Johann Beckmann in 1772 and then in 1776 in the latter’s *Anleitung zur Technologie*. Traces of it can be found in English in Jacob Bigelow’s *Elements of Technology* of 1829. The goal of *technology* was to describe, classify, and analyse the technical operations of the mechanical arts, or ‘the science of the arts and of the works of art,’ in the words of Christian Wolff.

The discipline itself was rarely the subject of study: it was only at a seminar led by Georges Canguilhem at the Institut d’histoire des sciences from 1963 to 1965 that a systematic history of the ‘beginnings of technology’ was carried out. By this was meant ‘the establishment of the discourse on technical operations as a scientific discourse.’ The authors of the published version of this collective endeavour, Jacques Guillerme and Jan Sebestik, nevertheless stated from the outset that this ‘history of méta-technie implies a history of technie itself.’

Today, English, and other languages in its wake, tends to ignore this distinction, describing technology not as connected to a discourse on technical matters, to the ‘logos’ – a meaning described as ‘now archaic’ in a recent essay by Leo Marx in the journal *Technology and Culture* – but rather as ‘the range of technical activities founded on the application of the sciences to industrial procedures,’ in Guillerme and Sebestik’s summary, or as ‘the mechanical arts collectively,’ in the words of Leo Marx in the

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2 Johann Beckmann, *Anleitung zur Technologie oder zur Kenntnìß der Handwerke*.
3 Christian Wolff, *Preliminary Discourse on Philosophy in General*, § 71, p. 38. Wolff adds that technology should ‘give the reason for the rules of art and of the works produced by art,’ ibid.
5 Ibid.
6 Leo Marx, ‘Technology: The Emergence of a Hazardous Concept’, 562. This article takes account of no non-English-language contribution in its discussion, particularly that of Jacques Guillerme and Jan Sebestik, which is much more complete, although much older.
7 Jacques Guillerme and Jan Sebestik, ‘Les Commencements de la technologie’, 42.
8 Leo Marx, ‘Technology’, 562. Eric Schatzberg, in *Technik Comes to America: Changing Meanings of Technology before 1930*, describes ‘the current characterization of technology as the
essay referenced above. To return to the field of film studies, in an article entitled ‘Toward a Theory of the History of Representational Technologies’, published in the journal *Iris* in 1984, Rick Altman noted the need to maintain the distinction, often done away with (particularly, in Altman’s view, by Jean-Louis Comolli), between ‘technique’ and ‘technology’. He does not really define these terms in his text, appearing to take their meaning as self-evident, but it seems that ‘technologies’ for him refers to machines as a whole and ‘techniques’ as the range of procedures adopted by those who operate them. He remarks:

Just as technology often automatizes an accepted technique, so new techniques often appear in reaction to – indeed in compensation for – the introduction of the technologies [...]. The important thing to remember is that a dialectical understanding of history is destroyed from the start by any theory which reduces to one those practices that interact as two.9

Yet, if the history of techniques truly distinguishes procedures from objects, it remains the case that it views their history as shared, seeing them as impossible to disentangle: the history of the methods of “workers” in flesh and blood – or rather made of wood and metal: men, or machines,’ as Lucien Febvre wrote.10 It is possible, on the other hand, that Altman’s remarks still hold true in seeing a dialectic between techniques and technologies as practices and discourses on practices. Adopting one meaning or the other of the word ‘technology’ thus alters the questions raised considerably, because a ‘technological innovation’, in the sense of Beckmann or Canguilhem, describes a transformation in the field of *discourses* on techniques, and thus appertains automatically and immediately to theory or historiography. On the other hand, technical evolution in the proper sense of the adjective has a particular status and, because of its essentially non-verbal nature, poses specific methodological problems.

In France, André Leroi-Gourhan is a fundamental figure in the renewal of the interest in technology and of the methods and issues associated with it. In 1936, he published one of his first major texts, ‘L’Homme et la nature: Essai de Technologie comparée’,11 in volume seven of the *Encyclopédie française*...
edited by Lucien Febvre. There, he proposed the new method ‘comparative technology’, or the study of the tools and modes of making in different cultures. It is from within this context, at the heart of this conception of technology, that Georges Friedmann has posed the problems of a sociology of labour. Because ‘all labour depends on technical conditions,’ Friedmann argued in a 1961 article in *Les Annales* that ‘the study of the instruments and devices which make up the workstation is technology. The sociology of labour thus has necessary connections with it.’ He added that ‘the goal of technology is to study, in tandem, the instrument and the way it is used. Technology is thus, or should be, seen in the fullness of its vocation, as a social science.’

At no time can technology distinguish technical objects from their users’ procedures, for while the objects determine the users’ gestures, their practices have also structured the tools – in their form, but also, perhaps, in the internal logic of the way they function. I will thus adhere to this definition of technology as the study of techniques, with the latter covering both machines and procedures.

**Machines/Dispositifs**

In his 1968-1969 course on ‘the invention and development of techniques’, Gilbert Simondon returned to the problem of technological classification. He proposed to distinguish, firstly, between the *tool* and the *instrument*, in that the ‘instrument equips the sensorial system, it serves to provide information, while the tool serves to carry out an action.’ The tool extends the effecting organs the way the instrument extends the sensory organs. The distinction was, however, rendered more complex: ‘the contrast between the tool and the instrument is neither absolute nor radical in its elementary forms: a rod can be used to strike or to dig, but also to prod, to sound or to explore.’ We can thus imagine a tool as an instrument, even if ‘through their improvement tools and instruments separate out into pure captors and pure effectors. One cannot employ a microscope as a tool without damaging it.’ The tool/instrument distinction is only partially inscribed in the structure of objects; it is determined in part by their use, which can suddenly decide on a change of category.

At a higher level of complexity are found *utensils* and *devices*, which form a ‘third kind of dispositif’ [...] capable of functioning alone, independently

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14 Ibid., 89.
of the human organism." Utensils and devices are no longer extensions of the operator, but are characterized by the autonomy of their energy. Under Simondon’s classification, they constitute the central point of the technical object, which carries out the mediation of energy and sometimes of information. Here, the machine is defined as the way these three poles are arranged in relation to each other:

The perfect machine can be seen as the result of a triadic joining of an instrument (the information or programme source), a tool (the effector which produces labour) and finally a utensil or device, producing or capturing energy. This energy is modulated by the entry of information (instrument) directing its use in the effector’s tool, which comes out of the machine.

Simondon’s classification system is situated within the narrow framework of the analysis of technical objects. It could be completed and perhaps contradicted by other classifications: there were, for example, many attempts at a taxonomy of machines throughout the nineteenth century in particular. One of these typologies is interesting: that proposed by Jacques Lafitte in his Réflexions sur la science des machines in 1932. Lafitte distinguishes three kinds of machines according to the degree of complexity, not strictly of their internal organization, but rather of their relations with their milieu: reflex machines; active machines; and passive machines. The difference between the two initial and more complex categories has to do with the ability of reflex machines to ‘modify [their] operation according to variations they perceive in their relations with their milieu.’ Passive machines, for their part, are fixed and immobile: ‘properly speaking, they do not operate.’ Poles, beams, buoys, rafts, ‘like most architectural constructions as well,’ are passive machines. For Lafitte they truly are, however, machines.

This idea is interesting for several reasons. Firstly, it makes it possible to think of an object as simple as a pole according to technical criteria – height versus circumference, rigidity, solidity, play, etc. – and a particular idea of how it operates. In addition, from a theoretical perspective, it makes it possible to separate the idea of a machine from that of a technical object

15 Ibid., 94.
16 Ibid., 95.
17 Jacques Lafitte, Réflexions sur la science des machines, 69.
18 Ibid., 70.
19 Ibid.
made up of mechanisms in the strict sense of the term. An object can be
devoid of mechanisms (gears, valves, cams, levers, etc.) and may even be
completely simple, and yet still be a machine in that it is conceived in terms
of its operation, functions, reactions, and systems of interaction between
incoming information and outgoing action.

It is well known that Michel Foucault, in *Discipline and Punish*, considered
Jeremy Bentham’s Panopticon an exemplary dispositif. This specific archi-
tectural construction, which could serve as a prison, but also as a hospital
or a school, was based on the contraposition between a central tower, from
which one can see without being seen, and a peripheral ring building made
up of cells without communication between them but completely and
totally visible from the tower. This ‘architectural figure’ was a ‘dispositif’
that enabled Foucault to construct this concept and the methodology of
his analysis: a ‘concerted distribution of bodies, surfaces, lights, gazes’ that
‘automatizes and disindividualizes power.’ But, for Foucault, the Panopticon
was also a ‘machine’:

The Panopticon is a machine for disassociating the see/being seen dyad
[...]. [It is] an arrangement whose internal mechanisms produce the
relation in which individuals are caught up [...]. There is a machinery
that assures dissymmetry, disequilibrium, difference [...]. Any individual,
taken almost at random, can operate the machine [...]. The Panopticon
is a marvellous machine which, whatever use one may wish to put it
to, produces homogeneous effects of power. A real subjection is born
mechanically from a fictitious relation. 21

The Panopticon is a dispositif because it is a machine: it functions, it manu-
factures, it mechanically links causes and effects. The fact that it may be
architectural and fixed, that its material may be individuals or desires,
does not change the fact that a dispositif is, all the same, a set-up made out
of mechanisms and that it produces. A dispositif is thus a machine in that
it is transformed by an intention.

