

# The Philosophy of Time-lapse Movies: Vision makers

Roberto Casati, Samaneh Yasaei

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## **The Philosophy of Time-lapse Movies: Vision makers**

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### **Roberto CASATI**

**Mailing address:** Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL Research University, UMR 8129, 29 rue d'Ulm 75005 Paris, France

### **Samaneh YASAEI**

**Mailing address:** Institut Jean Nicod, 29 rue d'Ulm 75005 Paris, France

**Phone number:** +33769152146

**E-mail:** [syasaei@cri.ens.fr](mailto:syasaei@cri.ens.fr)

## ***Abstract***

We investigate time lapse (TL) cinematographic sequences in their capacity of representational tools that make certain features of a phenomenon visually accessible. We introduce TL as a subcategory of Altered Pace sequences (AP) and discuss analogies and disanalogies of APs with other “vision making” informational and representational artifacts. We introduce some descriptive and explanatory notions, among which the notion of *epistemic advantage* of TLs, or the notion of pictures’ *silence*, and we assess the role of background knowledge in interpreting silent pictures. We claim that TL movies and, more in general, AP movies, in spite of their analogies with microscopes and telescopes, are representations with no informational equivalent, thus constitute a valuable addition to our epistemic repertoire. If they had an informational equivalent, this would have to include a time machine.

***Keywords:*** altered pace movies, cognitive artifact, perception, representational artifact, temporal perception, time lapse, time travel, moving image

Time lapse or accelerated movies (TL) were born with cinema and are now largely democratized; virtually each newly sold camera allows for TL shots that can be parametrized at will. Until recently, the history of TL was mainly that of its scientific use (Sicard 1998), with occasional artistic and entertainment manifestations. As with its dual, slow motion movies (SM), it was generally assumed that TLs could provide insight on the unfolding of some phenomena, literally *making visible* some features, patterns, elements of the phenomena they represented. To fix ideas, a classic instance is the use of TL for showing glaciers movements over periods of months and years (e.g. Extreme Ice Survey 2009). For SM, a paradigmatic example is the dynamics of impacts, such as droplets falling on water, or bullets piercing armors. It may be useful for taxonomical purposes to introduce a general category that encompasses both TL and SM movies. We propose the term Altered Pace movies (AP). AP movies are here meant as a well circumscribed category of their own. Arguably, many narrative and documentary movies alter – one way or another – the temporal structure of represented events and processes: temporal gaps, flashbacks, sequences run in the reverse are commonplace in moving images. However, the AP category we draw attention to is constituted by items where the time compression or expansion has been performed *uniformly* over a given interval. The AP label applies thus first and foremost to video sequences, that may or may not constitute whole movies. In what follows we use the label «movies» for referring mainly to any of those uniformly pace-altered sequences.

Since the seventies, the new theories on the philosophy of experimental cinema focusing on the syntax of films more than its content became more and more commonplace and made salient the interest of time manipulating operations. In this context, time-lapse manipulations were usually

considered as one of the characterizing dimensions of movies. Le Grice (1972) mentioned taking advantage of limitations and extensions tied to camera mechanisms in order to manipulate the time dimension of cinema. He considered cognition about duration and TL mechanism as a form of extended cognition the camera makes possible (Gaal-Holmes, 2015). The documentary aspect and the analogy of time-lapse with the visual technologies like telescopes and microscopes could be traced back to Dziga Vertov theory in “The Birth of Kino-eye” in which he mentioned the cinema as a set of apparatuses of representation for organizing the visible world (Vertov, 1984). As a matter of fact, time lapse uses interval alteration as the possibility of recording and displaying one’s observations, breaking spatial and temporal limits. To get control over the phenomenon and audience, the film-artists must master the rules and structures of observation/presentation. Conversely, what audiences will perceive and infer depends on how filmmakers employ the tools. Now, making visible a phenomenon by altering the temporal features is not just a technical instrument of cinema. It is a way to construe the documentary activity, not merely the attempt to produce a different visual effect. This essay thus investigates the interplay between the cognitive process, the technical rules and the representational means of TL sequences, that are summarized in the tenet that TL should be considered as *vision makers*.

