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l'information et de la communication

Sélection raisonnée de travaux

« **L'image-interface :**  
**Approche sémio-technique des objets hypermédias** »

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## Introduction

Ce volume du dossier d'habilitation à diriger de recherches présente une sélection raisonnée de mes travaux autour des médias numériques, de leurs spécificités à leurs cadres d'usage. J'ai structuré cette compilation en trois parties.

Dans la première section, « Les médias comme systèmes d'information », j'essaie de fournir des pistes pour penser les contenus médiatiques dans leur relation aux dispositifs numériques et, plus particulièrement aux logiciels et aux systèmes d'information. Un système d'information est donc perçu comme un ensemble technique où les échanges d'information se créent et se gèrent. Mais sans vouloir mettre l'accent sur les catégories et les genres médiatiques, mon intérêt est de voir comment les logiciels transforment les contenus. De cette manière, il m'intéresse d'investiguer comment un type de média (visuel, auditif, tactile) est modifié, amplifié, accédé, transmis... et toutes les variétés de médiations via les composants des logiciels.

Ensuite, dans la deuxième partie, « Interventions techniques d'un point de vue SIC », met en pratique les conceptions théoriques. On observe que ces expérimentations répondent à un contexte qui oscille entre la pédagogie, la manipulation technique, la représentation de l'information, la navigation des espaces numériques. Vus en ordre chronologique descendant, les trois textes choisis permettent d'apprécier un passage de l'analyse visuelle, esthétique et métamorphique des médias vers des interventions à la frontières de l'art et du design. Bien que je ne me présente comme un designer ou artiste, il est souvent chez le récepteur de ces explorations qu'un dialogue affectif et émotionnel s'entame avec les images.

Dans la dernière partie, « Vers une approche sémiotique des objets hypermédia », je rassemble trois contributions publiées auprès de la communauté de chercheurs en sémiotique et communication. La terminologie utilisée pour décrire quelques phénomènes communicationnels provient surtout d'une école parisienne, élevée par

Algirdas Greimas. On contemple comment sa pensée reste d'actualité, ainsi que la notion de « structure » et « narrativité ». Le projet de longue durée qui se dessine à partir des travaux de cette section est de proposer un bagage acceptablement cohérent, ou, du moins, avec des outils solides pour tisser les liens entre les méthodes informationnelles et les approches de la science de la signification.

### **Notice de lecture**

Les textes ici présentés ont tous été rédigés par moi-même dans la langue de la publication<sup>1</sup>. Quant aux images et figures, elles sont le résultat de mes travaux en utilisant des procédures informatiques variées. Pour uniformiser le format et la mise en page des différentes maisons d'édition qui ont publié les textes, j'ai opté pour reprendre les versions originales et les adapter au style que j'utilisé dans les trois volumes de ce dossier d'HDR. Pour faciliter l'accès, j'ai traduit en français les résumés des articles dont la langue originale est étrangère (essentiellement en anglais, mais j'ai inclus un seul en espagnol).

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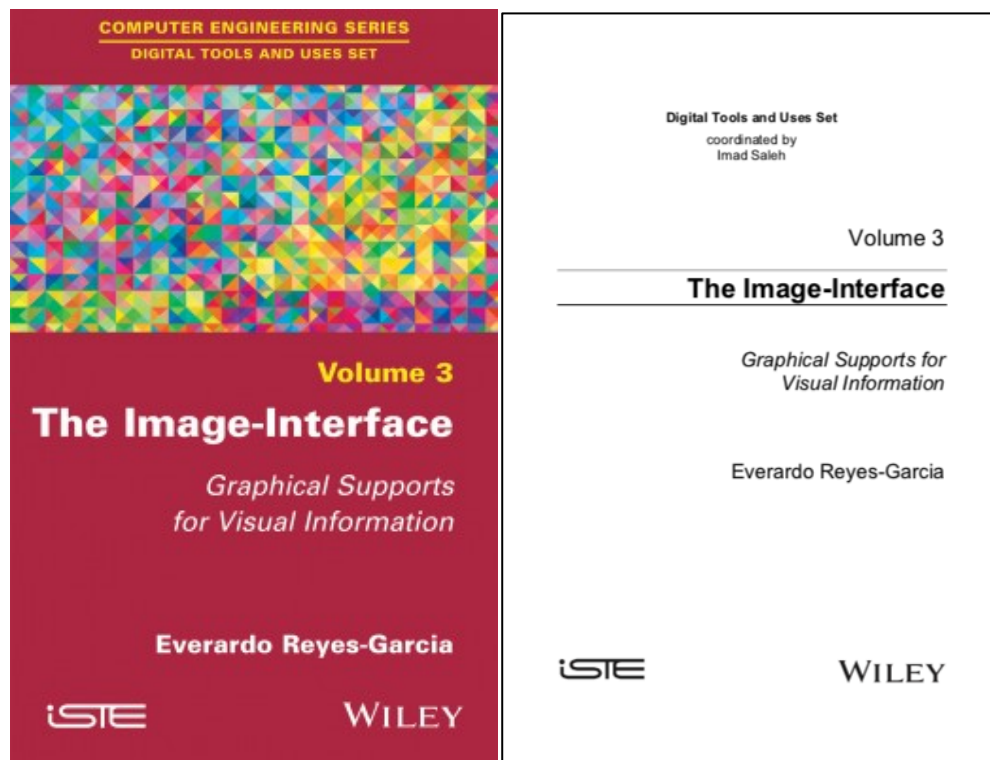
<sup>1</sup> La seule exception est l'article « New approaches to plastic language », co-rédigé avec Göran Sonesson et à paraître chez *Semiotica*, De Gruyter.