In several important articles, François Albera and Maria Tortajada, basing
themselves in part on Foucault, have developed an application of the concept
‘dispositif’ more specifically aimed at cinema and media. 22 Here, they revisit

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21 Ibid., 201-202.
22 François Albera and Maria Tortajada, ‘L’Épistémè “1900”’, 45-62; ‘Prolégomènes à une critique
des “Télé-dispositifs”’, 35-56; and ‘The Dispositive Does Not Exist!’, 21-44.
definitions of the concept: ‘The most common definition refers to “the way in which the organs of a device are placed” (circa 1860), soon supplemented by another meaning, that of sets of mechanical elements combined with a view to an effect, a result (Littré, 1874)’.23

Thus, a principle of placement and the ‘the pursuit of an effect’24 give the term dispositif a specific meaning in the technical vocabulary. Albera and Tortajada then distinguish several ‘technical levels’ of the dispositif in the sense in which they understand the term:

1. the dispositifs internal to the machine, a number of mechanisms operating with their own coherence; and 2. the machine itself, or the device, as an assembly of various clusters of mechanisms, of different internal dispositifs. [3. the external dispositif] the new disposition in which the device or the machine as dispositifs find their place, a disposition determined by a finality and a practice, and in which users, like the machines, are themselves elements.25

In connection with these definitions – those given here do not pretend to be exhaustive: Albera and Tortajada identify five levels, five definitions – the authors propose a programme of an ‘epistemology of dispositifs’, itself enacted on three levels of approach and ‘three types of notions calling for explanation’: the ‘concrete elements of the dispositif’ and the concepts immediately associated with them (in the case of cinema, the ‘film frame’, ‘the film’s advancement through the camera’, ‘projection’, etc.); the abstract notions associated with the dispositif or with the concrete elements constituting it (‘series’, ‘synthesis of movement’, etc.); and ‘key notions or type-notions’ (‘authenticity’ in the case of cinema for example).26

The concept machine privileged by the present volume has a clear connection with this concept dispositif and the programme of this epistemology. The distinction between a machine and a dispositif is not always clear or easy to establish or maintain. As we have seen, in Simondon, a dispositif can come into play in a context in which he explains what a machine is, and ‘machine’ also describes Foucault’s dispositif. Albera and Tortajada, explaining their elaboration of the dispositif, employ the terms ‘machination’ and ‘machinatio’,
‘an ingenious disposition or mechanism in its original sense [...]. Similarly, the words “machine” and “machiner” (“to arrange”) are used in French about a painting or a narrative composed with a given effect in mind.’

For our purposes in the present volume, I will nevertheless separate machines and dispositifs, the epistemology of machines (about which I will return below) and the epistemology of dispositifs, even though the latter certainly remain the overall framework in which this book is situated. Generally, I will retain the term ‘dispositif’ to describe a technical ensemble conceived according to its intention or within a system in which it interacts directly with a user-operator (a scientific experimenter, a cinematographer-photographer, a viewer, etc.). But here I wish to see media devices as machines before seeing them as dispositifs. It will be a matter of enquiring into their internal organization, their operating logic, how their relation to the operator has been conceived, and how this is enacted given the form of the machine, etc. Interaction with the user is not ruled out of this volume’s field of research, which would be absurd, but this interaction is primarily approached on the technical, mechanical, and concrete levels before being examined on the level of the expected result (of the entertainment in question) and the cultural and other issues around it. A machine is always a dispositif, but examining it as a machine makes it possible to isolate its singular properties apart from the field of spectatorship as it is culturally constructed and theoretically institutionalized – even though these properties are certainly not unaffected by the underlying spectatorial experience.

To view the Panopticon as a machine is to enquire, for example, into the precise concrete conditions of its operation: the exact shape of its windows; the thickness of the walls; the distance from the central tower to the peripheral ring; the manner of lighting (beginning in 1800 and then as these techniques evolved); how the necessary bodily movements were managed (in addition, for example, to those associated with hygiene) in this necessarily static layout; how listening was organized in this dispositif conceived of visually; the shape of the furniture in the cells to as not to create ‘blind spots’, etc. To write the history of the Panopticon as a machine would be to contrast Bentham’s project or idea with his practical achievements, to contrast the original plan to the real plans of institutions based on the principle, to study their construction and evolution – to no longer see variations as insignificant deviations from a fundamental principle but as a technical line of machines each with its own organization and coherence, conceived according to precise goals and a precise envisioning

of these goals and the means to achieve them, which, in return, can have epistemological implications with respect to the dispositif as it was caught up concretely in systems of ideas determined historically (meaning socially, politically, economically, and technically).

In a manner clearly similar to that of Foucault, Jonathan Crary has described the camera obscura as a ‘dispositif’. Emphasizing the fundamental multiplicity of the uses of this device, and remarking that ‘the camera obscura underwent continual modification’28 during the period he discusses (the seventeenth and eighteenth centuries), his principal focus is its role as epistemological model, as ‘the compulsory site from which vision can be conceived or represented’. From this perspective, in his view,

Above all it indicates the appearance of a new model of subjectivity, the hegemony of a new subject-effect. First of all, the camera obscura performs an operation of individuating; that is, it necessarily defines an observer as isolated, enclosed, and autonomous within its dark confines.29

But the camera obscura in the period he examines was, by then, only rarely a ‘dark chamber’: for many, it had become portable and (relatively) miniaturized boxes instead of chambers no longer concretely isolating the observer within dark confines. Can our conclusions thus still be the same? Must we think that the abstract principle of the camera obscura extends beyond its concrete technical incarnations, that this evolution of the camera obscura machine could have no epistemological implications, even if it brought about major ruptures at one and the same time in the forms, uses, and costs of the devices, along with the kinds of images they produce, the social classes with access to it, etc.?

The objects and projects discussed in the present volume will thus be examined in the first place as machines, as historically elaborated and concrete material fixtures. The concept of the machine will not be taken as describing a particular category of technical object, but rather as describing technical objects apprehended in a certain manner. To view a technical object as a machine is to see it in terms of its operation, form, and internal organization, involving in its singular logic not only a general abstract principle, but also every concrete detail that ensures its cohesion, properties (technical, economic, aesthetic), and singularity.

29 Ibid., 38-39.
To speak of machines is also to be a part of a long line of technological and theoretical thought and to think about dispositifs within a certain history of techniques and ideas.

Machines, Images, Movement

The Machines of Filippo Brunelleschi

In an article from 1953 entitled ‘Techniques et arts’, the art historian Pierre Francastel revisited that crucial moment, commented on and examined many times over: the Renaissance. He revisited it to emphasize one point in particular: the importance for the Quattrocento of a few ‘discoveries of a technical nature which seem to me to be major and which may be little known. We often seem in particular to forget the quite exceptional role played by Brunelleschi.’ For Francastel, Filippo Brunelleschi’s importance should not be gauged by his work as an architect and designer of some of the most beautiful buildings of his day, but rather as an inventor. As the inventor of a new architectural technique for the copula of the Santa Maria del Flore cathedral in Florence, which is ‘not simply a larger copula than the others; it is a copula which was made differently from every copula made until then’:

It is fundamentally different for a precise technical reason: a method, discovered by Brunelleschi, for constructing a copula directly in open space, without support [...]. Here we have a true case of a technical invention which brings with it a considerable series of aesthetic possibilities.

Other feats were connected to this major development, which ‘enables us to say that there truly was at that time a correlation between art and technical novelties.’ Brunelleschi was also a part of the ‘discovery of perspective, about which there is too much to be said, but which was not at all the discovery of a rational means to depict the world as it is on a two-dimensional surface. It was an arbitrary and artificial construction; a montage, a system [...].

31 Ibid., 156.
32 Ibid., 160.
33 Ibid., 159.
This, decidedly, was not negligible. But, Francastel argues, there is more, for ‘through Brunelleschi, a third original invention appeared at the beginning of the Quattrocento’:

I think of Brunelleschi the inventor of machines. Everyone knows that he was initially the inventor of a small optical instrument consisting of a kind of box. It had a panel on which a picture of Florence was painted. One placed one’s eye at the centre of this panel; there was a mirror at the other end, and a mirror below to reflect the sky. When you looked through the little hole, you saw reflected, in all its relief, the picture painted on the panel. This, moreover, was one of the sources of the Renaissance’s so-called realist perspective. But there was something more about Brunelleschi. In particular, a whole project involving the fabrication of machines, something also described in the forgotten texts by Vasari. Nevertheless, they make it possible to establish that the Quattrocento, the Renaissance, constructed a whole series of machines for countless spectacles of public life. All this activity prepared the evolution of theatre [...]. It enabled humankind to visualise, in a moving, living and changing manner, a whole series of myths and legends taken either from tradition or from the imagination of people of the day.34

This passage mixes several elements in a rather complex manner. In it, Francastel classifies as a ‘machine’ – and foremost among them – this dispositif invented by the Florentine architect Brunelleschi, which was recognized at the time as a real-life demonstration of linear perspective. Thus, of all the machines of which Brunelleschi was effectively the inventor – winches, cranes, etc. – Francastel chose as an example what he views as the prototype of the ‘optical box’ – boxes that truly began to circulate only in the mid-seventeenth century – which he associates with other kinds of more theatrical machinery within a vast ensemble he calls ‘spectacles of public life’. These machines are thereby immediately tied to ‘moving’, ‘living’, and ‘changing’ visualization – three adjectives were indeed necessary.

Yet, Brunelleschi’s ‘machine’, the ‘founding myth’ of perspective, albeit one never mentioned in histories of so-called pre-cinema, was not a box but a set of two moving panels (Illus. 1). One was painted and had a hole in it, the other was a hand mirror. On the painted panel was depicted,
more precisely than a picture of Florence, a perspectival image of the San Giovanni baptistery, seen from a point a few metres from the entrance to the Santa Maria del Flore cathedral. If a kindly viewer were to take up position at this spot and place his or her eye behind the hole in the panel, they could observe, by lifting and lowering the mirror at arm’s length, the perfect match between the image of the baptistery directly before them and its perspectival depiction. Here, Brunelleschi invented not only the foundational experience of perspective, but the first viewing dispositif in the modern sense: apart from the painting itself, the dispositif can only achieve the desired effect – the demonstration of the procedure – if the viewer agrees to be an integral part of it, looking with a single eye at one panel through the other by means of a mirror and positioned exactly in the sole spot in the world where this functions.