The reason we *prima facie* accept the characterization of TL and in general AP movies as *vision makers* springs from the fact that we accept the claim that in normal, ecological conditions we do not *see* have *visual access to* (the relevant aspects, features, patterns of) or visually notice the phenomena they represent. When looking at a real glacier, we do not see, or notice, any global pattern of movement (except the occasional, local fall of an ice block.) Similarly for SM: when looking at the impact of a drop of water, we do not see, or notice, the crown-shaped rebound of

droplets.<sup>1</sup> Glacier movements (and the fine dynamics of the impact of water drops) do not make it to the phenomenology of visual experience, that includes visual noticing and attending. TL (and SM) are here claimed to give experiential access to those phenomena.<sup>2</sup>

We think that the *making visible* thesis is, by and large, correct, for reasons that parallel those given in the literature to defend the claim that we do see with telescopes and microscopes (Pacherie 1995; see Cutting 1986; Gibson, 1986; Hacking, 1983; Marr 1982). However, we also think that there are reasons to modulate it, given an important asymmetry with telescopes and microscopes. The asymmetry reveals in turn the scope of the making visible thesis.

We start from a framing of the analogy of TL with telescopes. Telescopes give access to objects, properties and facts that are not visible to the naked eye. For instance all galaxies except a few are simply too far away, hence too faint, to be spotted with the naked eye even in the most advantageous sighting circumstances. Telescopes capture that small amount of light and reorganize it in a way as to generate a virtual image of the galaxy. ('Virtual image' is used in this description in the geometric sense in which the science of optics uses it, with little overlap with the ordinary meaning of the term to describe either pictures or mental items). That virtual image is visible with the unassisted eye. This brings the distant galaxy within the range of visible things, in a relatively innocent but precise sense: we can *inspect it visually*, *compare it visually* with other galaxies and with other more ordinary objects of similar shape (e.g. a top or a cloud). Microscopes do the same for small objects, bringing things that are invisible to the naked eye because too little within the realm of things that can be seen (visually inspected, compared with other ordinary objects under their visual profile: "paramecia look like decorated shoe soles"). When Galileo first used his contraption to observe features at the surface of the moon, he claimed that the device allowed him to move the study of celestial bodies from metaphysical (we could rephrase: highly inferential) discussions to "sensible experiences," i.e. to direct observation.<sup>3</sup>

The analogy with optical instruments, however, breaks down on an important point. Microscopes and telescopes are a particular class of cognitive artifacts: they are *information enhancers*. They do not generate public *representations* of the objects they target, and whose visual aspects they make accessible. Indeed, they do not *represent* anything. Their unique business is to tweak the information flow so as to make it compatible with and accessible to vision under the biological constraints of the naked eye.

TL and SM, on the other hand, *are* representations. They are constituted by a sequence of still frames, each of which is a *picture* of an object in a particular moment of time. Pictures are representational cognitive artifacts, not merely information enhancers (even though, of course, they can be and oftentimes are the result of a process that incorporates the use of information enhancers: e.g. a photograph taken with the assistance of a telescope, or plainly a photograph generated by a lens camera).

There is a somewhat unsettled discussion about whether we see the objects that photographs depict, or whether we just see representations of these objects (Benovsky 2012; Maynard 2000; Walton 1984). For our purposes, it is important to underline a commonly agreed upon distinction between the *vehicle* and the *content* of a representation. When you look at a photograph or a screen, still or moving colored shapes on the surface are representational vehicles; objects and events the image represents are its content. Relations between shapes, change of shape and color and rates of change are properties of the vehicle; these may or may not correspond to relations and changes in the represented content. If, in general, a change in vehicle is necessary to deliver a change in content (in order to represent the fall of a stone, the shapes in the vehicle must change over time), a change in vehicle is not sufficient for representing a change in content (a modification of colors on the vehicle, e.g. at sunset, may not alter the content, e.g. of a white house on a cliff). In particular, when discussing TL, we want to be able to draw a distinction

between the representation of an accelerated event (thus focusing on content), and the accelerated representation of an event (thus focusing on vehicle).

