The Calder Effect – Embodied Knowledge Through Moving Images

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Abstract

How can a contemporary technological apparatus reproduce the space of a gesture that is 40'000 years old? Through an iconic (or iconological) process, the project 'Les Mains Négatives' is an attempt to combine intensive archaeological, anthropological, iconological, phenomenological research on rock art painting, using technological tools and re-mediation processes from media arts. Focused on a teleological approach, our research addresses the means of communication and interaction: What is happening to one's consciousness when the body moves? Considering that rock art and cave ornamentations are not simple pictorial art, but a place for technical transmission, our aim is to show how rock art has been a medium for teaching via the medium of performance. The 'mise-en-oeuvre' of our apparatus generates an artistic object, whose primary goal is knowledge production through aesthetic experience.

Keywords: Trace Apparatus; Movement Perception; Remediation; Embodied Knowledge

Impulse

> A slow gentle impulse, as though one were moving a barge is almost infallible. In any case, gentle is the word. (Calder, 1943)

The exploratory research project *Les Mains Négatives* serves as an experimental apparatus for the observation and analysis of gestures. It establishes a relation to a poetic agency, which is constituted of images, sounds, and gestures. The visitors are invited to explore an archive-as-art-work, which is manifested in digital forms.

By bringing together images, sounds, and movement through interaction, we question the way an embodied relationship arises from reconstructed shapes of palaeolithic art and their

synthesised movements. In the digital, interactive apparatus, painting gestures can be (re-)performed as a the living experience of a fluid iconology. As gesture becomes both a carrier and a witness to the traces of a cosmography, the materiality of the archived objects, i.e., images or sounds, as well as the fluidity provided by the digital interactions, contribute to the performance of meaning and the constitution of a tacit way of knowing.

The cyclical process of discovery, interpretation, and construction of meaning enables the various media to migrate from physical bodies to digital ones and back. In this configuration, the tight causal link between image and sound-events and gestures contributes to the coherent, multi-modal perception that we expect from natural events.

First, images carry reduced and symbolised (re-)presentations of prior visual experience, in particular the cave paintings of the upper palaeolithic era. Then, sounds have the ability to constitute situating spaces and generate an immediate envelopment of the listener. Gestural interaction, finally, is what engages the visitor in an active investigation of the trans-media sphere. This provides a sense of ownership, in the discovery of the images and sounds while gestures generate multiple possible linkages. We combine these principles as a means for the creation of sensory experience and tacit knowledge (Polanyi, 1967).

Frame

> There are two processes gone through in making each stroke of painting or drawing. First, the eye and the brain, or the brain alone, must act and determine what it is desired to place on canvas or paper. This is a mental process. The second process is physical, for the hand must so control pencil or brush that the desired effect may be obtained, that the image the eye has carried to the brain may be correctly transmitted to canvas or paper. An artist may do great things after he has mastered one or the other of these processes, but he cannot achieve real heights with only one of them at his command. He must see and conceive things and also be able to execute them as he wishes. (Calder, 1926)

It is important to situate the experiences, implementations, and reflections presented in this article. Although we draw on scientific elements to argue our case, what we present is an arts-based research project, in which we explore relationships between motion and computing through the scope of practice-based research methods. Even if anthropological knowledge feeds the developments and flow of our installations, this is not an anthropological essay. Neither is our intent to fit into disciplines such as media archaeology, art history, or HCI and design theory by adopting their methodology. Ultimately, we aspire to demonstrate that by straddling disciplines, the synthesis of elements and processes, methods and experiences can provide valid insights and understanding of a different nature.

Rock Art

From the general observation that today's museum or centre for cultural interpretation in archaeology presents rock art merely as a pictorial art, we can deduce that painting techniques are rarely approached from a *performative* point of view; performative in the sense that the actor alters the form of a figuratively present object, in order to create a meaning. Ethnographic

analysis, however, provides the understanding that in each culture to which a painting belongs, the act of painting in itself is seen as a performance (Tiampo, 2011).

The aboriginal rock art painting tradition, for instance, as investigated by the anthropologist Barbara Glowczewski, reveals that 'dream-scapes' are drawn on the dancing and singing bodies (Glowczewski, 2004a, 2013). A commonly observed fact is that Aboriginal people paint on rock walls as well as onto their own bodies. Moreover, ethnographic research show that these paintings, their various kinds of patterns essentially made out of dots and lines, are sung and danced.

Based on this, a primary assumption represents our main opening: cave paintings belong to an entirely performative ritual, which on the one hand supports some kind of traditional sociability and on the other, belongs to a tradition of vernacular techniques that express typical forms of symbolism. Our analysis focuses on the missing links between the body and the painting: gestures, relationships, ideas, representations, symbols, icons, and patterns.

In the following, we will lay out different perspectives that intersect and converge in this investigation. Providing a point of departure, anthropological knowledge anchors the work with pre-historic materials as well as the contemporary cultural and art context. Taking into account media theories, the concept of re-mediation helps to illuminate the central working process. The perspective on perception and embodiment then moves the focus towards experience and the emergence of different senses of ownership and the embedding of ideas through direct action. Finally, completing the elements of our investigation, we consider the impact and possibilities offered by technological tools and transformation processes.

Between images and gestures

As a primary matter of fact, one can observe a singular practice, repeated and performed through the ages and across continents: Negative hands as an ancestral pictorial technique appear on prehistoric cave-walls, yet this tradition is still alive in various cultures today; it can be witnessed in Australia, India, and South Africa. One can also consider that rock art painting traditions survive in western society through graffiti and digital arts.