## Partie 01. Les médias comme systèmes d'information

Au sens large, les médias peuvent être conçus comme des programmes écrits à l'ordinateur qui se manifestent de manière graphique à l'écran, sous forme de texte, image, vidéo, logiciel, site web, visualisation de données ou comme toute autre réalisation numérique en général ayant le but de communiquer un message. Certes les médias peuvent aussi avoir des dimensions auditives et tactiles, mais dans les recherches ici réunies, l'accent se trouve sur les formes visuelles. Le caractère dynamique et presque éphémère des médias informatisés conduit à prendre en compte les supports, le *hardware*, les protocoles, les composants techniques de stockage et traitement de l'information qui vont déterminer en grande mesure le « mode d'existence » des objets médias.

Le premier texte est issu de mon ouvrage individuel *The Image-Interface : graphical supports for visual information* (Wiley-ISTE, 2017) J'ai repris intégralement l'introduction et la conclusion car elles englobent les objectifs généraux de mon approche sur les images-interfaces. Le deuxième texte est l'introduction à l'ouvrage collectif « Design de systèmes hypermédia interactifs » (2017). Ce texte, ainsi que tous les chapitres de l'ouvrage, ont été traduits à l'anglais par la maison d'édition ISTE. Ces deux premiers textes font partie de la collection « *Digital Tools & Uses* ». Le troisième texte, *Designing Pervasive Virtual Worlds*, date de 2015 et il s'agit d'un chapitre du livre *Handbook of Research on Digital Media and Creative Technologies*. Les idées principales du texte rallongent un autre chapitre que j'avais écrit en 2009 *Pervasive Virtual Worlds* dans la même maison d'édition. Le quatrième texte de cette compilation est un article de conférence, présenté publiquement à Rio de Janeiro, Brésil, auprès de la communauté d'artistes-chercheurs et praticiens en arts numériques.

## 1.1 L'image-interface : supports graphiques pour l'information visuelle



**Figure 1.** Couverture de l'ouvrage *The Image-Interface : graphical supports for visual information*.

Londres : Wiley-ISTE, 2017. ISBN : 978-1-78630-062-1

### 1.1.1 Présentation en français de l'ouvrage

Les pratiques et utilisations numériques sont façonnées par les représentations graphiques qui apparaissent à l'écran de l'ordinateur, constituant la surface principale pour la conception, la visualisation et l'interaction avec l'information numérique. Mais avant que toute image ou interface graphique soit rendu visible à l'écran il y a une série de niveaux qui détermine les propriétés visuelles. Afin de découvrir ces processus, il est nécessaire d'étudier les application logicielles, les éléments des interfaces graphiques, les langages et le code de programmation, les algorithmes, les structures et les types de données dans leur relation avec les résultants graphiques et leur possibilités de design.

Cet ouvrage s'intéresse aux interfaces comme images et aux images comme interfaces. Il offre un cadre de travail compréhensible pour examiner les représentations graphiques des informations visuelles. L'ouvrage explore le rapport entre les informations visuelles et leurs supports graphiques sur la base de l'informatique visuelle. Les supports graphiques sont conçus dans leurs aspects matériels et formels sous-jacents à la représentation des images numériques à l'écran.

### 1.1.2 Introduction intégrale en anglais de l'ouvrage, pp. XI - XVI

This book is situated within the period of time that has been influenced by the information age. The time span has developed from the invention of digital computers to the contemporary scene of massive generation and storage of data. From the standpoint of information and communication studies, this period of time is deeply related to electronic media. In this book we understand *data* as digital information and *electronic media* as the means to access and make sense of it.

In our present study we are interested in a particular modality of electronic media: the graphical mode. Although most of the perceptive physical world to human senses has been simulated and described with electronic media (sounds, smells, tastes can all be quantified and stored as bits and bytes for a latter representation), the vast majority of developments in electronic media has taken place in visual form. We look at the computer screen as the main material support where digital information is represented in order to convey meaning. Nowadays screens have become pervasive. We see and interact with them in laptop and smartphones displays, in desktop monitors, as beamer projections, in LED displays in elevators, city signage, museum exhibitions, park attractions, airports and public transportation. Screens can be public or private, shared or intimate (such as head-mounted displays).

The kinds of images depicted in computer screens are tightly related to the display technologies that underlie them. As computing power increases, for instance supporting more complex and multiple tasks, larger files, or higher resolutions, the look and style of images reflect on those advances. Consider the differences between a 1980s videogame graphics and today's consoles. Or let's evoke the first computer animations that were used in music video clips to compare them with today's amateur and blockbuster films. The World Wide Web has also witnessed this evolution. The first images supported by web browsers are not the same in quality and resolution if we consider recent developments in technologies such as CSS3 and WebGL. What we can observe in all these cases is foremost a quest for realism and hyperrealism. Technicians and artists have devoted great efforts to make images look "more real", i.e. to represent the physical world with more detail, with the highest possible similarity.

But at the same time, there is another kind of image in electronic media. In order to produce those realistic images, creators use the same computer screen in a different manner. They use graphical interfaces. Whether the authoring software is based on user

interface elements such as windows, icons, menus, pointers, or it uses a command-line console, it is the same rectangular space of the screen that is redrawn to allow the interaction between data and meaning.