Brunelleschi’s invention was thus crucially not a box, in particular because its goal was not to present an optical view: in order to demonstrate the accuracy of the construction, it had to compare natural and artificial perspective, and thus lower and raise its mirror. This is everything. This extraordinary dispositif inscribed movement in its very form; it cannot be a mere box, it is already a machine. In fact, movement is inscribed in it in a second manner: the part of the painted panel corresponding to the sky was not drawn by Brunelleschi, but rather covered with burnished silver,
so that the scene’s real sky, the movement of the clouds and the flight of birds, would be reflected there.\textsuperscript{35}

By situating Brunelleschi’s perspectival \textit{dispositif} in the ensemble of his machines rather than in relation with his ‘discovery of perspective’, Francastel is able to carry out a profound historiographical deconstruction/reconstruction. Firstly, this confirms, of course, the connection, he argues, exists between technique and art, between mechanical invention and aesthetic renewal in this pivotal Quattrocento period,\textsuperscript{36} echoing the connection he proposes exists in the contemporary era in his book \textit{Art and Technology in the Nineteenth and Twentieth Centuries}.\textsuperscript{37} But this also produces a connection, placing in this precise moment in the history of painting that of ‘countless spectacles of public life’, a concept applicable both to the theatre and to optical boxes, and all those machines whose point in common is moving, living, changing visualization. This was certainly the intellectual framework that led Francastel to assert in an article in the \textit{Revue de filmologie} in 1949 entitled ‘Espace et illusion’ that ‘it appears that the connection between cinema’s origins and the “arts of illusion” – which flourished to such an extent in the eighteenth century – has not until now been explored sufficiently.’\textsuperscript{38}

This shift towards the machine thus leads to a transformation of the connection to the image, to performed entertainment, to movement, and to the role of these in a cultural history that resituates cinema as a machine, a \textit{dispositif}, and mode of representation in a longer historical arc.

\textsuperscript{35} Curiously, Francastel’s description is erroneous, because he places the mirror part of the panel ‘below to reflect the sky’, as if the mirror’s right-left inversion also involved an up-down inversion. It is as if, in fact, the image was not observed through a hole and with a mirror but rather through a photographic (or cinematographic) lens carrying out this dual inversion. The first description of this \textit{dispositif} was written by Manetti (\textit{Vita di Filippo di ser Brunellesco}, around 1480). It was later widely commented upon, in particular of course by Hubert Damisch in \textit{L’Origine de la perspective} (Paris: Flammarion, 1987).

\textsuperscript{36} On the connection between the invention of perspective and Brunelleschi’s professional practice, see Giulio Carlo Argan’s fine essay ‘The Architecture of Brunelleschi and the Origins of Perspective Theory in the Fifteenth Century’: ‘it is thus impossible to distinguish Brunelleschi’s researches on perspective from his artistic activity, that is to say, from his architecture’ (p. 103). This essay is also quoted by Francastel in ‘Espace et illusion’, 74.

\textsuperscript{37} Pierre Francastel, \textit{Art and Technology in the Nineteenth and Twentieth Centuries}.

\textsuperscript{38} Pierre Francastel, ‘Espace et illusion’, 74. François Albera notes that Francastel worked with Louis Dimier on a study of these ‘arts of illusion’, for which he ‘took notes under the title “La perspective des peintres et les amusements d’optique”’. See Albera, ‘Pierre Francastel, le cinéma et la filmologie’, 312. On the arts of illusion and their connection to cinema and contemporary art, see Laurent Mannoni, Werner Nehes and Marina Warner, \textit{Eyes, Lies and Illusions: The Art of Deception}. 
Machines and Movement, Machines and Images

It appears, however, that there is a fairly strong connection between machines, images, and movement. The Viennese philosopher Ludwig Wittgenstein’s *Philosophical Investigations*, published posthumously in 1953, is not exactly a book of technology. And yet, Wittgenstein, from his exile in England, took up the question of what is, philosophically, a machine:

The machine as symbolizing its action: the action of a machine – I might say at first – seems to be there in it from the start. What does that mean? – If we know the machine, everything else, that is its movement, seems to be already completely determined […].

We use a machine, or the drawing of a machine, to symbolise a particular action of the machine. For instance, we give someone such a drawing and assume that he will derive the movement of the parts from it. (Just as we can give someone a number by telling him that it is the twenty-fifth in the series 1, 4, 9, 16 . . . ).

Within a wide-ranging research framework focused on language and its uses, this section of Wittgenstein’s book sets up a fundamental contrast between the machine ‘as symbol’ – the idea of the machine, or its image – and the ‘real machine’, which can function poorly, wear out, etc. Here, the machine appears to call up the image and movement; even to be defined as each. The machine both symbolizes and involves its ‘particular action’, and in principal is reduced to the entire determination of a series of movements constituting its action. To know a machine is precisely to know all of its movements. But knowing a machine means to become aware that all of its movements are already completely in the unique moment presented to us by the machine under observation itself or, especially, by its image – which appears here not to be an image in the traditional pictorial or photographic sense, but in the sense of a plan, a diagram, an explanatory drawing. An image of the mechanism of the machine. This image makes possible knowledge of the machine, knowledge that is concretely embodied in the ability to foresee all future movements – with the exception of the possible unexpected movements of the real machine. The actual machine contains all its future forms, just as the machine and its image appear to contain one another, to read Wittgenstein’s prolonged hesitation between these two terms. The definition of the machine thus shifts entirely to the cinematic paradigm:

'We might say that a machine, or the picture of it, is the first of a series of pictures which we have learnt to derive from this one'.40 For Wittgenstein the machine is a ‘cinematographical mechanism of knowledge’ in a completely different sense than it was seen as such by Henri Bergson: for the mind, it is an image that produces, through the activity of its viewer’s intellect, a series of images that develop potentially by means of deduction, beginning with the first. Here, the series of movements becomes a series of images.

The connections between machine, image, and movement are profound and intriguing, and crucial to Western culture. In 1968, Pontus Hultén organized an exhibition at the Museum of Modern Art in New York entitled ‘The Machine: As Seen at the End of the Mechanical Age’.41 The exhibition mixed machines and images of machines, from Leonardo da Vinci’s drawings of flying machines to electronic works by Nam June Paik. The Lumière Cinématographe had a place in a series that also included, for example, Vaucanson and Jaquet-Droz’s automata, paintings by Max Ernst and Francis Picabia, Marcel Duchamp’s devices, Neuville’s illustrations for Jules Verne’s novels, and, of course, Calder’s mobiles and Tinguely’s ‘meta-machines’, which were one of the centrepieces of the exhibition. Here, cinema was no longer a part of the ‘arts of illusion’ as a whole, but rather of another history of considerable importance, that of machines and their depiction – as images or as spectacle.

The recent historiography of technique has shown the complexity and fertility of this history of the connections between machines and representation. In fact, the Renaissance was not only the moment when linear perspective was invented; it was also the moment of an upheaval in the techniques of architectural plans and engineering drawings, an upheaval that corresponded with a series of transformations of their functions.

Machines call for drawings for a variety of reasons: it must be possible to depict the construction project for the client, to establish an efficient means of communication between engineers and craftspeople or workers, to record ideas for later reworking, etc.42 Verbal description is inadequate and ineffective; only the image – accompanied by verbal and quantified data (dimensions, etc.) – can produce knowledge of the machine making possible its construction and comprehension of it. Thus, the patent system joins, for each invention, an analytical description and explanatory diagrams.

40 Ibid.
41 K.G. Pontus Hultén, The Machine: As Seen at the End of the Mechanical Age.
But the machine calls for a particular kind of depiction. In ‘The Emergence of Combined Orthographic Projections’, Wolfgang Lefèvre has shown how the representation system commonly used in architectural and industrial drawings developed: by presenting an object in the form of two or three combined orthogonal projections – in perpendicular plans, one plan at ground level and two elevations. This made it possible to provide a range of information necessary to understanding the building or the machine. But this system did not suddenly appear, and Lefèvre shows the crucial role played in its emergence by Dürer in particular (Illus. 2). Dürer transferred this technique to architecture and then to painting, based, according to Lefèvre, on the practices of stone carvers.\(^{43}\) In addition, Lefèvre argues, the seemingly much greater technical simplicity of orthogonal projection compared to linear perspective suggests that the former predates the latter, which, in fact, appears not to be the case.\(^{44}\) Although perspective is more complex to construct geometrically, it appears to be older, undoubtedly because it is easier to grasp epistemologically. The principle of what today is known as orthogonal ‘projection’ was not known at the time, and the mathematization of space produced by perspective may have been a crucial epistemological prerequisite for a theoretical and practical comprehensive understanding of the issues around this ‘projection’ – this term, moreover, is anachronistic.\(^{45}\)

Architects and engineers before the early sixteenth century, therefore, did not have absolutely precise means for representing their projects. But Lefèvre shows how these systems were only necessary for certain contemporary practices, in particular for a certain way of organizing professions and a certain connection to issues of tradition and innovation:

As a rule, the architectural features of the planned building were not fixed in all their aspects and details in advance. Commissioner and architect confined themselves to appoint only main features when contracting. Above all two reasons seem to be responsible for this practice. First was the custom of postponing decisions on certain questions to a time when they could be made in light of the growing building. Second, and probably more important, was the fact that many features needed no explicit agreement because they were obvious within the given tradition of construction.\(^{46}\)

\(^{43}\) Wolfgang Lefèvre, ‘The Emergence of Combined Orthographic Projections’, 238.

\(^{44}\) Ibid., in particular p. 235.

\(^{45}\) For a sketch of the history of uses of the term ‘projection’, see Michel Frizot, ‘Un dessein projectif: la photographie’.

\(^{46}\) Wolfgang Lefèvre, ‘The Emergence of Combined Orthographic Projections’, 221.
It was thus within an ‘improvisatorial building practice’\textsuperscript{47} that architectural drawing techniques took on meaning until the fifteenth century. Today, the division of labour and the role of innovation in the organization of professional practices require – and produce – other techniques.

The complexity and fertility of the connection between machines and images is tied up with the other element discussed by Wittgenstein: the connection between machines and movement. To depict machines is basically to have to depict an action, a movement, and to depict it in such a way that beyond the form of the machine strictly speaking \textit{the form of its movement} is also made clear. Knowledge of machines is not distinct from knowledge of movement. What came to be the science of machines, the \textit{kinematic}, was one of the branches of knowledge born with the nineteenth century. The concept of the ‘kinematic’, formulated in particular out of Gaspard Monge’s lectures at the École Polytechnique in the very earliest

\textsuperscript{47} Ibid., 222.
years of the institution at the turn of the century, and then formalized by Ampère in his *Essai sur la philosophie des sciences* in 1834, was a means for the systematic study of machines, and in particular for classifying their fundamental elements: mechanisms. The kinematic would develop throughout the century at engineering schools, giving rise to several important volumes authored by Charles Laboulaye and Franz Reuleaux. At the beginning of his 1885 course at the Faculté des Sciences in Paris, Henri Poincaré provided the following fine definition: ‘the kinematic is the study of movements independently of the things which caused them, or more exactly the study the study of all possible movements.’ These remarks display a thrilling ambiguity: the science of machines is, precisely, the science of movement.