Addressing painting techniques, our research is mainly focused on technical gesture and body movement needed to produce a design: the painter's gesture, rather than its trace, i.e., the painting itself. The very pedestrian argument that during the last two decades our environments have taken a digital turn will help what follows, as a stumbling point for painting analysis. As such, we consider the transformation through technological tools as a process for providing new ways for action and meaning generation.

In addition, our research questions means of communication and interaction: what happens to one's consciousness when the body moves (Bergson, 2014)? Applied to painting technique analysis this first question could be turned into: what are the relationships between images and gestures? Set in a technological context, this very Bergsonian question leads to a pragmatic case-study: how can a person's behaviour evolve within an interactive apparatus? Our approach considers agency as a central element that generates sense, meaning, and significance in the exchange between a person and a cultural artefact (Dewey, 1998; Dubos, 2019a).

Returning to our first topic, we explore rock art paintings in those terms: what could have

been sung or danced outside the ornate caves? Could the airbrush painters of the Chauvet or Pech-Merle caves have painted their bodies in the same way the Australian aborigines paint trace-dotted maps of their *dreams* onto their skins?

When talking with the eminent French researcher Barbara Glowczewski, specialist of the aboriginal traditions, we understood that Aboriginal people do not only sing and dance while decorating cave walls with their paintings but do indeed share their dreams through the art of drawing (Glowczewski, 2004b). Moreover, their paintings express certain patterns in order to represent the movement of the universe. And while they dance, this same movement is described by their footwork. The rhythm of the dance expresses a transcendental connection that makes man a channel for communication between various layers of life.[1]

The cave is not a painting museum

Trying to uncover what painting could mean for our ancestors, we understand that the art of painting in Chauvet or Lascaux is not comparable to our contemporary white cube art galleries. The cave as such is to be understood as a technical or memorial place for the transmission of skills.

Considering the art of painting in itself, the painting is the trace of a human gesture. Moreover, it might have been composed of a dance, a song, or a performance. The paintings are traces of community rituals that recall moments of sharing.

Ritualistic practices are expressed in a holistic way. They offer a specific look at the universe. They also generate a transcendental link to the 'invisible'. This transcendental link to another world – the world of the spirits, the ancestors, the phantoms – is manifested through ritual performance.

The pioneering female anthropologist of the Siberian culture, Roberte Hamayon (Hamayon, 1994), described how *shamans* of Mongolia sing and talk to the spirits. Anthropologists know that the shamanic practices exist in order to listen, speak, converse, and to transform our environment through a metamorphosis. For the communities practising these rites, the *shaman* can travel through the spirit worlds and back (Dubos, 2019b). This metamorphosis is spiritual, energetic, or physical (Ingold, 2013; Hamayon, 1994; Warburg et al., 2003). Even if nobody can postulate that there were ever shamans in the caves,[2] we can still be inspired by the contemporary *shamanic* practices to imagine our ancestors' lives.

Linked to ritual, the painting carries its own environmental practice, and is linked to the direct environment of the painter who uses natural pigments that originates from his surroundings. In this sense, we investigate through our artistic proposal the ability of the digital technology apparatus to offer a new way to materialise and visualise these possible ancestral crossings.

[1]This is what Roberte Hamayon describes in her book: *La chasse à l'âme* (Hamayon, 1990) writing about shamanism. And it is how the archaeologist Jean Clottes grounded his theory on a shamanic interpretation of the paintings in the caves (Clottes and Lewis-Williams, 2007).

[2]The experts disagree about this question: Clottes' theory is largely contested and Hamayon specifically refutes what Clottes says about shamanism in the cave.

Performed embodiment

The state of being during a performance is by necessity *embodied*. Without physical presence and the ability to influence the environment through action, performance cannot occur. However, *embodiment* cannot be merely understood as the fact of *possessing a body* and being physically present in a situation. On the contrary, *embodiment* depends on the embedding and enmeshing of an organism within its environment through *extensive* sensorimotor interactions (Hutto and Myin, 2013, p. 6). The relation between sensory experience and movement generates perceptual experiences. It is mediated by skillful use of implicit, practical, non-propositional knowledge, in the continuous feedback loop between behaviour and sensory stimulation.

From a phenomenological point of view (Merleau-Ponty, 1964), the links between body and world, between action and perception, between action, phenomenon and the body are the central elements that generate experience; an experience that is primarily inscribed on a pre-reflective, sub-personal level. Thus, the *perceivers* and their environment are inextricably bound together: this constitutes the 'enactive' relation with the world (Thompson and Stapleton, 2009),

In a cultural situation, the central element of experience is the perception of the other, directly or mediated by artefacts. And even if perception's physiological mechanisms establish a link on a corporeal level with the perceived bodies of others (Gallagher, 2005), theory of mind postulates that perceiving another subject occurs through the reading of the others' intentions (Searle, 1983; Tsakiris and Haggard, 2010). Furthermore, the intersubjective link extends beyond immediate encounters. Another person's (subject's) presence is inferred by their traces. These traces are given intentionality and can become (albeit weaker) subjects themselves; in pre-reflective perception, they are assigned the same ability to be agents, to direct actions, and to influence their environments (Gallagher and Frith, 2003).

From ideas to patterns

An idea is itself an embodied process (Bergson, 2014). No thought exists outside of our skin, no thought lives outside of flesh and bones. Thinking is a matter of evolving time and space linked to body movement.