We are interested in studying the computer graphical interface as an image. For that matter, we have to take a step back from the representation of “realistic” images. Graphical interfaces are visual supports of information and we look at the way in which interfaces are constructed to convey meaning. Throughout the history of computing, the community of researchers in human-computer interaction (HCI) has developed models based on cognitive and language capacities in order to describe efficient ways to create graphical interfaces. Our study intends to contribute to the domain by relating interfaces to images. In other words, it is about regarding the visual constituents of interfaces before and at the moment they are identified as interfaces.

To illustrate our purpose, it is possible to list some visual constituents that exist not only in interfaces but in any other visual form of image. Following the theoretical tradition of visual semiotics, we can talk about plastic categories: colors, forms and textures. For each category, there are smaller units of analysis (colors can be described according to numerical values of saturation, brightness, “redness”, “greenness”, “blueness”). It is interesting to note that, when we describe a picture or an interface, we can establish relationships between units at the same granularity level of or we can reassemble them in other semantic units. Imagine, for this case, that the position of forms in an image motivates the perception of vectors of direction, by means of graphical abstraction and Gestalt principles. Hence, we could now examine “vector” patterns in different images, for example.

Studying interfaces as images means that there is visual meaning behind the construction of any authoring and exploring environment. Whereas one of the main influences of HCI in everyday interfaces can be perceived through the WIMP paradigm (which stands for Windows Icons Menus Pointers), it is necessary to broaden this perspective. Authoring software has a long tradition that builds on reading-writing schemes. The pioneering research on hypertext systems during the 1960s -long before the invention of the World Wide Web- introduced models for non-linear writing and reading. Among such models, we may cite the relational, the taxonomical, and the spatial.

While the first authoring environments were mainly conceived for textual content, the introduction of different types of media came with an explosion of paradigms and



visions. With the support for images, video and audio, creators could now explore storytelling in different ways. However, it was necessary to think about new metaphors to signify actions on abstract objects: to link, to import, to animate, to copy, to delete, to paste. Closely related to graphical interfaces, there is also the development of programming languages and programming paradigms. Starting from declarative and functional languages, then we saw the emergence of generative and object-oriented languages. The syntax is of course a visual matter. The kind of programming marks such as dots, commas, brackets, curly brackets is a way to represent dependencies, inheritances, and encapsulation of data. It is not surprising that more recent graphical programming languages were introduced: boxes connected to other objects by means of links and edges.

As it occurs with photographs and paintings, an interface as image can be approached as a diagram, symbol, index, and other categories of signs. The image of an interface conveys in itself the traces of its production. It is possible to relate the operative system, the authoring software, the complexity or simplicity of functionalities. It is also a symbol of its time: the visions foreseen to be accomplished with electronic media; the ideologies associated to such productions. Interfaces, through language and affordances, are meta-images of enunciation that speak to their users, in a similar instance of mirrors, reflections, windows, and depictions of the painter inside the painting.

Today any user of electronic devices can take photographs, add visual effects, edit them, share them, comment on them. New users have become a sort of media producers. Graphical interfaces have become easier to use, at least at their basic level. While we can study the evolution and the effect of portable devices in the aesthetics of social images, we are more interested in: How designers produce and distribute data and images? Which functionalities are integrated and which ones are left behind? How our new images and interfaces are shaping the emerging post-digital culture?

Designers in the information age are expected to invent new ways to explore information, to make sense of data in environments that change constantly. As it happened to pioneers of authoring systems, designers need to investigate new metaphors, new platforms, new actions that are possible with digital and networked technologies. In this context, designers and developers have embraced the World Wide Web as a privileged environment to create and distribute their creations. The technological possibilities of the contemporary Web, along with the development of

computing devices, allow to experiment and dream about such new models. The tradition of multimedia authoring systems converges today with massive quantities of social and historical data. The kind of interfaces that designers produce is related to reading-writing software in the sense that they are interactive, they support explorations, discoveries and insights that might have passed unattended otherwise. Designers are like image craftsmen because they take decisions about visual composition, arrangements, and metaphors. Moreover, they must reflect on the potential outcomes of the interface: the kind of data, format and media, the parameters that can be modified, the series of actions that a user can perform, the pertinent vocabulary, language, and syntax, etc.

While common users have increasingly access to cameras and image editing software, designers have a wide variety of production tools at their hands. Some research is necessary to investigate the kind of software available (desktop, mobile apps, web apps) as well as programming languages, APIs and libraries that handle data and communicate with the ever-changing environments. Although many software and production tools are developed with a particular objective in mind, it is interesting to see that tools can be mixed and remixed. While the material support remains constant (the screen), it is when we put attention at its configurations that innovations take place.

Thus design will not be for us a specific discipline where we position our study, nor a bunch of recipes and ready-made toolkits to add visual effects or improve the visual style of a project. Design will be understood as a way of life. It is more like a reflective thinking posture about our practices in order to produce new kinds of explorations and actions. It is about questioning defined models to propose unexpected schemes. It is about producing meaningful tools that communicate aptly in the context in which they function. It is about going beyond the pre-defined figure of a “user” and to consider her/him/them as “visitors”, “wanderers”, “researchers”, “learners”, “meaning-makers”. It is about taking seriously and responsively the work of tool-making; to remember that through our work we are also shaping ways of being (as it was suggested by Winograd and Flores [WIN 86, p. ix]).