It was not by chance, moreover, that one of Monge’s most important scientific contributions was the theorization of descriptive geometry, defined here by Charles Dupin: ‘The first goal of this science is to depict, on two-dimensional drawing sheets, every three-dimensional body in nature. The second goal is to deduce from such a depiction all the mathematical relations resulting from the form and position of these bodies’. This science, whose usefulness for military and civil engineering Dupin was already emphasizing, has been the basis for methods of depicting machines since that time. Descriptive geometry, based on orthogonal projection, produces a conventional visual depiction focused on the object rather than on space and respecting the ratio of magnitudes. It makes it possible to recognize immediately the object depicted on the basis of the drawing’s visual resemblance, but does not involve a perceptual ‘realism’ of the same kind as traditional linear perspective.

Thus, machines and buildings call for the image – they call for an always multiple and plural image, for series of images or combined projections. In return, these images demonstrate not only the internal organization or the


51 Charles Dupin, *Essai historique sur les services et les travaux scientifiques de Gaspard Monge*, 96.

52 Ibid. See in particular the chapter ‘Géométrie appliquée à la mécanique’, 142-144.
configuration of machines, they also demonstrate, directly or indirectly, in their very form, in the representational techniques employed, the range of contemporary practices that produced them and through which they take on meaning. With them, they become a system. A ‘network of adherences’ holds together all these elements, technical and visual, gestural and mechanical. Machines call for images, but these are singular images with a singular connection to their subject: a subject whose fundamental quality is, precisely, a certain kind of movement.

The Machine and the Non-Verbal

There is, therefore, an obligatory passage through the image which, even if we were not to push the equivalency of the image and the machine to the same indeterminacy as Wittgenstein, constitutes one of technology’s strong methodological specificities. Already between the late sixteenth and late eighteenth centuries ‘machine theatres’ were folio printed books made up of a series of full-page figures, often very handsomely printed, accompanied by a caption and a brief commentary. Each plate, engraved on wood or copper, depicted a machine or an instrument in perspective in a landscape, a workshop or an abstract space. There the author depicted ‘various greatly necessary secrets to every Republic, as useful as they are delightful’ of which he declared himself to be the inventor.53

The first and perhaps most famous of these theatres, the Théâtre des instrumens mathematiques et mechaniques de Jaques Besson, Dauphinois, docte Mathematicien: Avec l’interprétation des Figures d’icelui, par François Beroald, which went through several editions between 1578 and 1602,54 showed 60 figures on odd-numbered pages. For each, on the verso, was a ‘proposition by the author’ setting out the function of the machine and its novelty, along with a ‘declaration of the figure’ that sketched an analytical description (Illus. 3). The figures were not plans or diagrams but perspectival engravings showing the machine alone or with its users. The perspective was sometimes altered by somewhat odd foreshortenings, because the clarity of the machine’s operation had to take precedence, although this was an entirely relative clarity.

54 For details on the editions, see ibid., 35-36.
Subsequently, technological volumes continued systematically to be illustrated. The French edition of Franz Reuleaux's *Kinematics of Machinery*, one of the most important books of this kind in the nineteenth century, was published ‘with 459 engravings in the text’ and was, in addition, accompanied by a detachable and foldable ‘atlas’ made up of eight large plates.\(^55\) This time, however, the engravings and plates were geometrical diagrams or depictions of mechanisms drawn strictly to scale in orthogonal projection. Henry T. Brown’s volume *Five Hundred and Seven Mechanical Movements*,\(^56\) published in the United States in 1868, had a layout close to that of the volume by Besson: plates of diagrams on the left-hand page and commentary about them on the right.

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55 This ‘atlas’ appears not to have formed part of the English edition published a year earlier. See Franz Reuleaux, *The Kinematics of Machinery: Outlines of a Theory of Machines*, and Cinématique: Principes fondamentaux d’une théorie générale des machines.

56 Henry T. Brown, *Five Hundred and Seven Mechanical Movements*. Various modern-day reprints of this volume exist.
Similarly, André Leroi-Gourhan’s foundational article on ‘comparative technology’ illustrated the method in three plates containing 75 drawings by the author (Illus. 4).\textsuperscript{57} And Louis Lumière’s letters on strictly mechanical problems, in particular those letters to the engineer-inventor Jules Carpentier, in charge of the industrial production of the Cinématographe – and (thus) in charge of its fine-tuning – are the only published Lumière letters to be accompanied by sketches and diagrams, explaining the problems to be solved.\textsuperscript{58}

The machine’s affinity with the image – along with that of technique – thus takes concrete, material shape in the seeming impossibility of explaining a machine without at a certain moment depicting it. This aspect is one of the important specificities of technology as a discipline and of the history of technique: they are massively confronted with the ‘non-verbal’. In fact, in 1963, Francastel described the need for ‘awareness of the existence of visual thinking irreducible to any other kind,’ something he described as ‘one of humankind’s major systems of thought in history’: ‘This thinking has the singular quality, among many others, of using a non-verbal medium or base. In this sense it is, with verbal thinking and mathematical thinking, one of the three forces of the human mind’.\textsuperscript{59}

This distinction is crucial for Francastel, for this is what justifies the sociology of art project: ‘Today, works of art provide us with the largest ensemble of still-unused documents on life today and in past societies. One of the goals of the present generation should be the incorporation of non-written sources into the history of civilizations’\textsuperscript{60}

The problems this incorporation poses are, primarily, methodological, and then, inseparably, theoretical and epistemological: ‘There is no doubt […] that we cannot align the methods and values arising out of this thinking with the methods and values which a society’s other major modes of expression display, in particular verbal thinking and mathematical thinking’\textsuperscript{61}

The analysis and history of machines and of technique in general pose similar problems, precisely because they are largely a part, if not of ‘visual thinking’ then in any event of ‘non-verbal’ thinking.

As we will see later on in the concrete cases I will examine, the way techniques are constituted and evolve eludes complete and conscious

\textsuperscript{57} André Leroi-Gourhan, ‘L’Homme et la nature’ 7, no. 10, 8, 7 and 15, and 7, no. 12, 2.
\textsuperscript{58} See Auguste and Louis Lumière, \textit{Letters}, 55ff.
\textsuperscript{60} Ibid., 93.
\textsuperscript{61} Ibid.
Illustration 4 – Technical instruments compared. Drawings by André Leroi-Gourhan, 'L’Homme et la nature'.
verbal formalization. Ways of doing are learned and transmitted through explanation, but also by example and imitation. The potter or woodworker’s ‘artistry’, which gives the material its ‘correct form’, can be depicted but can be described only with difficulty. It is even more difficult to justify it by means of rational and completely coherent arguments. When Marcel Mauss defined a technique as an ‘effective traditional act’, he was referring to the fundamentally historical and collective nature of technique. But tradition evokes a way of being a part of an oral or gestural and non-written history, one that can be pictured but not theorized. Similarly, machines can be described or explained – in their patent for example – but these descriptions are never complete and could not ever be so, because some elements of a machine will elude such description. These elements are not necessarily the most complex: those are the heart of the matter, the central point of the patent. Rather, it is the most obvious things, the things which at a certain moment in history go without saying for the inventor, the reader, the user. For example, the architectural features that ‘did not need to be explicitly discussed because they were obvious within a given construction tradition,’ in Lefèvre’s description. These features were not verbalized in contracts or elsewhere because the parties saw no interest in doing so. Doing so would prolong texts and discussions indefinitely and needlessly. Above all, the parties were no longer even aware of these features’ existence. They were the local ‘paradigm’, in the words of Thomas Kuhn; they could only be reconstructed through an intermediary step of reconsidering the objects themselves, and the images of these objects. It is a matter, in Francastel’s words, of ‘striving to recreate, through ensembles of works, the characteristic figurative systems of a given milieu and era, thanks to which it becomes possible for us to complete or rectify our general interpretation of a given period of history.’

These non-verbal aspects are valuable precisely because they engage and operate under the aegis of epistemological systems on a level situated prior to the verbal and the formulated. They are the means to accede to the parts of these systems that their users themselves are unaware of – in the way, in Walter Benjamin’s description, the photographic machine could give access to something like an ‘optical unconscious’. The Lumière Cinématographe’s intermittent cam was abundantly discussed and described explicitly in numerous texts by the Lumières and their contemporaries, and until recently as well, as a fundamental contribution to their machine. But never did

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Lumière or anyone else in cinema’s written history, theory, or technology before the mid-1990s describe the lenses used, for example. This given of the machine was thus not the subject of any discourse, even though its concrete application was extremely important, a point to which I will return. An analysis of the Cinématographe focused on discourses around it could only perpetuate this overlooking – or suppression – of the camera lens. It is thus up to a technological analysis of the Cinématographe machine to take on the task of studying these two of its organs – the cam, but also the lens – while at the same time taking into account their respective presence and absence in discourse on the machine.

The hypothesis of the specificity of ‘visual thinking’, beginning with its non-verbal structure in particular, is connected to discussions of the possibility of isolating a characteristic form of ‘technical thinking’ 64 distinct from scientific thinking, as well as of the possible function attributed to it. This question was essential, for example, for Georges Canguilhem, whose first two scholarly papers, in 1937 and 1938, took up technique, precisely. His Essai sur quelques problèmes concernant le normal et la pathologique of 1943 announced a turn to the study of medicine, in that it is ‘a technique or art at the intersection of several sciences’; more particularly, it is ‘a technique for establishing or restoring normalcy.’ 65 Canguilhem would be a central figure in raising the question of technique in the scientific field in the post-war period, as Lucien Febvre was before the war.