Anthropological studies have shown that trance and shamanic states or modified consciousness can create various types of perceptions, which create more than hallucinations, patterns of imagery (Lewis-Williams and Clottes, 1998). Even if this hypothesis is controversial, it reveals that modified states of consciousness depend on specific patterns and 'architectures' of (re-)presentation for mental imagery to emerge. It is acknowledged that a certain kind of *universal* is appearing to human's mind in trance.

As a consequence, one can question the future of technology in a predictive perspective. Because today most of the interactions are mediated by screen technologies, physiologically, the eye-brain relation becomes the core of the 'emotional fabric' in all the media spaces we occupy.

If most of our research deals with the study of gestural sequences, in return, one can wonder: How to invent a *combinatorial* logic that invites action? What kind of future can emerge if we free the eye-brain connection and solicit the proprioceptive approach? How can a better embodiment of technologies be achieved; one that considers gestures, patterns – and going further – ecologies of practices and mind, which all reside at the core of culture making (Bateson,

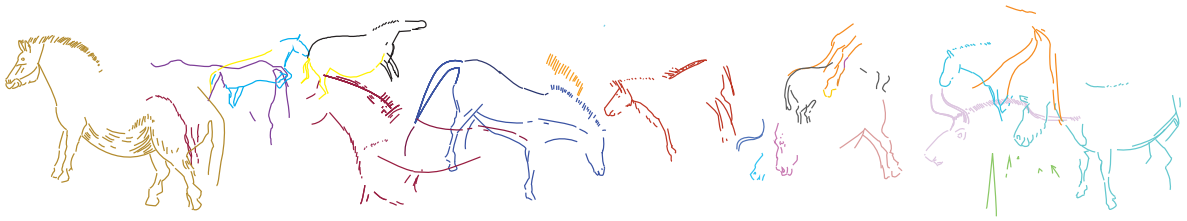

Figure 1: Re-tracing the horses of the Trois Frères cave in vector format. Source: Panneau LXIII. Trois-Frères (Ariège). Sanctuaire. Ensemble 13. Cheveaux n°146 à 150. Relevé H. Breuil. D'après Bégouën, Breuil, 1958. (Azéma, 2010)

1972; Ruesch et al., 2017)?

One is never far from the time of the ritual, explored by the artists through vocal pieces, drum games, the rattling of shells. The core of our concerns is this space, in which ritual objects are linked to representations. Perhaps a new kind of ritual is invented here and operates at the intersection between arts, anthropology, and technology?

Re-Mediation

When one ventures into a painted cave, the first thing one can see is a hand print. This print may be negative, a so-called negative hand, traced on the wall of the cave. The hand warns that you are entering into a singular space. This is a space where you see and hear something – where you receive something.

The same happens in a media environment, where the reading of signs becomes a central concern. "Re-mediation makes us aware that all media are at one level a 'play of signs,' ... [and] have the same claim to reality as more tangible cultural artefacts; photographs, films, and computer applications are as real as airplanes and buildings." (Bolter and Grusin, 1999, p.22)

When creating work, we use digital media and their fluidity to generate juxtapositions of elements from disparate layers of culture. This provides a direct 'enactive' engagement that includes physical presence and immediate 'manipulation' of the media objects. The playful approach to in-tangible or re-mediated images or sounds reinforces engagement and the sense of immersion. This engagement, partly engendered by suspension of disbelief, gives meaning to the exchange with the cultural artefact. We enter into an exchange with images, dreams, and imaginary entities that we can attribute to the artists of upper palaeolithic art.

Very few people are allowed to access the caves that hold these rock-art paintings and can thus experience the sites in person. The experience of the passage into the cave, into the dark, with varying light and shadows is unique. An art historian hypothesis emphasises that through means of shadow play, parietal art signifies gestures of painting with the hands (David and Lefrère, 2013).

Nowadays, unless a direct experience is allowed, all encounters with these spaces are mediated through (still and moving) images, to be viewed out of context. As a consequence, a distance remains to an immediate experience, provoked by the medial representations, but also by a gap in time and a gap in place that is difficult to bridge.

Media-art techniques may provide a way to access corresponding experiences. In the appa-

ratus, the arrangement offered to the visitor is to perceive, receive and to re-materialise a new experience.

Through the creation of a re-mediated situations that allow entering into contact with these layers of human culture, a different relationship may be established. Physical presence, direct action, spatial and sonic embedding all create an interface that emphasises the embodied, tacit, tangible ways of understanding.

'Knowing' the meaning of the cave paintings (or of any cultural artefact) obtains a different status through the embodied engagement. In this sense, *iconological* processes of juxtaposing images, first developed in the early 20th Century (Rampley, 2001), can now be extended to create an *icono-performative* engagement.

Subjective links and interaction

Ever since humanity exists in traditional arts practices, we are used to interacting with invisible worlds. What can interactive arts reveal that function as a truly new category? What is the point today to revive or reinvent the cave? Does it provide ways of understanding of a new kind of awareness?

Interaction with media enables to perceive fluid relationships between ourselves and images, sounds, and spaces. Even though they are based on simulation, interactive media have the ability to take on some of the characteristics of living things, or at least of motile physical objects. They no longer need to represent a 'real' object but can establish novel ways of connecting and translating elements between domains.

Transporting enough *signifiers* of physicality or even corporeality, the *re-presentations* in new media become *re-presences* that relate to the viewer, not just on a symbolic level, but enter into a directly *affective* relationship, to which we react on all levels. Mark Hansen asserts that: "The reaffirmation of the affective body as the 'enframer' of information correlates with the fundamental shift in the materiality of the media: the body's centrality increases proportionally with the de-differentiation of media. ... transforming media from forms of actual inscription of 'reality' into variable interfaces for rendering the raw data of reality." (Hansen, 2004, p.21)

The *intentionality* of interaction, the *directed-ness* of gestures and actions, obtains its meaning from the target or the goal of the interaction. In this teleological projection, the intentional action towards the other (thing) – the inter' – establishes the subjective link and assigns to the media-objects a stronger characteristic of presence or existence than a passively related-to media element.