As we said, screens have become pervasive; they are material supports of representations. But at the same time, the screen is alive; it reconfigures itself as formal support. The computer screen is today’s canvas of painters, designers, researchers and students in information and communication. Interfaces are the pervasive kind of images of the information age.

## Contents of the book

Chapter 1, “Describing images”, compiles relevant insights forged within the tradition of sciences, humanities, and media studies about the study of images. Although this is not a book about interpreting cultural images, it does take into account research that puts attention on material and technological descriptions of images. This is important because we will identify levels of analysis and methodologies that in other chapters will be used as strategies to design and produce visual interfaces. In this respect, a brief discussion regarding the notion of interface is also contemplated.

Chapter 2, “Describing graphical information”, is devoted to the foundations of graphical information. In this part we consider images as data and digital information. We look at the technical aspects that define a digital image: from data types and data structures required to render an image on the computer screen to seminal algorithms and image processing techniques.

Chapter 3, “Practicing image-interfaces”, adopts a pragmatic perspective towards image-interfaces; it studies how image-interfaces are practiced, observing the different manners in which those elements are put together, notably through software applications. This chapter is organized into different categories according to practices of imaging, for example image editing, parametric design, but also writing and Web environments. As long as we talk about image-interfaces, not only the result of some software manipulation is of our concern, but also the graphical elements that accompany the user to achieve such transformations.

Chapter 4, “Designing image-interfaces”, places special attention to those cases where the image being manipulated acts as the graphical interface. It deals with multidisciplinary fields at the crossroad of several disciplines, such as graphic design, data science, computer science, and humanities. The kinds of results that are produced from those perspectives include data visualization, networks graphs, infographics, cultural analytics, and data art.

Chapter 5, “Prototyping image-interfaces”, present our own productions and experiments created within the context of image-interface and data visualization. It covers a range of prototypes, screen shots, and sample code for scripting software applications, integrating data and media visualization, and extending the generated images beyond the screen, to “data physicalization” via 3D printing.

The conclusion part points to perspectives that still have little or recent exposition to information sciences. The term “visual hacking” is employed to make reference to speculative advances in image-interfaces inspired by the non-visible electromagnetic spectrum, non-Euclidean geometry, obfuscated code and exotic data structures, and critical and radical design. Finally, the appendices section summarizes in form of tables the software applications discussed in chapter 3. It also includes tables of JavaScript libraries, web links to data visualizations and tools.

### **1.1.3 Conclusion intégrale de l’ouvrage : « Into Visual Hacking », pp. 233-239**

This book studies interfaces as images and images as interfaces. On the one hand, it considers the graphical properties of user interfaces as they appear on electronic screen. On the other hand, it also takes into account the image and graphical representations of symbolic data as a mechanism to interact and produce knowledge. As we have seen, this double perspective has become a prominent paradigm in sciences and humanities, which constantly let their field to be assisted by software and computers. Moreover, with the growing interest on “data culture” and associated terms (“big data”, “open data”, “data visualization”, “datification”, etc.), the increasing use of graphical methods to present and analyze data has grown exponentially.

The purpose of the book has been to unfold, or rather to have a brief glance at the layers underlying digital imagery. The intention of such endeavor has been to understand how and where do graphical supports come from and, likely, to question and make design interventions on them. This pragmatic approach exhorts to understand but also to produce new methods and graphical configurations.

The methodology chosen to uncover the intricate layers of digital imagery complexity has followed a rather linear model of semiotic inspiration that goes from signs to texts to objects to practices and then to strategies. At the bottom layer are situated the most basic and abstract entities that create meaning: signs. For digital images, the main signs are similar to other digital media: data types, data structures, and algorithms. Then, the text level is determined by programming languages, graphical interfaces, and file formats. At the object level, the most concrete materiality of digital image is seized: screens, cameras, and printing devices.

In the last two chapters the book offers examples of how the layers of elements are practiced. First, in chapter 4, a historical review of media software is given to locate how interfacial arrangements and interfacial logics appear. Second, in chapter 5, I document

and discuss my own productions and graphical interventions within a scientific and educational context.

It is clear that more work needs to be done. Some levels demand to be unfolded more deeply and appreciated in full detail. This task became out of the scope of the present book because of issues of time and length. Nonetheless I hope in its actual form, this study serves as an overall guide to identify entry points and potential connections between levels.

At the current state, I want to conclude by pointing to some exciting developments and clues for future projects, a series of practices that cover what I call “visual hacking”, allowing to move and flow from one level to another, to use and re-use techniques from one visual domain into another, to construct or intervene on optical devices, to get conscience that images are delimited by greater layers of technical, social and political complexity that have to be considered.

### **Non-visible waves visualization**

In section 1.1.1 the electromagnetic spectrum helped us to situate visible light among other types of wave radiation: (in decreasing magnitude order) gamma, x-ray, ultraviolet, infrared, t-ray, microwave, and radio waves.

Regarding gamma rays, image examples can be found in astrophysics. For example, the popular images captured with the Energetic Gamma Ray Experiment Telescope (EGRET), specially the gamma-ray sky maps, are well known<sup>2</sup>. For X-ray, UV and infrared, museums and professional institutions have produced techniques based on such waves that allow for analyzing differently a painting. For example X-radiography penetrates the paint layers and might uncover previous sketches by an artist<sup>3</sup>. Finally, for radio wave and Wi-Fi range waves, artist Nickolay Lamm, for example, produced in 2013 a series of photographs where the viewer can imagine the size, color, and shape of signals<sup>4</sup>.