The first of these two papers, ‘Descartes et la technique’, is an affecting picture of a Descartes of small things, ultimately creating a kind of suggestive self-portrait of the doctor and epistemologist:

One feels an admiring surprise at seeing Descartes take up indiscriminately and with the same conscientious methodical intelligence the most special and the most disparate technical problems: smoking chimneys, elevating waters and draining swamps, medical diagnoses, the use and dosage of medicines, fountains believed to be miraculous, automata, the trajectories of cannon balls, the speed of bullets, the strength of swords, the sonority of church bells. 66

64 This is the title of a volume by Julien Pacotte published in 1931. See La Pensée technique.
65 Georges Canguilhem, Le Normal et le pathologique, 7–8.
Here, the consideration of techniques seems to be less a philosophical decision than a kind of quality of attention and a rejection of the traditional hierarchies of the noble and the insignificant. It represents the idea that not only ‘the size of lenses for optical instruments, the construction of machines and medical art’ – which constitute ‘the most common topics of his thoughts’ – but also ‘the routines of the simple country dweller and the soldier’ engage his thinking. There is a decided interest in technique, and Descartes’ greatness is also to have ‘not disdained “lowering his thinking to the least inventions by mechanics”.’

In his text, Canguilhem describes technique as ‘an action which is always to some degree synthetic and thus impossible to analyse’ – which is ‘not, from a Cartesian point of view itself, to deprive it of all value, because to do so is to see in it a means of creation, however inferior it may be.’ A ‘technical synthesis’ can be creative in various ways, but it is as a synthetic action that it can outpace or ‘shame theory’, which is essentially analytical. This synthesis is that of passing to the act of creation, he would say in 1938 (‘theoretical lucidity can never be an adequate reason for passing to action’), which means that technique can be conceived in the framework of a ‘theory of creation, meaning at bottom an aesthetic.’

This synthesis that is the technical action or object is what makes it elude complete reducibility to the verbal and what constructs its affinity with the image. It is the task of an epistemology of machines to develop methods to make it possible to express this non-verbal part as well as the verbal part and to grant both their role, in Francastel’s words, in a ‘general interpretation of a given period of history’ – within a certain episteme, in the end, confronting this fundamental dimension of technique with the conceptual and paradigmatic meshing of contemporaneous thinking.

The Performance and the Device: Machines-Archives

Techniques and practices thus constitute a specific level where things that elude theory, or even verbal formulation by practitioners themselves, are

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67 Ibid., 492.
68 Ibid., 493.
69 Ibid., 497.
71 Georges Canguilhem, ‘Descartes et la technique’, 497.
72 See the sense given to this Foucauldian concept by François Albera and Maria Tortajada in L’Épistémé "1900".
discovered. Their essentially gestural and traditional nature makes them a fleeting subject that is difficult to apprehend. How to write their history? How to recover the means of reliably describing ways of doing about which we do not, precisely, have written records? In the field of media, how, exactly, can we succeed in reconstructing in a coherent manner the performative practices of a past era – with the dimension performance proving, to be essential in the perceptions of users, viewers, and operators?

In the introduction to his book Canadian Film Technology, 1896–1986, the former head of technical operations and research of the National Film Board of Canada, Gerald G. Graham, provides some autobiographical context:

My father started the family career in show business as a ticket taker in the Dominion Theatre in Ottawa (1910). Shortly thereafter, he was operating the Edison Vitascope projector when film programs were introduced as fillers between stage shows. The projector was located in the open at the front centre of the balcony. The absence of a projection booth was not an oversight on the part of the management, since the projectionist was also required to enforce order among balcony patrons while the lights were out. The projected film was collected in a bushel basket, or simply fell on the floor, and had to be sorted out, cleaned and rewound between shows.73

This brief description provides a number of interesting pieces of information on the kind of performance that could make up a film screening around 1910, at least in this Canadian movie theatre. The procedure described appears quite different from the image we may have of such events: here, as Graham points out, the projectionist was not shut up in a booth but worked in plain view, despite the technical difficulties. The reason was not to exhibit the dispositif in a manner related to some supposed remnant of the ‘novelty period’ of film exhibition, but in order to economize on labour costs: in this way, the operator could also and at the same time keep order. It thus appears that in the early 1910s the projector was not always hidden from public view.

But what importance should we attach to this report? Graham offers a precise description, but he remains an indirect witness (he was born in 1917), writing several decades after the events. In addition, it is difficult to know how widespread the practices of the Dominion Theatre in Ottawa were.

73 Gerald G. Graham, Canadian Film Technology, 1896–1986, 15. It appears that the Dominion Theatre became Bennett’s Theatre and was later torn down.
Performance is, precisely, the most evanescent and elusive dimension of the film medium, the one that, by definition, leaves the fewest traces. What we can know about it comes from the descriptions of participants; in most cases, these descriptions are those of viewers and thus oriented towards what they came to see, i.e. the screening, the films, and the attractions, not the venue or the overall setting. There are no archives of performances as such, of the concrete operating practices and protocols of film projection or of shooting a film.

But performing a media consists of putting into operation a certain technical dispositif, a machine, and how this machine was conceived is not a neutral matter. On the one hand, this conception itself is formed according to the pictured use of the machine, in keeping with contemporary practices. As Gilbert Simondon wrote, ‘What resides in machines is human reality, human gestures fixed and crystallized into working structures’.

Machines, as solid and durable by nature as performance is ephemeral, thus constitute in themselves archives of gestures. They record the memory of uses in objects. This is the perspective of André Leroi-Gourhan’s ‘comparative technology’ project. As he remarked in 1943 in Évolution et techniques, ‘ethnology can, up to a certain point, make predictions about a tool’s handle and its use as a whole from the shape of its blade.’

Tools, therefore, trace that which cannot be reconstructed by any other document: the history of techniques is a form of archaeology. But this requires knowledge, which makes possible deductions – from the blade to the handle and then the tool as a whole and finally to its use.

In his 1961 article quoted above, Georges Friedmann emphasized the need for technology for the sociology of labour he had in mind:

The study of instruments and devices which make up the work station is technology [...]. The study of labour cannot do without a profound familiarity with its technical conditions [...]. Labour is inscribed in the structure of the tool and the machine to the point that, in pre-historical or historical periods for which we have no document to explain the practical forms of labour, these forms take shape through the discovery of an instrument or tool.

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Here, machines no longer seem to be a collection of mechanisms, but rather to belong to an ensemble called the ‘work station’. They contribute to structuring the worker’s tasks and to organizing the relations between professions. A Technicolor camera from the early 1940s, built for what was known as Technicolor process 4 (a three-colour process that was practically the sole method for producing colour films in Hollywood until the 1950s), ran three black-and-white film strips simultaneously behind a single lens equipped with a beam splitter and three coloured filters. It thus weighed much more than other cameras, was much bigger, and made more noise. It had to be enclosed in a soundproof blimp, which made it even heavier and more cumbersome: it could no longer be handled by a single person. It required a greater mechanical set-up and, as a result, was usually attached to a dolly in order to move it about. It brought with it a whole range of heavy and complex operating procedures and a mode of production that required a particular kind of economical operation, while organizing the working methods of the camera assistants, camera operators, and technicians.

In a different technical sphere, time marking on the image film stock and on the sound tape, invented by Jean-Pierre Beauviala for his company Aäton, is a procedure that is strictly internal to devices, as it is carried out inside the camera or sound recorder. And yet, its implications for the way film shoots are organized were immediate, as this system was invented in order to dispense with the clapper, which synchronizes the sound and image of every shot. But the effects of the invention were different according to the use to which it was put. In ‘traditional’ fiction, time marking enables the technician in charge to avoid disrupting the actor’s concentration with an ill-timed clack right in front of their face. In documentary film, this system – used for example by Robert Kramer in Route One/USA (1989) – makes it possible to avoid disrupting the activities of the people being filmed, but also to start up the camera and the tape recorder independently of each other. The sound recorder can record without interruption (sound tape is much cheaper than motion picture film) while the camera operator or the film director can decide to stop and restart the camera without losing synchronization.

In these concrete examples, the intertwining of machines and practices and of devices, working methods, professional hierarchies, the economic conditions of production, and even aesthetic projects, is apparent. Machines thus function as archives of practices and gestures, and the history of

78 See Jean-Pierre Beauviala, ‘A Revolutionary New Approach to Time Marking on Film, Sound and Video Tape’.
techniques becomes an archaeology of machines. A movie camera from 1945 or 1915 tells us about the way they were used by cinematographers of the day; a projector from 1903 or 2013 informs us what viewers saw in screening venues in those times.

For, in the case of media dispositifs, machines seem to be archives on a different level: that of modes of perception and systems of representation. In his article ‘The Stereopticon and Cinema’, Charles Musser emphasizes the importance of a number of changes to cinema’s dispositif that appeared simultaneously in the latter half of 1903. The first of these changes was the introduction in the United States of ‘the three-blade shutter on motion picture machines, which sharply reduced the flicker effect and made spectatorship much more pleasurable. Before this moment, the cutting back and forth from slides to film was not only common but desirable.’

From that time on, the screening could thus be made up of only films, without alternating with the projection of magic lantern slides, and films began to get longer and more structured. But we must qualify this claim. First, as early as 1896 a projector such as the Biograph, which used wide-gauge film (69mm) at high speed (about 30 frames per second), had much less flicker than its competitors. Later, the 1910 Kinemacolor Handbook reveals that, at the time, it was still quite common for the operator of a ‘cinema’ (or rather, in the local parlance of the day, a Bioscope), to also acquire a magic lantern when purchasing a movie projector. This attests – once again through machines – to the fact that long after 1903, fixed images continued to alternate with moving pictures. The case of Kinemacolor, however, is unique in several ways, to which I will return below.

In any event, Musser’s hypothesis does not revert to technological determinism, or see as mere technical ‘progress’ the very astute and theoretically exciting idea of reducing flicker when showing moving pictures by adding a blade to the projector’s shutter: to reduce flicker, one needs more rapid flicker. Firstly, we must note that the precise observation of machines from a given period provides us with valuable information on the exact form of the presentation they produced. From there we must construct not a linear history of techniques guided by the notion of progress, but an archaeology of techniques that reconstructs the coherence of each of them, and its cohesion with a certain kind of entertainment, the ‘network of adherences’ that ties it to a certain cultural ensemble. This should also remind us that the

reconstructions of the early moving pictures we have today are effectively only facsimiles, even when they are seen on 35mm in the original aspect ratio and at the original speed. To what extent can we understand these moving pictures, as they were shown and commented on at the time, without seeing them projected as they were projected then – with a particular lens and a particular shutter, lamp, take-up mechanism, screen, power source, etc.? The ‘preservation of projection practices’ Fossati spoke of has not taken place in this case, apart from a few very rare attempts to reconstruct original screening circumstances.  