In the TL of glacier example, it looks to us as if glaciers are flowing faster than their usual flowing rate. But of course, this is not the case: glaciers are not changing at the rate they would if the representation was not a TL. Still there is an impression as if glaciers are flowing faster, and this visual aspect is important precisely because of the epistemic weight we want TLs to carry; for instance, when we visually compare the flowing patterns in glaciers' movements in a TL with, say, the flow of a stream of molasses out of a jar. What accounts for the visual impression that it is glaciers that are moving faster? Our proposal is that the acceleration concerns *the temporal displacement<sup>4</sup> of the viewer* – his or her temporal *perspective*.

To take a SM example from fiction, in *Spider Man* (Sam Raimi, 2002) there is an attempt at representing the main character's extraordinary perceptual states from his peculiar point of view (Ziskin and Bryce 2002). We may surmise that Peter Parker's newly acquired super visual system has a faster refresh rate than that of ordinary humans, whereby he sees other people's movements as much slower – and is able to fend off threatening blows from bullying Flash Thompson. The director simulates a slow motion of the blow, with Parker's head turning at “normal” speed so as to stress the difference between the two characters's *perspective* on the unfolding of events (this is stressed by the surprised look of Parker).

The discussion of a spatial analogy is in order. When we look at a distant tree through binoculars, we can claim that we see a larger tree than with the unassisted eye; maybe the unassisted eye is unable to resolve the single tree, it only sees the green expanse of a far away forest. We can however also claim that the tree we see is in no sense any larger: trees do not suddenly expand when we look at them through binoculars. However, we need to use the “larger tree” notion in order to account for what happens when we run visual checks of the tree – for instance, when we

compare what we see in the binoculars to figures in a botany atlas.) To save both intuitions (impression of “larger than”, and tree that however does not change its size just because of our observation), we can say that the binocular “moves” our viewpoint close to the tree. The change is in the viewpoint, not in the observed object or event.<sup>5</sup> (The same holds for microscopic observation.)

Likewise, an observation made through a TL is like a kind of *linear time travel*, performed with eyes wide open. (The same can be said for SL and for other AP movies, such as movies run in reverse. Interestingly, no spatial analogy is easily available for reverse time motions. Upside down pictures? Pictures with inverted colors?)

TL, as we said, are *representational* artifacts. They do not have an informational analogon, the way a tree seen through a telescope provides an analogon for an enlarged picture of the same tree. However, it is not difficult to imagine what such an analogon would be like, if it existed. It would be like the window frame of a time travel machine, allowing the passenger to look out during the travel. If we could move in time at a rate faster than the normal time flow (faster than “one second per second”) we would be able to see glaciers flowing like jam, and if the rate was much slower, we would be able to see drop impacts generate droplet crowns. If microscopes and telescopes give us access to objects that are not visible to the naked eye, SMs and TLs give us access to events that are not visible to the *dynamically naked* eye.

A couple of caveats are in order. First, the *making visible* thesis may be interpreted as suggesting other analogies of AP movies with microscopes or telescopes. For instance, telescopes make visible items that the naked human eye is too weak to see. However, it can be objected that no improvement of the eye could make humans perceive glaciers’ slow movements.<sup>1</sup> In our

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We are indebted to an anonymous referee for this point.

discussion we consider *making visible* in a less restrictive sense than simply enhancing our peripheral visual capabilities. Visual access is not just a matter of eye improvement.

Second, the sense in which we talk of AP movies acting like time machines is quite restrictive. If you look at a video recording of an episode of your childhood, you are in a kind of time machine situation (you visually access past events). And some authors (Wilson 1988) have argued that cinema is like a time machine (Cf. Casati 2003). But in most cases, the analogy with time machines only concerns the outcome of the time travel. You time travel to your childhood, then stop the time machine, and start look out of its window: what you see is what the video recording shows you. In the cases we discuss, of AP movies, it is as if you looked out of the time machine window *during the travel* itself.