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<sup>2</sup> <https://heasarc.nasa.gov/docs/cgro/images/epo/gallery/skymaps/index.html>

<sup>3</sup> The Art Institute of Chicago has elaborated examination techniques applied to the work of painter Pablo Picasso: UV light, x-rays, and infrared reflectography. More info at: <http://www.artic.edu/collections/conservation/revealing-picasso-conservation-project/examination-techniques>

<sup>4</sup> <http://nickolaylamm.com/art-for-clients/what-if-you-could-see-wifi/>

## Nano-scale

It was discussed in section 2.2.1 that the passage from binary code to data types is the departing point in our study. It was mentioned that we could go deeper into electronic operations if we place our interest into circuits and how signals behave among digital components. In section 4.2.6.2 we explored graphical representations of circuit components. To continue the reduction of scale several steps further, we could also go into details of electrons and other subatomic particles (recall section 1.1.1): properties of quantum information (qubit systems) such as parallelism, entanglement, interference or superposition, or nanophotonics and its applications (plasmonic nano-lasers, nano-structure light-emitting diodes, photonic crystal nanowires, nano-structured waveguides, thin films with a negative refractive index, anti-reflection with nano-structures for solar cells, high-sensitivity plasmonic biosensors, etc. [LEE 15, p. vii]), to mention some of examples. At this level we could find new representation models of probably new electronic components that go beyond binary oppositions.

## Exotic data structures, esoteric languages, obfuscated code

In section 2.3.2 we saw different data structures that prove efficiency to handle and store visual information. If we take as example a series of objects within a digital world, we typically have a scene graph containing the objects. But it is common to store the same data scene in several different structures, for example “a list of characters in the world for efficient iteration during Artificial Intelligence simulation, a hash grid for collision detection, and a BSP tree for rendering them” [HUG 14, p. 1102]. As graphics programs evolve and differ in their needs, new structures also can be designed. Sometimes called *exotic data structures* because they combine simpler data structures or data types in different manners required for very particular tasks. An example, applicable to visual information, would be the left-leaning red-black (LLRB) tree, as it might provide “a fast priority queue for a large data set” [HUG 14, p. 1102], others could be the smushed list, the unlinked list, and search-bush<sup>5</sup>. The manner in which we can design and implement new data structures depends on the programming language we use.

While the customization of data structures to achieve a specific goal might seem exotic to some users, programming languages may also be created as means of political, artistic, and individual expression. Esoteric languages like Piet, Haifu, Chef, among many

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<sup>5</sup> As proposed by blogger Leigh Simpson in <https://blog.simpleigh.com/2012/10/exotic-data-structures/>  
A larger list of data structures can be found at: [https://en.wikipedia.org/wiki/List\\_of\\_data\\_structures](https://en.wikipedia.org/wiki/List_of_data_structures)

other languages, algorithms, and operating systems emphasize the expressive aspect of enunciation. For example, in *Piet* the code is considered itself a piece of modern art inspired by painter Piet Mondrian; in *Haifu* the language is based on Eastern philosophy; and, in *Chef* programs produce kitchen recipes<sup>6</sup>.

But we do not have to use an esoteric language to intentionally signify the difficulty of understanding code (or at least the expected ease championed by commercial discourses). The practice of obfuscated code suggests that “coding can resist clarity and elegance to strive instead for complexity... making the familiar unfamiliar” [MON 08, p. 198]. Thus examples of such code can be found in beginners that misspelled or write erroneous yet executable line of code. Indeed, for some experimented programmers the way in which JavaScript handles data types and structures has led to think of fragments of code as incomprehensible or unpredictable.

### **Speculative and critical software**

Following media theorist Matthew Fuller, in terms of “speculative software” software simulates ideology. In this respect, all software components, from the most abstract to the most concrete, figure as simulations that can be interrogated and questioned. Speculative software would be software that reveals its processes as it enacts them: “What characterizes speculative work in software is, first, the ability to operate reflexively upon itself and the condition of being software (...) to make visible the dynamics, structures, regimes, and drives of each of the little events which it connects to. Second, (...) to make the ready ordering of data, categories, and subjects spasm out of control. Third, it is to subject the consequences of these first two stages to the havoc of invention” [FUL 03, p. 32]. For any speculative effort on software it is, once again, necessary to go further down the GUI.

As we mentioned, one of the main departing point of thinking different about our graphical interfaces and interactive systems is to keep considering them as fulfilling a need of some imaginary user. User may not have needs. Users may not have a determined goal or information to obtain from a system. What happens if we think about users as “wanderers”, or as “specialized researchers”, or as tourists in a new city, trying to understand differences and culture. Speculative software would then satisfy more fuzzy

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<sup>6</sup> A list is available online: <http://www.dangermouse.net/esoteric/>

and general objectives. Which lessons can we learn from here? How can we formalize an interface with this scenario in mind?