It has become impossible to relive the real *visual experience* of a Méliès Kinetograph screening or a Robert William Paul Theatrograph screening – to see the coherence between the form of the moving pictures and the technical conditions of their perception. It remains that, in this case and a few others, the preservation of machines makes it *possible in principle* to repeat such an experience, which the machines have archived as a *potentiality*.

**Machines/Systems**

Machines are archives because they are not autonomous entities; instead, they are integral parts of broader formations, which can be defined differently depending on one’s approach. These formations are what André Leroi-Gourhan called a ‘technical milieu’ and Bertrand Gille a ‘technical system’:

> As a rule, all techniques are, to varying degrees, dependent on one another, and there must be a certain coherence among them. This ensemble of coherences at different levels of every structure of every ensemble and of every sector makes up what we could call a technical system.

A technical object thus finds itself caught up in a vast network of interdependencies, which, on the one hand, makes possible its existence and, on the other hand, assigns it a precise function. For a movie camera to exist, there must be manufacturers capable of making it with the precision needed for it to function, at a cost that allows for its commercialization. There must also

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81 In particular at the Conservatoire des techniques of the Cinémathèque française, headed by Laurent Mannoni.
83 Bertrand Gille, ‘Prolégomènes à une histoire des techniques’, 19.
be, in traditional photo-chemical cinema, manufacturers of film stock with a form (width, thickness, size and positioning of the sprocket holes, solidity, etc.) that is compatible with the camera machine. There must be laboratories for treating this film stock and efficient circulation systems to move the film stock between factory, laboratory, and shooting location. One then needs places to show the result. In digital cinema, one needs manipulation software and media on which to store the productions in digital laboratories; here, too, one must organize the circulation of the material. ‘Film’ cameras still exist today and, if well preserved, these machines will be able to be used for quite a long time; but if no one is manufacturing film stock, or if all the photo-chemical laboratories close or simply no longer maintain their developing baths, these cameras will become largely unusable. Their material existence as objects is not in question as such, but industrial transformations bring about a change in the technical system, and in the new system their function as machines is no longer assured.

The technical object is thus tied to systems in two ways, whereby it constitutes an objectification, and thus an archiving, of its historical state. In Simondon’s formulation, on the one hand, ‘the operator’s gestures are also part of the technical reality,’ while, on the other, ‘technical objects are part of technical ensembles.’ Thus, ‘technical objects cannot be considered as absolute realities and as existing by themselves, even after having been constructed. Their technicity can be understood only through the integration of the activity of a human user or the functioning of a technical ensemble.’

To analyse machines, Simondon established a distinction between three technical levels. In On the Mode of Existence of Technical Objects, he calls these levels the element, the individual, and the ensemble; in his 1968-1969 course on invention, these categories became ‘sub-ensembles or elements’, ‘technical networks’, and ‘individualized technical objects, those Lafitte named, precisely, machines’ – with the particularity that ‘the individualized technical object, whose elements are multi-functional, join the network’s organizational mode with that of the sub-ensemble or element.’ Simondon’s technical ensembles or networks are not Gille’s ‘technical systems’: for Simondon, a mine, for example, is a technical network, bringing together transportation systems (on one’s back or by wheelbarrow, sled, or wagon on rails, etc.), ventilation systems, water pumping systems and systems for

85 Ibid., 53ff.
86 Gilbert Simondon, L’Invention dans les techniques, 163-164.
lowering workers into the ground and for extracting minerals (the mine shaft). The ensemble can only function by coordinating each of its elements.

In our quest to describe our object of study technologically, we must remember that, in this context, the term ‘cinema’ can describe several distinct and complementary entities:

- a *principle*: the illusion of movement by means of the rapid succession of a series of images. This definition, however, is debatable, and subject to caution and possible objections, as it appears that no fixed definition can be given. It is interesting to note nonetheless that the cultural and epistemological unity of ‘cinema’ has not seemed particularly threatened, at least until the appearance of the digital, even though it functions on the same bases. This principle could be carried out technically in several different ways (the intermittent advancement of a light sensitive tape, periodic scanning of a photo-luminescent screen by an electron, etc.), each of which has seen various distinct working forms. This level is the *element* or the *component*, to use Simondon’s terms: it refers to what happens *inside machines*. In the terminology used by François Albera and Maria Tortajada, it is on this level that the ‘internal *dispositif*’ is located. 87 This is also the level in question, for example, in Henri Bergson’s analysis in the chapter on the ‘cinematographical mechanism of knowledge’ in his book *Creative Evolution*.

- a *dispositif*, in the sense Albera and Tortajada use the term: a determined relation between a viewer and a show involving images put into motion with added sound through the use of machinery; here, the term describes a mechanical and architectural ensemble. Here, too, this *dispositif* has seen and still takes a great number of profoundly different working forms: those geared to large audiences (the movie theatre), small audiences (domestic *dispositifs* or *dispositifs* accessible to a limited number of people: televisions, computer screens) or to a single viewer (Kinetoscope, Mutoscope, portable television, Moviola, mobile telephone); commercial and non-commercial (classroom, scientific laboratory, factory); permanent or temporary; professional (35mm, D-Cinema) or amateur (16mm, Super-8, DV and HD video, amateur projector), etc. 88

87 François Albera and Maria Tortajada, ‘The Dispositive Does Not Exist!’, 22.
Individualized cinema machines directly tied to production or reception are located on this level – cameras, projectors and, if one must include ‘passive machines’, venues.

It should be noted here that the proliferation of devices that struck commentators in the nineteenth century (optical toys and visual shows of all kinds, from the Thaumatrope to the Diorama) and has struck those in the twenty-first (the profusion of contemporary media objects) is a constant throughout the history of the medium. The history of cinema as a dispositif limited to the experience of moving images in a paid-admission dark theatre is a history of film theory, but it is not a history of cinema.

The Spirograph, for example, invented by Theodore Brown in 1907, was a cinema projector made for domestic use and employing a flexible acetate disc measuring 26cm in diameter and holding some 1200 images (Illus. 5). It was commercialized by Charles Urban in the early 1920s. The Spirograph catalogue contains several hundred titles. The filmmaker Werner Nekes’ collection contains a great number and a great variety of optical dispositifs dating from before the twentieth century, but it also contains a 1957 Radio-cinéphone, a combination of telephone receiver and turntable for playing record albums and small-screen 16mm sound-film viewing dispositif. This collection also contains a Scopitone, an audiovisual jukebox produced by the Cameca company in 195889 and intended for use as a coin-operated machine for group viewing – albeit the size of the audience could hardly be ‘a large crowd’. These devices have been overlooked by film theory and forgotten by film history. Like many others, they testify to the extreme and constant diversity throughout the twentieth century of the ways in which moving pictures were received. Here, we should recall Roland Barthes’ remarks in the first issue of the journal Communications in 1961: ‘cinema’s imperialism over other forms of visual information today can be understood historically, but cannot be justified epistemologically.’90

– a technical network, in the sense in which Gilbert Simondon uses the term: here, ‘cinema’ describes the organization of all the machines (cameras, printers, editing tables, projectors, etc.), places (production studios, laboratories, screening rooms, factories where machines are made, etc. – illus. 6), technical procedures and forms of circulation amongst these elements, which enable the production of a concrete cinema object and ensure its presence in the culture. This network can

89 See Bodo von Dewitz and Werner Nekes, eds., Ich sehe was, was du nicht siehst! Sehmaschinen und Bilderwelten: Die Sammlung Werner Nekes, 403-404.
be vast, even global (a ‘Hollywood’-style cinema, industrially produced and distributed worldwide) or limited to more specialized distribution systems (experimental cinema, educational cinema, professional training cinema, political cinema) or even to the most minimal form possible (films made and shown by a single person, sometimes with a single machine: the home movie). Of course, even in this latter case a technical ensemble is implied, making the functioning of this mini-network possible. The level of the network is structured by the circulation of a base (film stock, a digital file on disc, a server or other ad hoc material element): the ‘film’, evolving from its component parts to its final form. This network is also structured by a variety of factors, in particular the way the professions involved in each of its levels are organized (performers, technicians and creative collaborators, engineers, manual workers, etc.).
Illustration 6 – The Pathé plant (le Film vierge Pathé. Manuel de développement et de tirage, 1926).
A technology of cinema should examine each of these levels, as well as the way they interact. But it should not do so in the abstract – according to a general and ideal ‘cinematic principle’ – but rather by a precise analysis of singular historical cases in which the principle is seen to materialize. For it is these singular cases, in the opacity of their coherence, which can inform us about what has taken place.

An Example: The Principle and Machines – The Camera Obscura

The camera obscura, mentioned above, is an exemplary case of an extremely diverse ensemble of machines unified by a fundamental principle, described here by Leonardo da Vinci:

If the front of a building or some piazza or field which is illuminated by the sun has a dwelling opposite to it, and if in the front which does not face the sun you make a small round hole all the illuminated objects will transmit their images through this hole and will be visible inside the dwelling on the opposite wall which should be made white.91

Already, this description shows that apart from the principle, the result is tied to certain precise technical points: the size and shape of the hole, the direction it faces vis-À-vis the sun, the white wall-screen. It is no longer an abstract configuration per se, but a real machine subject to operating constraints. In another fragment, Leonardo ‘receive[s] this images on a white paper placed within this dark room rather near to the hole.’ In this case, the objects will appear ‘in their proper form and colours,’ not only inverted, but also ‘much smaller.’ The paper-screen ‘must be extremely thin and looked at from behind.’92 This is a completely different set-up: the screen becomes mobile, the images are transformed, and the machine is accompanied by precise instructions for its use.

This machine would undergo its first major transformations in the sixteenth century, notably the addition of a lens for sharpness (Illus. 7), or even two lenses combined in order to put the image upright. Then, in the eighteenth and nineteenth centuries, the machine saw a great many variations. In particular, as we know, it became portable: the first known version was that of Canaletto in the mid-eighteenth century, famous for his

92 Ibid., 110.
pictures of Venice and prints of engravings. This machine went from being a ‘chamber’ (*camera*) to a ‘box’, or to one of their possible intermediaries (folding tent, etc.). Each time, certain constraints had to be observed: one needed a lens and a screen, which should be white, a good distance from the lens, and itself shaded from direct light.