### ***The silence of pictures***

Now consider. A small picture can represent a large object, but that it represents it *as* large is an extrinsic feature of the picture, and it has to do with further computational aspects, i.e. with rules we implicitly employ when we interpret the picture. One may claim that pictures are *silent*<sup>6</sup> about the real dimension of the objects they represent: “This could be a picture of Lilliput” (said of a picture of the village of Barbizon). However this holds only in the abstract. Indeed *silence* is always mitigated by the availability of background knowledge about content (*typically* houses and people have certain sizes, etc.) The workings of this background knowledge become apparent when there are conflicts: Gulliver enters the scene and sits next to a house that is much smaller than he is, packed with people greeting him from windows. The picture begs us to make choices: is this a giant visiting a normal-sized village, or is he a normally sized person in a miniaturized setting? These choices require more inferences, exploration of the picture, involvement of yet more background knowledge.

But – and this is a crucial point – *if we do* make a choice, we have to postulate a computation that enabled the choice. The computational mechanism whereby we finally make this choice is an anchoring mechanism. An object is taken as a reference, and each other object's size is determined in an inferential cascade of size assignments. A Lilliputian, say, is seen as having the normal human size; houses around her are normalized, and Gulliver is seen as a giant.

Anchoring is a widespread ingredient of many visual computations. The Moon is a dark object (*maria* are filled with basalt, fig. 1) but as it is the brightest object in the night and (locally) in the day sky, it is seen as bright white. If a crow intercepts your car's light at night, it is seen as white as a dove (Gilchrist et al. 1999).

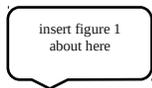


Fig. 1 Anchoring modulates color perception. Absent a lighter celestial body, the moon is seen as white. But when seen on the background of much brighter items (here the clouds on Earth) the visual system retrieves its true color (gray). Note that the satellite sees a full moon, hence the luminance is the same as when we see the full moon from Earth. Image credit: The far side of the moon, illuminated by the sun, as it crosses between the DSCOVR spacecraft's Earth Polychromatic Imaging Camera (EPIC) camera and telescope, and the Earth. Image credit: *From a million miles away NASA camera shows moon crossing face of earth* (NASA and NOAA, 2015).

Anchoring does not only pertain to the chromatic dimension. In the case of TLs or SMs, we avail ourselves of the notion of *temporal anchoring*. In the sequence *A boy in Marseille* (Yasaei, 2017) a boy is asked to stand still for two minutes, where a scene filled with people coming and going unfolds in the background (Fig. 2). The boy's slow movements provide a temporal anchor. The underlying visual computation is likely based on the fact that is chosen as an anchor whichever resembles more the normal time course: everything else is seen as accelerated. If, on the other

hand, there is no anchor, we see the acceleration, but we attribute it to the movie (the vehicle), not to the event (the content).



Figure 2. The boy's movement provides a temporal anchor.

*A boy in Marseille* (Yasaei, 2017).

The video was custom produced to highlight a temporal anchoring *ambiguity* parallel to the one found in the image displaying people of different sizes. The moving image begs us to make choices, and anchoring is the explanation of the choice we end up making.

Framing and anchoring effects play an important role in the perception of movies that are intended to highlight some key properties of the represented events. The *DIAL* project (Roberto Casati and Goffredo Puccetti, 2016) realized a TL of the shadow of Burj Khalifa – as of 2016, the tallest building in the world – near the winter solstice of 2016. The constraint of the shooting was to keep the shadow always in the middle of the picture (Fig. 3). This constraint anchors the picture to the Sun-Earth direction; the only moving elements – at a perceivable pace – are landscape features, which make, when played at an accelerated rate, the Earth's rotation visible. In this project, *two* visual computations are tweaked in order to deliver the intended effect. The first is temporal anchoring; the second is spatial framing – keeping the shadow parallel to the image frame “locks” the spatial frame of reference to the shadow, and makes the world appear to move.<sup>7</sup>

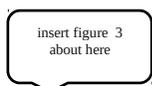


Figure 3. Perceiving the Earth's rotation. *DIAL project* (Casati and Puccetti, 2018).

When anchoring is not available, the behavior of represented objects may be awkward, not experienced as an acceleration. In the *Spring Equinox TL Spinning Shadows* (Casati, 2014c), trees moved by the wind appear to shake unnaturally. The intriguing observation made possible by this TL is that at the end of the day shadows climb trees and “quit” the Earth, a phenomenon that is not visible with the dynamically naked eye.