The relationship between art, design, and technology can be observed from the standpoint of disruption and aesthetic provocations. The importance of fostering such practices is to challenge traditional movements toward standardization and sustainable perfection of society. Computers and code, however, hold a human imprint, which is charged with questions that art and philosophy can speculate to answer. For example, my project “Disrupting 3D models” is a small application made with Processing with the intention to open an external 3D model (STL format) and to render its geometry in three different modes: quads, triangles, and points. The application proposes three parameters to disrupt the geometric composition following semi-stochastic procedures. The results are chaotic 3D meshes of the original model; it is a non-figurative approach to 3D models that drives the attention to the unstable and material part of digital media.

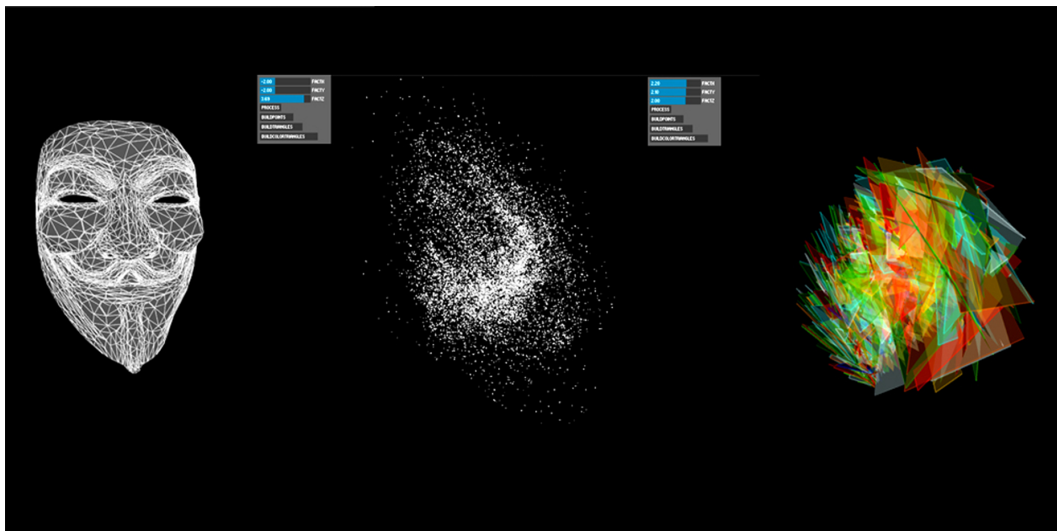


Figure 6.1. Disrupting 3D models. Three geometric configurations of the same 3D object.

### New directions for graphical supports

At the moment of writing these lines, machine and deep learning try to consolidate as prominent contemporary fields of research, not only for visual computing (via machine vision, for example) but also in experimental psychology (to test supervised and unsupervised learning algorithms) and next-gen user interfaces.

Perhaps Google is the enterprise that has made the most of publicity from their research advances. They have made publicly available programming libraries such as



TensorFlow<sup>7</sup>, and datasets generated with their own social doodling projects such as Quick Draw<sup>8</sup>. Also, machine intelligence has been applied to automatically detect similarities among tens of thousands of art images in form of artistic experiments<sup>9</sup>.

At different stages and moments, it has been advocated the emergence of new interface paradigms for some time now: natural, ambient, conversational and intelligent, to mention a few examples. While it is clearly promising to fusion developments in speech recognition and machine learning, we also believe information will always be ultimately displayed on graphical supports. Voice commands and body gestures might be replicated by graphical navigational functionalities while returning visual feedback. In ambient intelligence and hyper-cities, the graphical supports might be projected onto physical objects or perhaps simulated into VR devices. For those scenarios to become widespread we also believe more research is still required in 3D interfaces<sup>10</sup> and in higher spatial dimensions (using non-Euclidean geometry or 4D).

For anybody interested to take in charge the upcoming challenges and to produce new visual methods and graphical supports, let's not be discouraged by the complexity of levels studied in this book. Hand-drawn designs and self-made sculptures have proven versatile and powerful to think outside the box of delimited software functionalities. As we saw with data visualization precursors, this is also valid for post-digital comers<sup>11</sup>. All fields are invited to collaborate (anthropology, literature, archaeology, documentation and archival, game studies, religion studies, chemistry, biology, cognitive science, etc.) and, as it often occurs elsewhere, the most important step is the first one, as long as we have an idea of the surface support and the direction we might take. Let us then try to continue hacking digital visual information.

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<sup>7</sup> <https://www.tensorflow.org/>

<sup>8</sup> <https://quickdraw.withgoogle.com/>

<sup>9</sup> <https://artsexperiments.withgoogle.com>

<sup>10</sup> 3D is used in the sense of the Experimental Visualization Lab at UCSB, USA

<http://vislab.mat.ucsb.edu/>

<sup>11</sup> catalogue on 1001 building forms, all sketched by hand with the intention to go beyond computational possibilities [BLA 08].

## 1.2 Design de systèmes hypermédia interactifs



**Figure 2.** Couverture de l'ouvrage *Design de systèmes hypermédia interactifs*. Londres : ISTE, 2017. ISBN : 978-1-78405-264-5. Traduit à l'anglais par ISTE Éditions. Co-édité avec Nasreddine Bouhaï. Contributions de: Orélie Desfriches-Doria, Stéphane Crozat, María Inés Laitano, Leslie Matté Ganet, Dominique Cunin, Donato Ricci, Robin De Mourat, Christophe Leclercq et Bruno Latour.