The emergence of movement in entangled traces

Once placed in the surround projection space of the Immersive Lab, the archaeological traces of the *grotte des Trois Frères* are made to appear as if the animal shapes were interwoven in a mobile. The shapes seen on the cave walls are no longer mere lines, tracing the shapes of shadow puppets, but become animal figures, ready to move. For the observer of these lines, the horses appear as entanglements, such as described by Tim Ingold.[3]

[3]Tim Ingold describes entanglement as: "a meshwork of interwoven lines of growth and movement" (Ingold, 2010, p.3). Entanglement is to be understood as an alternative to the idea of networks of connections, favouring

In Animal Sketching (Calder, 1926), Calder narrates the days he spent at the Zoo of New York, watching animals, learning how to draw them. In his essay, he talks about movement as relationship between the tracer's hand and his eye. When he speaks of a movement, he is not interested in the physical movement of the animal (on an etiological level) but rather in a perceived moment, so as to know how to trace it. What interests him, beyond the symbolic identity of the animal, is its dynamics.

Our work on the idea that the animals can show themselves under the shape of a mobile requires several steps. When re-tracing the horses' shapes from the archaeological survey of the cave, one learns to draw them in one single stroke. This *re-drawing*, necessary to transfer the shapes into the digital domain, is at the same time a re-embodying, the passage of the shape through a perceiving subject, through an eye-hand link, *via* a gesture in a 'material' process. At the same time, it is a *dematerialisation* into code and sequences of numbers, objects to be manipulated by symbolic, digital processes.

Sounding cave and presence mediation

The sound dimension of painted palaeolithic caves and rocks are presented in the results of acoustical studies carried out in several Palaeolithic painted caves since 1983 (Reznikoff, 1995). They have revealed a deep connection between paintings and acoustical qualities of the locations of the paintings in the caves. The more a location of a cave resonates, the more paintings there are in this location. Studies of the picture/sound relationship in open spaces with painted rocks have given analogous correlations. In other words: the painting are placed on resonant walls. This means that sound has a great importance in the choice of the location of the painting (Blesser and Salter, 2007, p.74–75).

Parietal art magnifies the gestures of painting with the hands through means of shadows at play. Only when taking into consideration the dynamics of spaces in the flickering unstable light of a fire and the acoustic resonances of the caves, can the dynamic, performative nature of rock art be understood. This is why our research posits the use of *dynamics*, both visual and sonic, as a lens through which to investigate action, intention, reaction, perception, as well as collective creation.

Translation

With 'Les Mains Négatives', we investigate translation processes and the experience of a common and shared experiences with palaeolithic art.[4] To provide concrete processes and use-cases for this investigation, we observe three levels of re-mediation through three different technical implementations.

As such, the artistic practices, the configuration through technological solutions, and the analytic reflections combine to create our cross-disciplinary method.

The three translation modes developed and investigated here are (in chronological order): a screen-based, body-size interactive experience; a virtualised experience in a VR-environment; a

instead "[t]he entwining of ... ever-extending trajectories..." (Ingold, 2010, p.11).

[4] `http://www.littleheartmovement.org/?p=1477` NB: All URLs valid in August 2019.

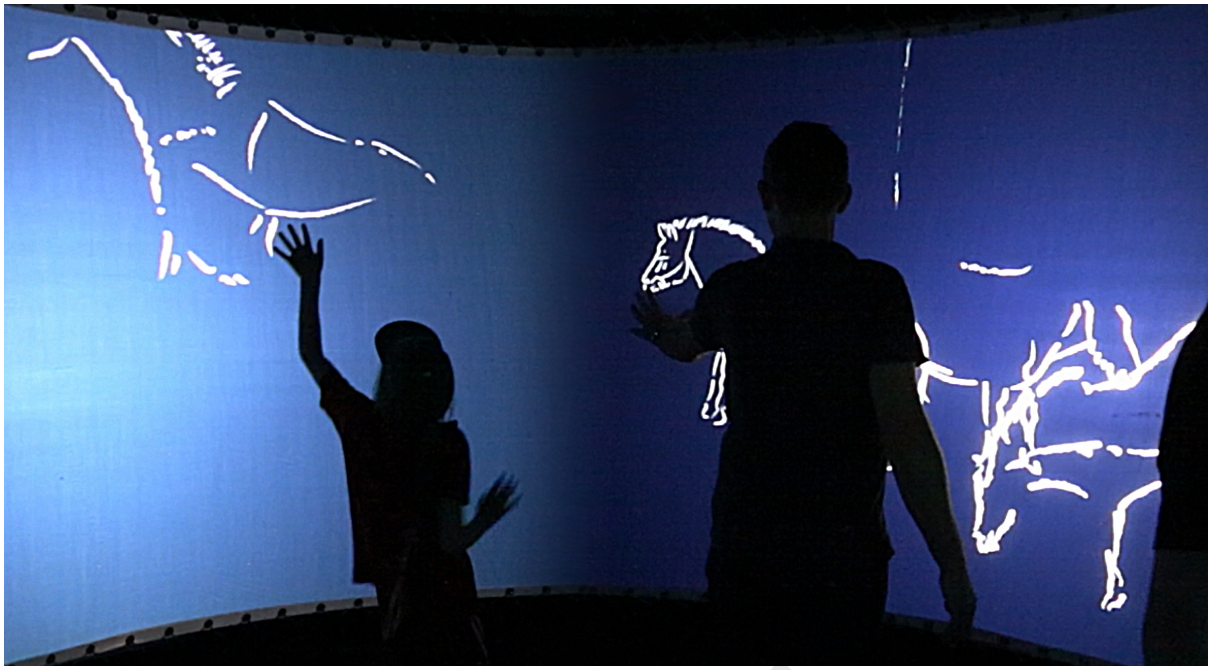

Figure 2: Interacting with the luminous animal shapes moving on the body-size panoramic screen.

re-configuration with physical shapes in the dynamic assembly of an actual mobile.