The features a TL can contribute to represent can be extremely high level and abstract. In *the Around the Solstice TL*, each frame collects a position of the Sun at sunrise. Each day the Sun rises in a different location, reaching a southernmost point on the Winter solstice (in the Northern hemisphere), then rising each day in a more and more northern position (Casati, 2014b). The TL shows a movement of the Sun on the horizon, but of course there is no such unitary movement in nature.

Finally, a pedagogical use of TL can take advantage of situated models (Casati 2014a). A globe that is so oriented that the place at the top corresponds to the place where the globe is situated, and such that the globe's axis is parallel to the Earth's axis (Fig. 4), will display, when put under the sun, a pattern of light and shadow that exactly corresponds to the pattern that at the same time occurs on the planet. The TL of the situated model shows in real time the illumination pattern of

the Earth on a given day. Here as in other cases some specific observations are made possible by the TL acceleration. For instance, in a movie shoot around the boreal Summer solstice, it is possible to observe that the area south of the Antarctic Polar Circle is in the shade during the whole day.

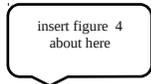


Figure 4. *Oriented Globe* (Casati, 2014)

### ***The computational account***

When inspecting a TL movie, the computations we mentioned (as well as some others) characterize the particular epistemic profile of the representational artifact. The key ingredient of this profile is that part of the computational burden of the observation is displaced to the visual system. *Displacement* is a key notion here (Casati 2017). It occurs in a number of other cases (but, be it said, it is not a definitory feature of epistemic artifacts in general; other operations are available.) Consider what happens when you want to communicate about a certain content, say, the number of trains leaving between 9am and 10am. You may send a disorganized, bag-of-words list of times, and your party will have to read out all items one after the other in order to find out the relevant pieces of information. You may, however, highlight the relevant trains in the list. The non-highlights list and the highlights list are informationally equivalent: no train between 9am and 10am is present in one list which is not present in the other. But they are computationally very different: the computational effort to extract the relevant information from the highlights list is considerably lesser (Simon 1978). Trivial as this may appear, the example points to an important architectural feature of our engagement with cognitive artifacts. The computational

burden can be displaced from a complex orchestration of conscious routines (reading, recognizing, storing in working memory as you scrutinize the non-highlighted list) to the visual system, that has a mighty computational army to perform the singling out task.

Two side morals can be drawn here. The first, is that the epistemic artifact is not carrying the computational burden. There is a recent but robust tradition of describing what goes on in cases like this, whose main tenet is that we *offload* cognitive tasks to the artifact. This is true in some cases (e.g. when we do offload computations to GPS-based navigation systems or to pocket calculators) but not in many other significant cases (such as highlighting as described above, map reading, picture observation). A certain narrative of de-humanization has it that we literally store our knowledge in cognitive artifacts (libraries, hard disks, the cloud) (Clark 1998). This may be true for certain practices and engagements with artifacts, but not for all of them. The second moral is that displacement is however, at bottom, a kind of de-humanization. By displacing the computational burden to the visual system we delegate it to a sub-personal part of ourselves: and the visual system is not a person, has no duties or responsibilities.

### ***Obtaining knowledge from TL***

When looking at a TL of a glacier, we shift to the visual system some computations that without the temporal displacement of the viewpoint would engage complex inferences – be they or not assisted by static pictures (e.g. the still frames of each phase of the displacement). We would have to mentally mark the position of the glacier front at different times (store those in memory or on paper to realize that there was movement, calculate ground covered in different time intervals to obtain speed and compare speeds over different intervals to detect accelerations or decelerations, etc.). Movements, speeds and accelerations are on the other hand immediately available on visual inspection of the TL. We assume that our viewpoint is displaced in time at constant speed, and we

immediately perceive higher order patterns of accelerations in the scene. Thus certain computations are shifted to the visual system, that is well endowed to make sense of dynamic features and comparisons.