### 1.2.1 Présentation en français de l'ouvrage

Les systèmes hypermédia, pourtant apparus il y a plusieurs décennies, restent un sujet d'étude constant. En effet, avec les avancées technologiques et la variété de supports, des nouveaux systèmes voient régulièrement le jour, dans des champs et contextes divers. C'est la raison pour laquelle la recherche conceptuelle et fonctionnelle les concernant reste importante et nécessaire.

Design de systèmes hypermédia interactifs aborde les systèmes hypermédia d'un point de vue théorique et pratique, de manière à la fois originale et scientifique. Il traite de leurs manières de représenter et d'interagir avec l'information, et met l'accent sur leurs processus de conception. Les auteurs des systèmes y présentent la complexité des facteurs sous-jacente à l'aspect design, la mise en œuvre et la maintenance des outils destinés à un usage humain

A travers ces réflexions, cet ouvrage traite des questions qui mettent non seulement l'utilisateur, mais également la société, les enjeux modernes, les disciplines scientifiques et la culture, au cœur des systèmes hypermédia.

### 1.2.2 Introduction intégrale de l'ouvrage, pp. 11 - 20

Les mots « hypertexte » et « hypermédia » ont été introduits dans la littérature scientifique il y a 51 ans, lorsque l'informaticien et visionnaire Ted Nelson décrit sa structure de fichiers ELF (*evolutionary list file*). L'idée principale du système consistait à rapprocher l'ordinateur aux usages personnels et créatifs des utilisateurs. Pour Nelson, l'information nécessite d'un environnement souple mais capable de supporter des « arrangements idiosyncratiques », modifiables, et en état transitoire car les alternatives d'organisation n'ont pas une décision finale ou définitive [NEL 65]. Comme nous le verrons dans cet ouvrage, parler aujourd'hui des « systèmes hypermédia » reste un sujet d'actualité<sup>12</sup>. Au cours des années les perspectives ont évolué et on peut identifier des écoles qui se sont instaurées (aux États-Unis, en France, aux pays de l'Europe du nord, pour mentionner quelques exemples<sup>13</sup>), mais l'essentiel est que nous continuons à exploiter (et n'avons pas encore exploitées toutes) les possibilités offertes par ces systèmes.

Les études des hypermédiâs comprennent l'ensemble des problèmes, méthodes, outils, usages et idéologies qui s'y associent. Dans la littérature, ces études ont été abordées à plusieurs moments des problématiques technologiques : interaction homme-machine, systèmes de documentation, littérature et poésie numérique, enseignement en ligne, nouveaux médias, Web, réseaux sociaux et, plus récemment, humanités numériques et Internet des objets. Cette ubiquité, et persistance, peut s'expliquer par le fait que les systèmes hypermédiâs sont un type particulier de logiciel orienté à relier l'information numérique dans un environnement graphique.

En effet, les systèmes hypermédia sont des productions qui existent à l'écran et cette propriété entraîne des questions liées aux supports d'affichage. Au contraire des textes imprimés ou engravés sur des surfaces solides, les textes numériques sont représentés sous forme de deux composants basiques –des « liens » et des « nœuds »– et leur

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Introduction rédigée par Everardo REYES-GARCIA

<sup>12</sup> Le lecteur peut avoir une idée plus complète de problématiques récentes à travers les actes de deux des conférences internationales pionnières du domaine qui continuent à exister : « HT » de l'*Association for Computing Machinery* (ACM) initiée en 1987 à Caroline du Nord, États-Unis, et « H2PTM » organisée par le Laboratoire Paragraphe de l'Université Paris 8, initiée en 1989 à Paris.

<sup>13</sup> Parmi les contributeurs principaux, on peut simplement évoquer quelques noms : George Landow [LAN 06], Jay Bolter, Michael Joyce, Mark Bernstein, Stuart Moulthrop aux États-Unis ; Jean-Pierre Balpe, Imad Saleh, Jean Clément, Marc Nanard, Sylvie Leleu-Merviel en France ; Uffe Wiil, Peter Nürnberg, Espen Aarseth, dans les pays du nord. Nous citons également les ouvrages collectifs [WAR 03], [SAL 05], [BER 09], [ANG 15].

intégration suit des règles provenant des champs disciplinaires d'application. Autrement dit, ils nécessitent d'un modèle de structuration pour que l'information reliée soit utilisable et compréhensible par les utilisateurs.

Ainsi, nœuds et liens ensemble donnent lieu à une structure hypertextuelle. Dans l'environnement informatique, l'écran est le lieu de référence sur lequel les contenus des nœuds et les relations des liens s'actualisent et se rafraichissent. De plus, la rhétorique des hypertextes nous apprend que le sens émerge par l'appréhension de la structuration des idées et cela s'effectue non seulement par les choix de navigation (d'un nœud à un autre) mais aussi par les retours constants dans le contenu lui-même (c'est-à-dire dans le modèle de sa structuration). Le problème est donc de disposer de repères de la structure, comme c'est le cas des titres de sections, chapitres, notes de bas de page, numérotation, dans les textes imprimés, mais cette fois-ci, pour des formats électroniques.

Historiquement, on peut distinguer deux axes interdépendants dans la recherche en hypermédias : les systèmes et les modèles. Le premier fait référence aux aspects techniques et d'ingénierie de logiciels (architectures, formats et structures de données). De ce point de vue, l'évolution technique des systèmes est souvent perçue comme allant des hypermédias monolithiques (où les composants résident dans un même lieu) aux systèmes ouverts par le biais d'abstractions de services (où les fonctionnalités et contenus d'information peuvent exister comme des blocs indépendants et à la demande).