Today, we tend to subsume these machines into the category defined by the general principle, but also to see them as having the same use, by thinking of the camera obscura only as an aid to drawing or – in the work of Jonathan Crary, for example – as an epistemological model for vision. This reduces the machine to an abstract property of geometrical optics. The ‘explanation of the way in which vision is made,’ in the volume *La Dioptrique oculaire* by Chérubin d’Orléans⁹³ (Illus. 8) is exemplary of a moment when the scientific and the allegorical could merge. Here, the image is produced in a camera obscura, but this camera obscura is not an organ and not an eye, nor is it an abstract or empty place: it is an office with thick walls containing pencils and a work table, orbs, and a door closed with a solid metal lock. If this figure represents ‘the way in which direct vision is made,’ we must conclude that thought and knowledge, but also the intimacy of these constructions, are not immaterial to this – that they are the very site where ‘direct vision’ is produced. This epistemological role is, therefore, indisputable. But the historical phenomena which envelop it are singularly complex.

We should note, firstly, that the camera obscura is not an obvious choice of method for assisting in perspectival drawing. In *On Painting* (1435), the foundational treatise on the theory of linear perspective, Alberti describes his ‘intersectional veil,’ which he presents as his own invention: ‘a veil

⁹³ Chérubin d’Orléans, *La Dioptrique oculaire, ou la théorique, la positive et la mécanique de l’oculaire dioptrique en toutes ses espèces*, 64.
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woven of very thin threads and loosely intertwined, dyed with any colour, subdivided with thicker threads according to parallel partitions, in as many squares as you like, and held stretched by a frame.\textsuperscript{94}

A century later, Dürer, in his classic and fundamental \textit{Underweysung der Messung mit dem Zirckel und Richtscheyt}, presented four perspectival methods – two in the first edition of 1525 (the glass panel and the window\textsuperscript{95}), to which he added two others in the second edition of 1538\textsuperscript{96} (the method attributed by him to Jacob Keser, and the grid, which was a variation on the intersectional veil – Illus. 9). Each of these methods was adapted to a precise use: the portrait (the glass panel or the grid); foreshortening objects (the window); or, finally, when one wanted to adapt the glass panel to a painting in which the distance from the point of view to the surface of the painting was greater than arm’s length (the Keser method). This latter technique was an astute solution to a concrete technical problem.

These volumes were crucial manuals for painters and were foundational in the history of perspective. Yet, none of them included among the methods


\textsuperscript{95} In which the ‘point of view’ is disassociated from the painter’s eye and the visual ray ‘conveys’ in the form of a suspended thread, making it fascinating theoretically.

\textsuperscript{96} See Albrecht Dürer, \textit{The Painter’s Manual}, 431-437.
for obtaining perspective the camera obscura, even though it was already well known. At the same time, the history of the camera obscura, apart from the history of perspective, is itself extremely complex.

After these mentions in the work of Leonardo and a few others, the camera obscura would be widely popularized as an instrument of ‘natural magic’. This trend was begun by Giambattista Della Porta in *Magiae Naturalis*, a fundamental volume for the culture of the day. The first edition of this book was published in four volumes in 1558 and it was republished in a new version made up of twenty books appearing for the first time in 1589. There were numerous translations and reprints. Laurent Mannoni has pointed out the description found in this latter version of true spectacles put on through the intermediary, the mediating, of a camera obscura: an entire stag hunt, with the hunters, the animals, real or fabricated trees, children playing in the vicinity, every gesture and movement, even noises and the sound of trumpets, appeared on a white sheet before friends seated in the camera obscura.\(^97\) Della Porta mounted other examples of these *prestiggi* – paintings that, cleverly lit, seemed to make their images float, in the middle of the night, above the heads of the assembly.\(^98\) This connection between the camera obscura and *spectacle* is fundamental to its history, as can be seen in this comment by Jonathan Crary:

\[
\begin{align*}
\text{Many contemporary accounts of the camera obscura single out as its most impressive feature its representation of movement. Observers frequently}
\end{align*}
\]

In venting Cinema, Crary spoke with astonishment of the flickering images within the camera of pedestrians in motion or branches moving in the wind as being more lifelike than the original objects.99

Crary insists on this point: it is this ability to render movement in particular that distinguishes the camera obscura from ‘experience of a perspectival construction.’100 In fact, this cultural – and technical – use of the camera obscura continues today, when other uses have been lost. In a few places in the world one still finds examples of the camera obscura, which one pays to observe from inside it the spectacle of the world around it – a point of view – in the form of images transmitted to a dark room through the use of lenses and mirrors. One of the most remarkable, according to John Hammond, is the Great Union Camera in Douglas on the Isle of Man, probably built in 1887 and still in operation today. Its roof is equipped with eleven skylights, each with a lens and a mirror, which project the view onto eleven tables arranged in a circle in the centre of the room.101 It is thus a camera obscura, but in the form of a paid show that, since the 1880s, has presented, horizontally, moving images to large numbers of people – and whose form is closer to a panorama than to what one pictures when one thinks of a camera obscura. Others of the same sort were set up at the Clifton Observatory in Bristol; in Portmeirion, Wales; in Edinburgh, Scotland; in Marburg, Germany; and in San Francisco (built in 1939). In 1935, the optical engineer and amateur astronomer Horace E. Dall had one built on the roof of his home in Luton, England.102

This tradition developed in a partially autonomous manner, or, in any event, independently of the idea of using the camera obscura as an aid to drawing, or even of perspective. That said, how radical this independence was is debatable: the camera obscura was one of the very rare image production dispositifs some of which projected images onto horizontal screens, even though the initial form employed vertical screens: the walls of the room. And horizontal image dispositifs, precisely, were those variants made to assist drawing, with the screen becoming a table. In 1900, Theodore Brown produced a dispositif that reversed this principle: the Designoscope, vertically projecting drawings made on the spot by the operator.103 The horizontal

99 Jonathan Crary, Techniques of the Observer, 34.
100 Ibid.
102 Ibid., 147-152.
103 Described in the supplement to the British Journal of Photography, January 1900. See Stephen Herbert, Theodore Brown’s Magic Pictures: The Art and Inventions of a Multi-Media Pioneer, 16-17,
presentation of images in these panoramic camera obscura, such as that of Douglas, was not the obvious choice: the panorama-like form of the building suggested rather that the images be cast onto the walls. By presenting these images on a horizontal table, this dispositif became more a part of the history of the camera obscura, in a sense, than that of the panorama. The machine thus carries in its form a history that surpasses it.

Of course, the camera obscura was in addition an important dispositif for assisting in the making of perspectival drawings. It was described in Pratica della Perspettiva by Daniele Barbaro, for example, ten years after the first edition of his Magiae Naturalis, as a ‘natural way to put in perspective,’ although it was not employed as such in any significant way for another century.

But these histories intersect with another. While Della Porta's Magiae Naturalis seems to us today to be a book of ‘white magic’, the ambiguity of its status in the culture of its day can be seen in the fact that it was closely read by the savant Johannes Kepler. If a critical shift in the epistemology of optics took place with Kepler and the publication of Ad Vitellionem paralipomena in 1604, the camera obscura played a very important role in this. Gérard Simon has demonstrated the extent to which Kepler's adoption of an experimental approach brought about profound changes in optics. We can easily describe this experimental approach as consisting of truly thinking through technically the camera obscura ‘machine’. This thinking through took place in a particular scientific context, in which astronomy played an especially important role, with the Paralipomena addressing the ‘optical part’ of the question. In it, the study of eclipses is central, and it is noteworthy from this perspective that the first known illustration of a camera obscura describes, precisely, its use in watching an eclipse, making it possible to observe an eclipse without damaging one's eyes, and possibly to retain a trace of the positions of the heavenly bodies on the screen. Reinerus Gemma-Frisius used this method to observe an eclipse of the sun in Louvain on 24 June 1544 and published an

which describes how this principle was present in the nineteenth-century tradition of scientific magic lanterns, vertical-projection devices from which are descended the transparency projectors familiar in today's classrooms. Others variant of this mode are, of course, the dispositifs used in animated cinema.

104 Daniele Barbaro, La Pratica della Perspettiva, 192. This camera obscura is mentioned after Dürer's ‘window method’. Barbaro is famous for having been among the first to mention the addition of a lens – ‘un’occhiale da vecchio’, an old person's eyeglass.

105 The following discussion is largely based on Gérard Simon's volume Archéologie de la vision: L'optique, le corps, la peinture, 207-213.
illustration of it the following year in his *De Radio Astronomica et Geometrica*. Kepler was familiar with this use of the device. But the instrument was not without problems: in some cases, it appeared to introduce measures that contradicted direct observation (when not in eclipse, it showed the diameter of the moon appearing one fifth smaller). Kepler sought to resolve this problem through technical study of the camera obscura and the precise conditions under which its image was formed. I will not outline every aspect of this endeavour in detail, but it involved several stages.

The first thing Kepler examined was the size of the opening of the chamber. This opening should be very small, much smaller than the (angular) size of the light source and negligible in comparison. If it were not, and the hole were too large, the image of the opening itself would be superimposed on that of the object being observed, blurring perception of it and misrepresenting its size. That said, if the opening were really too small, the image would not be adequately lit. *Real* cases, i.e. not the abstract cases described by geometrical optics, thus made compromise necessary.

The second thing Kepler studied was the screen. He carried out an experiment, by moving the screen inside the camera obscura, placing it at different distances for the opening through which the rays of light entered. He thus saw both the source image – the inverted image – and the image of the hole itself – a right-side-up image – take shape and dissolve. Each point of the source then had to be seen as producing on the image not an equivalent point but rather a spot that, under optimal technical conditions, could be reduced approximately to a point.

He then proposed two technical improvements. The first consisted of placing a glass flask filled with water behind the hole. He observed that by moving the screen to a particular spot, the image became sharper than before, and sharper than anywhere else in the space. He demonstrated the reason for this by geometric means: the spherical dioptrė made the rays of light coming from the same point of the source converge again in a single point.

But his demonstration also proved that through the spherical dioptrė the rays of light distant from the axis passing through the centre of the hole and the flask were more refracted than the others and were dispersed, no longer converging in a single point. He thus placed a diaphragm between the hole and the dioptrė, preventing the marginal rays of light from disturbing the formation of the image.