Now, displacing the computational burden to the visual system is not to say that the visual system does *all* the epistemic work. The visual system has cognitive resources that are by and large dictated and optimized by its evolutionary history. It is not supposed to directly adjudicate on anything that goes just beyond that very limited brief (tell apart objects and background, locate objects at a distance, keep track of objects, decide whether a certain item is faster than another, etc.). There is no scientist homunculus embedded in vision. Good as the visual system is at perceiving complex patterns, it is not making any scientific use of them. Higher-order knowledge may make use of the delivery of the visual system, but it requires a lot more than just the deployment of visual routines.

In this respect, it is important to remark that a TL is not just a “cognitive time saver”. It is not that we spare ourselves the tiresome burden of tracking over long months the development of an ice front. For sure, some forms of perceptual time compression are time savers. Warnings about the use of medication are routinely read out at the end of radio and TV ads, at a quick rate that borders on intelligibility. And for sure, this cognitive advantage is trivially exemplified in TL as well. However the cognitive advantage we are after here belongs more in the realm of cognitive displacement. Making visible is, after all, precisely that. We can access many complex features of the evolution of an ice front – not just the shortening of the glacier, but also its becoming thinner, the evolution of detritus it carries, etc.

As we just mentioned a TL in the auditory modality, auditory patterns in the TL of auditory representation of earthquakes, obtained by first transducing representations of seismic waves into sound patterns and then running them at a faster speed (Winters and Weinberg, 2015), take us

closer to the understanding that quakes are in the end oversize collisions of vast and massive objects. By playing back seismographic recordings at a faster speed, we can literally *make audible* events that are largely in the infrasonic range. But without an understanding of plate tectonics, what we hear are just suggestive auditory patterns; they could be noises made by colliding pieces of tin. (Note that sonified/accelerated earthquakes present the same issues we discussed with time-lapses: the fact that we hear images of sounds and not the sound themselves, and the silence of the representation, that requires some anchoring procedure.)

Similarly, in the case of the TL of glacier front evolution, our understanding of the visibly available accelerations is modulated by our knowledge (that what we see is not molasses but ice, that it has a certain substantial size and is not smaller than an Alpine valley, etc.). The anchoring computation acts within the visual system, but it is fed or even prompted by the activation of background knowledge.

### ***Conclusions and further work***

We introduced the general notion of Altered Pace movies to encompass various modifications of the representational vehicle. We discussed an analogy of TLs with telescopes, and a corresponding analogy of SMs with microscopes. The analogy breaks down on the fact that TLs are not purely informational artifacts, but are inherently representational in a way neither telescopes nor microscopes are. The great epistemic value of TLs is that there is no informational device that could do the work they do. Such a device would need to incorporate a time machine – nothing less. The cognitive advantage of TLs is that they make visible changes that are below the threshold of human temporal perception. Without TLs, these changes can only be explicitly inferred by comparing different still frames of the represented events. TLs shift the computational burden carried by those inferences to some routines of the visual system. We further claimed that

our ability to make sense of TLs for getting knowledge about the events they represent requires the notion of change in temporal perspective: TLs do not represent accelerated events, but changes of viewpoints in time. In the glacier case, the TL does not represent fast flowing glaciers, but glaciers that flow at their actual speed, as seen by an observer that moves quickly in time. The interpretation of TLs is not an exclusive property of the visual system: although time anchoring routines are responsible for an attribution of speed of flow to glaciers, the anchoring itself depends on some background knowledge, as in itself pictures are silent about (some) of the properties they depict.

From the standpoint of this paper, the distinction between various types of time modified movies is not relevant. A normal movie of a glacier run at twenty-fold speed, or a sampling of still frames run at an accelerated speed, all present the same epistemic advantages, based on the same computational and architectural mechanisms (displacement of some queries to the visual system.) Open research questions concern then the limits of acceptable accelerations (what can be learned by a movie run in 1000-fold speed?), that may change according to the represented domain, and the emergence of artifacts in the representation (e.g. the seeming inversion of the movement of a wheel). The discussion of this paper has been largely limited to time lapse movies. A generalization to Altered Pace movies could show commonalities (and highlight differences) with Slow Motion movies and other types of Altered Pace movies, such as movies run in the reverse. We also restricted our discussion to movies that represent natural phenomena, and only hinted at the study of social phenomena by use of AP movies. It would be interesting to see what visual advantages become salient in systematically accelerating (or slowing down) social interactions. Another generalization, that we hinted at by discussion the sonification of earthquakes, could include other sensory modalities, such as hearing. Phonolapses exist but are typically exploited in the artistic sphere (Spitz 2010). Once more, underlying commonalities would make it possible to