Body-sized immersive interaction

Within the interactive media-space of the Immersive Lab of the University of the Arts of Zurich, the visitors are invited to explore projected image and sound constellations.[5]

The darkened, physical space of this modern-day 'media-cave' envelops the visitor in the same way an ancient cave does. Entering this space implies the passage from an ordinary place into a mediated, constructed space of representations, as well as a multi-sensory engagement.

In the panoramic screen space, the cave-paintings are projected in a life-size scale (see Fig. 2).[6] Their moving presence invites a touch-based interaction; a sensory exploration of the transformations that are effected through the digital image- and sound-processes.

Contrary to a purely virtual experience, the coherence of the physical space includes the touch-based interaction and provides a constant and continuous experience for the visitor. Because the projection space is open to several visitors at the same time, it also enables a shared and social moment where exploration, discovery, and learning can occur in a mutual exchange.

The body-sized presence of the animal-shapes provides a first, almost direct encounter. The digitally reworked, two-dimensional shapes are combined in a simulated mobile that is animated by a physics model. Their hierarchical relationships are hidden by the flat spatial disposition and the invisible mechanics. A touch-interaction with one of the animal shapes on the screen gets translated into an impulse that sets the shape and its dependant nodes into motion.

Technically, the simulation runs in a C++ media-environment[7] using a cube-map projection

[5] `http://immersivelab.zhdk.ch`

[6] See video of this translation mode `http://immersivelab.zhdk.ch/?page_id=3599`.

[7] `www.openframeworks.cc`

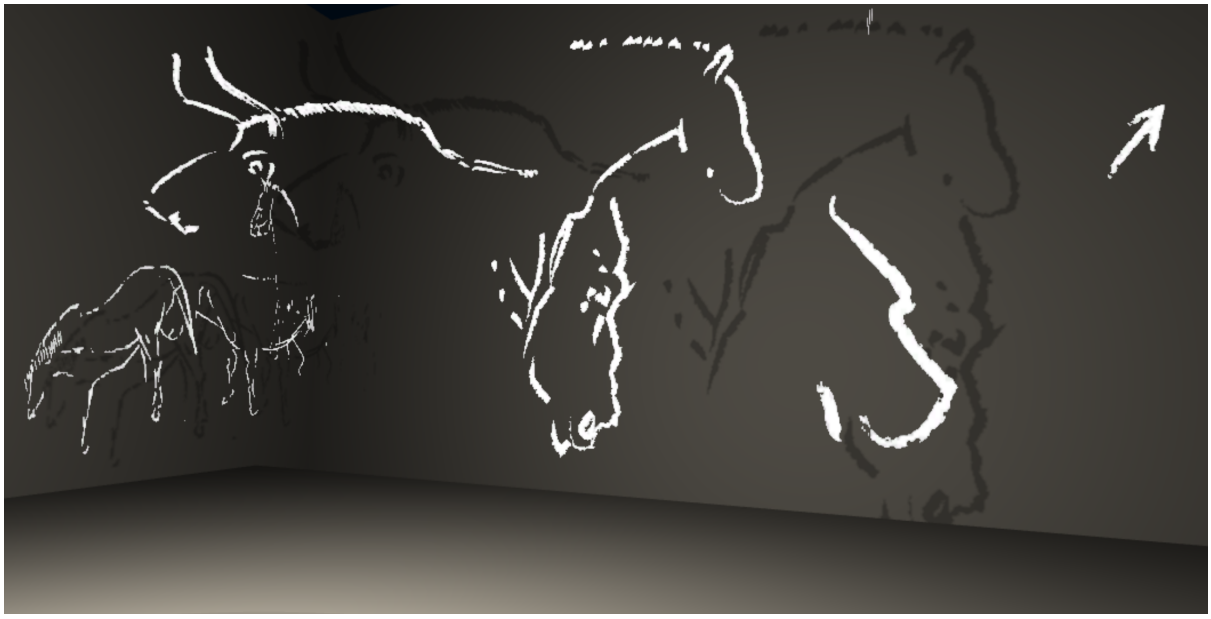

Figure 3: The moving animal shapes casting their shadows in the VR-environment.

onto the cylindrical screen-space. The entire screen is observed using a computer vision system operating in infrared light. This translates hand touches on the screen surface into multiple cursors that can be used to interact with the simulation software (Schacher and Bisig, 2017).

Virtualised experience

The translated form in the VR-environment de-materialises the experience and immerses the visitor in both the visual and auditory domains (see fig. 3).[8] The interaction through hand-gestures is maintained by tracking of the hands, and thus the engagement and agency remain strongly linked. The sense of immersion is increased and stimulates the experience of place by inviting the visitor into cave-like spaces, from abstract rooms to real, *photogram* captures of cave spaces.