All these experiments resulted in a number of crucial new inventions for the history of optics as a science. They were the result of Kepler’s interest not only in the fact that an image is formed, but in the quality of that image and the technical conditions that influence it. Here, taking into account
technique – the material, the way the machine and its procedures are inscribed in the image itself – was foundational on a theoretical level and produced an epistemological rupture. For, after the connection between the eye and the camera obscura had been identified, by Leonardo da Vinci in particular, these experiments led Kepler to understand the true architecture of the eye and the respective functions of the cornea, the pupil, the iris, and the retina, by analogy with what he had observed about the camera obscura. He definitively identified the camera obscura’s role as an epistemological model for describing and thinking about vision, a role that would become fundamental in later years. Thus, there was born in his thinking a sense of the instrument’s true effective power – and, more precisely, a manner of technical thinking about the instrument.

Kepler’s position in this instance corresponds to what Georges Canguilhem describes in his article ‘Descartes et la technique’:

Knowledge of nature, according to the Dioptrics essay, thus doubly depends on human technique. First, in the sense that the instrument, in this case the magnifying glass, serves for the discovery of new phenomena […]. Next and above all in the sense that technical imperfection provides the ‘opportunity’ for theoretical research through ‘difficulties’ which must be resolved. Science proceeds from technique not in the sense that the true is a codification of the useful, a recording of success, but on the contrary in the sense that technical obstacles, lack of success and setbacks, invite the mind to inquire into the nature of the resistances encountered by human art, to perceive the object independently of human desires and to seek true knowledge.¹⁰⁶

The imperfection of the camera obscura as an instrument led Kepler to research that is theoretical because it is, in the first place, experimental, i.e. technical. His research emerged in reaction to the observation that a number of ‘difficulties’, which Kepler elaborated and posed as problems, in the strongest sense of the term, through the very form of this research.

Various elements of these developments around the camera obscura are relevant to our discussion here. Firstly, the instrument partially corresponds to the distinctions established with respect to ‘cinema’. In fact, the term ‘camera obscura’ can describe both a fundamental principle, which gives unity to the whole, and machines, which involve casting the principle

¹⁰⁶ Georges Canguilhem, ‘Descartes et la technique’, 496-497.
into different forms, conceived each time with regard to a specific task, a specific use, and a specific conceptual context and imaginary. At least three fundamental technical lines develop out of the principle; each is distinct, but the three are joined by a number of shared properties, although with great variation between individual devices – even if the unity preserved in the term camera obscura shows that their variety is still perceived culturally as a coherent whole. Schematically, we can describe the first strand as scientific: here, the camera obscura is an instrument, with its constraints with respect to precision and reliability, which makes measurement possible. In the second, the camera obscura is a dispositif for assisting in perspective drawing – from this viewpoint it is as much a tool as an instrument. This strand appears considerably later, and would give rise to portable dispositifs showing images on horizontal screens making it possible to create an outline superimposed on the image. In the third strand, finally, the camera obscura is a machine for producing moving image shows for audiences of varying sizes. This is a dispositif in the limited sense in which Albera and Tortajada employ the term. Depiction of movement is crucial for this third group; this is clearly not so in the first case, and is mostly an inconvenience in the second.

Laurent Mannoni emphasizes that Della Porta’s presentation of the camera obscura as a dispositif for creating spectacle reveals a connection between the camera obscura and the cinema. And yet this connection does not at all involve photography. In a different sense, the connection between the camera obscura and photography seems undeniable in certain respects, technical above all, as can be seen in the texts written by Daguerre himself in which he described the daguerreotype as consisting in ‘the spontaneous reproduction of images of nature received in the camera obscura, not with their colours but with great subtlety in their tonal gradations.’ This connection can also be found on the cultural level, but solely in the case of the camera obscura as an instrument to assist in drawing, as seen in Arago’s report to the Chamber of Deputies at its session of 3 July 1839, which establishes this clearly.

We should view this in relation to the fact that in the early years of photography no ontological distinction was made between photographic images and drawings, as seen in texts of the period. In 1849, for example, Joseph Plateau could propose to apply photography to the Phenakisticope:

107 Louis Daguerre, Historique et description des procédés du Daguerréotype et du Diorama rédigés par Daguerre, 57.
One could make plaster casts, for example, of the models of the sixteen modifications to the sequential figure whose image one wishes to produce in the combined device we are concerned with, and then *take with a daguerreotype a couple of drawings* of each of these sixteen models, and finally transpose these drawings onto the two discs.\(^\text{109}\)

This clearly dates from *before* the ‘photographic snapshot’, but it also dates from before the separation of drawing and photography as two ontologically opposed means of producing images: here, the daguerreotype is seen as a particular way of ‘taking’ a drawing. Because today the drawing/photography distinction is radical and completely assimilated, the connection between the camera obscura and photography is no longer comprehensible.\(^\text{110}\)

These strands are not, of course, hermetically sealed, and taking them into account should not reduce the singularity of each device in belonging to one or another group. One of the most famous classical illustrations of the camera obscura is also certainly one of the strangest and most enigmatic. It appears on plate 27 of the first edition of Athanasius Kirchner’s *Ars magna lucis et umbrae* in 1646 (Illus. 10). Although often reproduced, it is rarely commented on.\(^\text{111}\) The two other figures in the plate show images produced by nature itself: images (or letters of the alphabet) that appear on stones or on cut trees, created without human intervention; and anthropomorphic landscapes. The lower third of the page shows a scene with a human figure that will be explained a few pages further on.\(^\text{112}\) Kircher describes his camera obscura as a *machine*. It consists of a double cubic chamber that appears, on this scale, nearly four metres across. Except for two apertures on the exterior walls, opposite each other, there is no opening onto the outside. The interior walls are screens onto which images are projected. A square trapdoor at the figure’s feet clearly serves as an entrance and exit; the chamber sits on two long wooden beams, suggesting what the text confirms: the chamber is ‘portable’: ‘it can be carried easily by two men,’ reads the description. The man inside is wearing elegant clothing (only one person is shown, but one

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\(^{112}\) Athanasius Kircher, *Ars magna lucis et umbrae in decem Libros digesta*, 812. The first known published illustration of a magic lantern appeared in the second, expanded edition of this volume in 1671.
In venting Camera man imagine that there was room for several others; he has one hand raised in front of him in a way suggestive of a painter’s gesture, but he has no tool with him. This could also merely be a gesture of attentively pointing out a detail in the image before him.

The images produced by this machine are two landscapes, inverted left-right and top-bottom, with the engraving barely smaller than the original (a one third reduction in the case of the landscape on the left and no reduction of the bush in the landscape on the right). But this is not the only distortion of perspective in the engraving: the original landscapes seem dislocated with respect to the perpendicular to the walls represented by the beams on the ground. The landscapes are clearly in the background, and presented to us frontally when they ‘should’ be at a right angle. These distortions of perspective could appear contradictory if the goal was to vaunt the camera obscura as an instrument that, precisely, fabricates images in perspective.¹¹³

This machine is enigmatic for several reasons. Firstly, it appears technically improbable: two men could not ‘easily’ transport a set-up like this. In addition, it is hard to see how it stands up and of what material the interior wall could be made for it to be rigid and yet transparent. John

¹¹³ But these distortions were not rare in treatises on perspective. See Eduardo Ralickas, ‘Reflections on the Pragmatics of the Illustrated Perspective Treatise: Performative Failures and (Pre-) Romantic Innovations’.
H. Hammond has suggested that it is not depicted to scale and that, in fact, it may have been ‘large enough to admit the head and shoulders’ rather than an entire person.\textsuperscript{114} For Hammond, it resembles the model described 50 years later, in 1694, by Robert Hooke, an oblong set-up enclosing the painter’s head (Illus. 11);\textsuperscript{115} it also resembles the Swiss artist Alfons Schilling’s \textit{Dunkelkammerhut} (1984, illus. 12).\textsuperscript{116} Yet, the difference in dates and technical equipment (Hooke’s machine clearly has a lens, while Kircher’s appears not to) makes this doubtful, as well as logically incoherent: the painter would have an image literally behind his head, unable to see it and without any need to, because with a sole opening/lens, he only had to turn in the other direction to view the other part of the landscape.

Kircher’s machine is also exceptional because it is dual: a double wall and especially a double landscape shown simultaneously in front of the observer and behind his back. The viewer can or must turn around in the machine in order to join the two images – or to paint them in turn, perhaps according to the orientation of the sun, lighting particular parts better at certain times of the day?\textsuperscript{117} Kircher summarily describes some of the possible uses of his machine. Artificial spectacles of every description could be depicted in it. From it, one can observe hills, camps, forests, humans, animals, and diverse scenes in such a way that ‘no painter’s art would suffice to draw such variety.’\textsuperscript{118} The machine could also, of course, be of use to the painter who wanted to depict all these things.

It is not my goal here to reduce the strangeness of Kircher’s machine, which is \textit{actually} absolutely singular and improbable. Nor is my goal to reject the \textit{dispositif} in the name of this improbability. Kircher’s illustration traces a project that has \textit{a degree of consistency} with practices of the day – uses of the camera obscura, illustration practices – and thus belongs entirely to the post-Renaissance episteme.

\textsuperscript{115} Ibid., 23.
\textsuperscript{116} In Nike Bätzner, Werner Nekes and Eva Schmidt, eds., \textit{Blickmaschinen oder wie Bilder entstehen: Die zeitgenössische Kunst schaut auf die Sammlung Werner Nekes}, 44.
\textsuperscript{117} Peter Greenaway has undoubtedly best shown the use of perspective machines, in \textit{The Draughtsman’s Contract} (1982). The device in the film is a ‘grid’ and not a camera obscura. One changed position while painting according to the orientation of the sun. Complete immobility on the part of the figures being painted was required – thus residents and workers disappeared, for example.
\textsuperscript{118} Athanasius Kircher, \textit{Ars magna lucis}, 812.
But in this plural vein of machines described by the expression camera obscura, should we think that there was a sole early invention followed by occasional innovations, or should we identify various major inventions? What would the criteria be for such a distinction, if it were to make sense and have value? These questions are inseparably technological and historiographical.