single out specific issues, in particular by assessing which relevant computational rules are specific of the visual and auditory system. Further work will have to address the question of veridicality. Scientists use TLs as a tool for discovery. When TLs are offered as evidence, they help scientists observe the otherwise unavailable features of a phenomenon. But how can we obtain knowledge from a representational vehicle that is deliberately distorting some features of the represented object? Vision making is only a step, and not an innocent one, on the path to knowledge.

## Notes

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A note is in order about the specifics of TL. The moving image production system generates a representational artifact. Altering the components and the process of production delivers different types of moving images. This process is constructed of:

i) Input, that is the series of still images from a scene capturing it by chunking up movement in still images. The interval between the frames could be variate. But if we take the standard time scale movie as a point of reference, a rate less than 24 fps will give the impression of jumping movement, whereas a rate higher than 24fps will produce a smoother representation. Persistence of vision is taken advantage of, as in general the result of this process - i.e. perceiving the succession of still images as a continuous moving image by the human brain – is the very principle of the moving image. In TL, it should be stressed that the capturing frame rate is important because the purpose in TL is to make the changes visible. If the capture is too slow the spectator does not recognize the changes as perceptible, and if the number of captured frames is small the movement is jerky and recognition of changes is hard.

ii) The “time machine mechanism”, that depending on the kind of moving image, consists in a decision making process about frame rate, editing the series frame and the respect of aesthetic or communication constraints.

iii) Output: the moving image will be displayed in 16-24 fps to create the illusion of movement in watching the sequence of still images on a fix support.

The input in one of the original moving images apparatuses, the Phenakistoscope by Joseph Plateau (1832), was a set of drawings placed between the notches of the viewer; the display mechanism works by rotating the disk and looking through the notches at a mirror. The display process in TL has a similar structure. Watching a movie means watching the individual frames, one after the other at a fast pace. The number of the frames which is shown depends on the film’s speed. In standard film, projectors show us 24 frames per second; each different frame flickers three times rapidly, so that in total, we watch seventy-two frames per second. According to Yoshihiko Kuroki (2006), the ratio between motion speed and the frame rate of projection can be raised to 240 frames per second. In this condition, our visual system can see these frames without being distracted. In another study, Waston estimates 120 frames per second for average viewers can be perceived comfortably, although that does not mean that this condition increases a sense of reality. In TL videos, time is intentionally modified, the purpose depending on the subject of the representation (Kanai 2006). It is this manipulation that is taken to provide a clearer perception of movement and to offer a rapid review for informational purposes.

A claim can be made about an all-encompassing notion of seeing, according to which we may actually see an event such as a glacier’s movement although we would not be able to notice or recognize it (in the same sense in which we can be said to have seen the Queen of England although we did not recognize her). Here we subscribe to a narrower notion of seeing, according to which on top of being in visual contact

with an object or an event, we also need to discriminate it spatially or temporally (Dretske 1969).

3 Galileo indulges in expressing the cognitive pleasures that accompany the conquest of visual access: “Then to have got rid of disputes about the Galaxy or Milky Way, and to have made its nature clear to the very senses, not to say to the understanding, seems by no means a matter which ought to be considered of slight importance. In addition to this, to point out, as with one’s finger, the nature of those stars which every one of the astronomers up to this time has called *nebulous*, and to demonstrate that it is very different from what has hitherto been believed, will be pleasant, and very fine.” (Galileo 1880)

4 We use the term 'displacement' to avoid ambiguity with spatial movement. *Temporal* 'movement' or 'displacement' are metaphors that would deserve an independent discussion.

5 The claim is not completely accurate given the properties of telescopic and microscopic optics, that deliver compressed perspectives, but the approximation is sufficient to our discussion.

6 Silence is a notion used in literature about the content of perception (see Travis, 2004).

7 Some TL of this section are visible at the address: [cognitivedesigners.scigog.fr](http://cognitivedesigners.scigog.fr).