The animated movements of animals in a space *around and through* the visitor provides a corporeal sense of an encounter. Scaling the imagery to the size of a human body, the horses' shapes take a 'presence' in the virtual space, which establishes a strong physical sensation, suggesting an embodied encounter with images.

The Calder-style mobile changes status from an object to a configuration of moving bodies with which to interact from within. In addition to the direct action on the images/animals, the shadows cast by the animals onto the walls of the 'cave' space become a central pictorial element. By gestural manipulation and through the moving constellations of animal shapes, a moving painting of shadow silhouettes emerges, which gives body to the claim that animal paintings in upper palaeolithic times[9] were a form of proto-cinema, a form of animated images, frozen in varying postures of movement (Azéma, 2010). The movement induced into the animals' silhouettes creates – through superposition – exemplars of rock art, as they are found in actual

[8] See video of this translation mode `https://www.youtube.com/watch?v=bjLVj-Ars5o`.

[9] The upper palaeolithic era stretched from 40'000 to 10'000 BC.

cave-paintings.

Technically, the simulation in the VR environment is coded in Unity,[10] and is running the inverse kinematics IK calculations in a custom C#-script. The touch interaction is captured by a Leap-motion hand-tracker, which provides spatial hand positions and allows for gesture detection in the 3D environment.

The *sound* for both experiences is generated interactively and is directly dependent on the visitor's interaction. To function as a metaphor, the triggers and collisions of the hands and animal shapes are *sonified* using sounds of resonating metal, in order to mimic virtual wind-chimes. In both cases, the sound is distributed spatially around the listener: in the former case a 16 channel surround-system renders the sound-events ambisonically (Schacher and Kocher, 2006), in the latter case, these surround streams are rendered with binaural processing, in order to maintain the spatial coherence of sound-events in the headphones.

The mobile, a dynamic physical reconfiguration

The final form of re-mediation is a reconfiguration of the animal shapes as physical objects in an actual Calder-style mobile (see fig. 4).[11]

The delicate animal tracings are scaled down and re-materialised as 3D-printed wire-shapes. Attached to each other in dependency in the multi-level mobile, they exhibit again the capacity to cast moving shadows, to superpose their shapes in the visual field of the viewer, thus creating a multi-layered, shifting image space.

Their perception and the physical rapport with the viewer becomes grounded in the concrete analogue reality – even if the animal traces have crossed tens of millennia and were transformed through digital image and fabrication processes, they still live with movement animated by a light breeze.

The visitor interacts with the mobile not by touch, but through the enactive space of perception, where, for example, changing the viewing position reconfigures the 'Gestalt' of the mobile (Katz, 1950). The viewer influences the movement of the mobile by blowing gently and thus actively modify the shadows that are cast.

Models and gestures

Physical models, physical modelling in a computational sense, provide a simulated representation of a natural phenomenon. In our case, the two layers of simulation include the image space and the space of physics of the Calder mobile (Baek and Yoo, 2001; Johnston, 2016).

Using inverse kinematics IK (Burdick, 1989), the simple rotations (torque) triggered by a touch on an element are propagated through the inheritance on the tree-topology of the mobile (see Fig 5).

Nodes in the mobile, the animal shapes, are connected via (invisible) beams to other nodes, going up to the root of the inverted tree, which is the only fixed point in space. The same as in a real mobile, an impulse is mainly applied to the receiving node and is only transferred partially up the hierarchy and across to its siblings.

[10] `www.unity.com`

[11] See video of this translation mode `https://www.youtube.com/watch?v=6Ol21Y7TBso`.

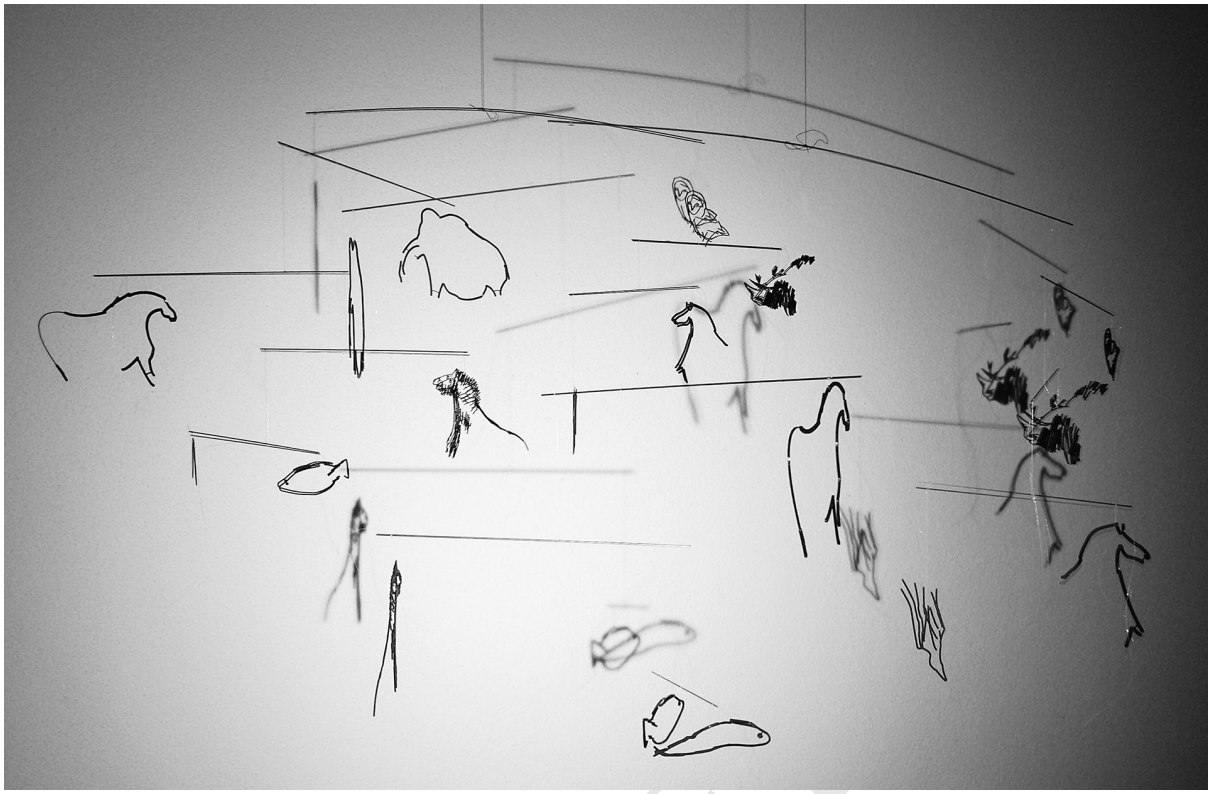

Figure 4: The physical Calder-style mobile with the 3D-printed animal shapes originating from the Saulges caves in western France. Note the shadow-play and superposition occurring through the spatial displacement.

Conceptually, the modelling takes also place in the translation of upper palaeolithic painting strokes into simulated objects. They can move in 3D space and thus, return to the symbolic animals a kind of mobility. This is a translation that does not make the original image-trace motile again (Plisson, 2015) but moves the shape within the iconographical field of vision. Through this process, the animal shapes are juxtaposed and their presence is amplified in the shifting perspective through the shadows cast onto the background of the space. The simulation 'mobilises' the shapes and provides complex movement dynamics. Because it is based on real-world experience and is anchored in contemporary visual culture, the simulation of the mobile remains accessible. To the viewer, the mobile re-establishes a dynamic relationship, between the elements, the space, the physical forms, light, shadows, sounds, perspective through a process of layering of information.

Gestural interaction creates a direct physical sensation, not by painting animals or strokes directly, but by setting them in motion and then being surrounded by the continuously re-configuring shapes and shadows of the animal traces. The life-size projections in the VR-implementation provide an engagement with arm-gestures that evoke and mirror the space of the original painting gestures. Touch-based interaction on the panoramic screen creates an enactive relationship at an intimate distance (see Fig. 2).

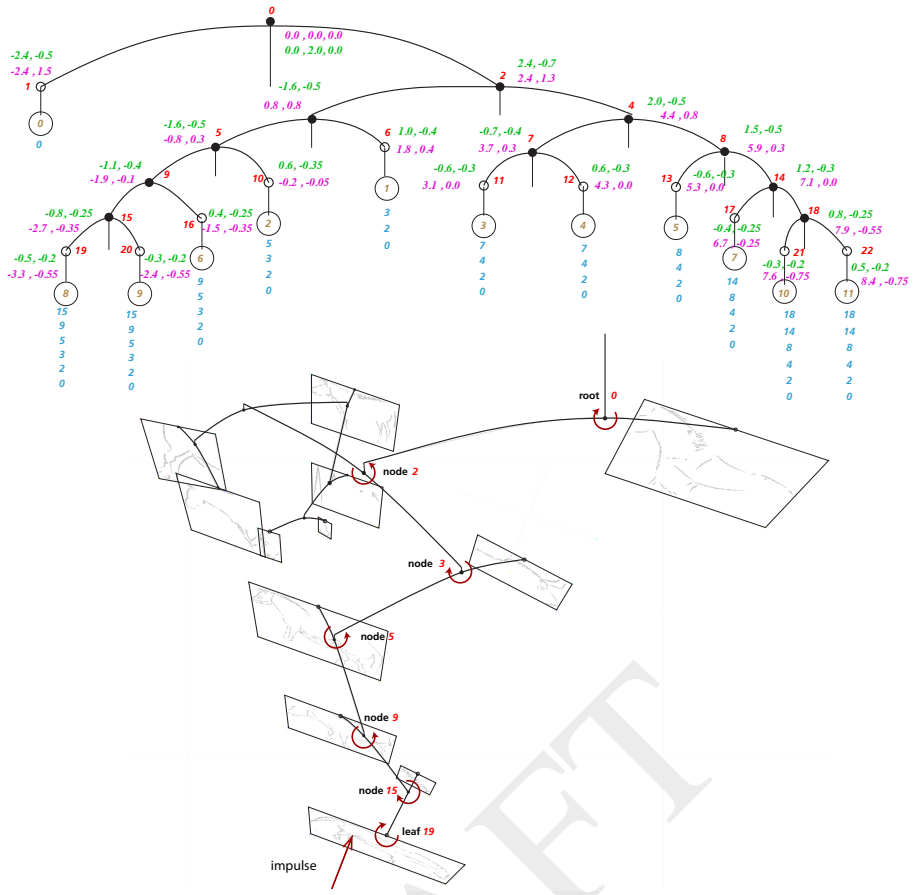

Figure 5: The tree structure of the Calder-style mobile with positions and inheritance (top), and the propagation of a movement impulse with positive and negative rotations (torque) via inherited relative positions of nodes (at bottom).

The Calder Effect

> Also, there is the possibility of using motion in an object as part of the design and composition. The sculpture then becomes in one sense a machine, and as such it will be necessary to design it as a machine, so that the moving parts shall have a reasonable ruggedness. Even those sculptures designed to be propelled by the wind are still machines, and should be considered thus, as well as aesthetically. However, the mechanical element must never control the aesthetic. Much better a poor machine and a good sculpture.(Calder, 1943)

In Animal Sketching, Calder talks about the movement, the relation of the tracer's hand to that of the designer's eye and by extension, to the body of the moving animal Calder (1926). What interests him is the relationship between the symbolic identity of the animal and its dynamics.

When Calder speaks of movement, he also speaks about pose. Calder is not interested in the etiological perspective, but rather in a perceived dynamic moment, so as to know how to trace it. It is a matter of considering elements of knowledge as dynamics.

There is an interest to distinguish between the two notions of dynamics and kinematics: In physics, kinematics corresponds to the study of movements independently of the causes that

produce them; to the study of all possible movements. If space is the notion corresponding to geometry, kinematics introduces the notion of time. The term dynamics is used to describe the forces, causes of the movement. The term dynamics is also used to describe what can change over time.

Therefore, the pigments, the traces, the painting technique, plus the singular arrangement of the animal shapes is meaningful in the senses it combines various elements for an illusion of a movement: a dynamic.

Moreover, this perception of the dynamics creates a relationship between the eye and the hand: a way of understanding or processing knowledge, as our body is formed by the physical world – relationships of balance, force, strength, and thought; the manifestation of an abstraction that we are able to perceive through the body.

Somehow, the animal paintings of the cave are vectors of knowledge, because they are witnesses of a story. But their arrangement, the traces of the painting, but also the gesture teaches us something of the era of the painter: the history of the technicity, and the narrative formed by the images.

The cave is an imaginary space for animals and animations, as well as for the animus' (spirit's) manifestation. It is an apparatus for various kinds of bodies in motion. Marc Azéma, in 'The prehistoric cinema' (Azéma, 2011; Azéma and Rivère, 2012), shows how animals are already animated elements. According to him, the shadows open up the spaces of simulation of animated movements. Getting them back into play, within a physical system, allows us to apprehend them in a new, experiential manner. Through movement, by touching or pushing, the relationship of the elements of this cosmography, the horses, are reorganised as a movement of fundamental elements, according to their physical dimensions.

The mobile structures that we built investigate the animal arrangements and thus become devices for perception of physical, corporeal, and embodied knowledge and history. The gestural interaction with the mobiles allows us to go from abstract representation to the production of knowledge through dynamic perception. This is what we call 'The Calder Effect'.

A final note on Entanglement

The 'Calder Effect' is the encounter of an object in space, which allows, by *enaction*, to generate a different field of knowledge: a transductive vector between the tool, the thought, and the body. From an analytical point of view, we could continue the reflection and spin the aesthetic intent of Calder, bringing it closer to Ingold's development on the notion of entanglement.[12]

Speaking of moving objects, Calder points out that mechanical elements must never take control over the aesthetic measure of the work. Tim Ingold himself, developing the notion of entanglement, also criticises the structural and quasi-mechanical approach of the network (web) concept (Callon, 2006) – where the network is built by axes, nodes, and directions. If

[12] "Life is lived in a zone in which earthly substances and aerial media are brought together in the constitution of beings which, in their activity, participate in weaving the textures of the land. Here, organisms figure not as externally bounded entities but as bundles of interwoven lines of growth and movement, together constituting a meshwork in fluid space. The environment, then, comprises not the surroundings of the organism but a zone of entanglement." (Ingold, 2008, p.1796)

the notion of *network* or *web* refers to a mechanical representation of activity, entanglement is a multidimensional depiction of many forms of lives, interwoven.

In the concept of entanglement appear bodies, spirits and intertwined movements. The machine-network organises in turn the forms and the relations according to a structure. When this structure is made dynamic and perceivable, this is what we call the Calder effect: the bringing together of the invisible architecture of the movements that lead to superimposed and printed forms perceived in entanglements.

Resonance

This project investigates the space between the time of history and the time of new technologies. If one looks at the geostationary satellites, they are 36'000 km away. The cave paintings are 36'000 years old. In those dimensions, we question the techno-digital tools and their use.

We trace a connection from cave painting techniques to the immersive media apparatus, coincidentally also called a CAVE. (Cruz-Neira et al., 1992).[13]

To resume, whether it be cave paintings, Calder's drawing of animals at the New York Zoo and his mobiles, or the technological apparatus: these elements all talk about the relationship between the environment, the body, and perception. In our configurations, the technological apparatus allows us to re-arrange and re-mediate the intertwining of palaeolithic paintings. The 'Calder Effect' allows us to think differently about the arrangement of animals in the cave, according to a dynamic way of thinking: Horses are not only animated images (a kinetic shape) but are installed in a dynamic flow.

After deciphering the movement of the animals in the *grotte des Trois Frères*, one can even wonder if the horses' positions were not meant to describe the movements of star constellations. This changes how we consider our ancestors, the Aurignaciens, who, we believe, had complex and refined thoughts and ideas.

And we – as the *Brand New Ancients* described by the poetess Kate Tempest (Tempest, 2017) – "are much more than the sum of the things that belong to us," when our action is entangled in a perpetual motion of humanity, knowledge, and transmission. As brand-new researchers, we need to think in terms of dynamic movement in order to further develop and transmit knowledge for the improvement of interdisciplinarity. Intelligence has no boundaries.

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[13] Chicago Automatic Virtual Environment: `https://edtechmagazine.com/higher/article/2013/01/university-illinois-chicago-virtual-realitys-cave-pioneer`

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