Le deuxième, pour sa part, s'est concentré sur les modèles de navigation, types de structures, ergonomie et problèmes cognitifs. Quant aux modèles de navigation, nous disposons d'un répertoire et vocabulaire des modèles de structures hypertextuelles. [PET 11] en résume cinq :

- Structures associatives : permettent d'associer de manière arbitraire (avec des liens) des pièces d'information (des nœuds).

- Structures spatiales : leur emploi est basé sur des attributs visuels (tels que les couleurs, les formes, les dimensions, les positions dans l'espace) pour représenter des relations.

- Structures taxonomiques : supportent plusieurs tâches de catégorisation. Les relations se représentent davantage par inclusion et exclusion que par association.

– Structures argumentatives ou à base de problèmes : permettent de « typer » les entités (nœuds ou liens) selon les problèmes à discuter, les postures à propos des problèmes et les évidences supportant ou réfutant les postures.

– Structures d’annotation et métadonnées : peuvent s’utiliser afin d’ajouter des commentaires ou des informations descriptives en relation aux entités ou à l’ensemble de la structure d’information.

Ces modèles sont utilisés dans plusieurs domaines supportant surtout l’aide à la prise de décisions. Mais il est possible également d’utiliser et repérer des structures hypertextuelles dans un contexte artistique. Le terme bien connu de « littérature ergodique » [AAR 12], par exemple, regarde les systèmes du point de vue du travail effectué par un lecteur afin de trouver son chemin dans le texte. Ce travail peut se construire dans un parcours de lecture traditionnel ou, au contraire, commencer par un corpus où tout est lié pour ensuite supprimer des liens progressivement jusqu’arriver à un point satisfaisant (ce que Bernstein appelle les « hypertextes sculpturaux ») ou, encore, par des « narratives fractales », suggérant que deux nœuds contigus peuvent s’amplifier en ajoutant un troisième nœud entre les deux et en répliquant le principe de manière récursive [HAR 12]. En termes généraux, on parle des « hypertextes étranges » pour évoquer la nécessité d’outils exotiques qui nous mettent à l’égard de ce qui est attendu pour chercher des nouveaux espaces alternatifs [BER 01].

Comme nous l’avons soulevé, ces modèles s’implémentent et se représentent sous forme graphique à l’écran. Revenons à Ted Nelson. Si son système ELF se situait à un niveau général, presque comme un système d’exploitation ou un « *middleware* » traversant divers services et formats de fichiers existants sur une machine (textes, images, vidéos, sons), d’autres systèmes ont apparu ayant une motivation ou vocation plus spécifique : NLS de Douglas Engelbart, HyperCard d’Apple, Director de Macromedia, Xanadu du même Ted Nelson, Hyperties de Ben Schneiderman, Storyspace et Tinderbox de Eastgate Systems<sup>14</sup>.

Plus récemment, avec l’arrivée du Web, les navigateurs deviennent la plateforme de développement préféré pour expérimenter, adapter et implémenter des fonctionnalités hypermédia. Clarifions que le Web n’est pas synonyme ni d’Internet ni de système

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<sup>14</sup> Tinderbox et Storyspace, développés par Eastgate Systems, sont toujours maintenus pour les nouvelles versions du OS X : <http://www.eastgate.com/>

hypermédia. Le Web est un médium d'information et communication qui emploie des technologies en réseau (comme le protocole HTTP) pour accéder à des informations distribuées (localisées par des URL) sous un format particulier (le langage HTML). Au cours de vingt-cinq ans d'existence, le Web est devenu le médium le plus répandu et omniprésent, cependant ses capacités techniques restent limitées par rapport à un système hypermédia robuste. De plus, son « langage média »<sup>15</sup> a suivi une évolution que l'on peut caractériser par la logique de la « remédiation » [BOL 00], c'est-à-dire que la plupart de ses modes de fonctionnement et représentation ont été inspirés des médias de masse existants (le livre, la télévision, le cinéma, la radio).

À l'heure actuelle, nous pensons que l'environnement est propice pour une nouvelle vague de systèmes hypermédia. Premièrement, les possibilités techniques du Web se sont amplifiées (avec des recommandations comme SVG, WebGL, WebRTC, Web Audio API) tout en gardant la même base technique (le trinôme HTML, CSS, JavaScript) ; ceci a aidé à développer une culture du Web sur une base stable.

Deuxièmement, le Web maintient son aspect libre et ouvert, soutenu par des communautés de développeurs (professionnels, scientifiques, artistes et amateurs) qui partagent leur code informatique, créent de bibliothèques et publient des manuels et tutoriels. Il s'agit d'une intelligence collective ; d'une écologie participative autorégulée et basée sur le respect des pratiques.

Troisièmement, le Web peut communiquer avec d'autres objets techniques (logiciels, interfaces physiques, objets du quotidien) et organiques (le monde vivant). Le développement des systèmes hypermédia oblige à penser « en-dehors » de l'écran en considérant leurs aspects cognitifs et perceptifs, leur contexte spatio-temporel, leur préservation et leurs conséquences sociales.

Enfin, les sciences humaines et sociales, en faisant recours aux technologies numériques, se trouvent en plein bouleversement. Les environnements informatiques ne sont plus seulement les outils pour traiter et analyser les données obtenues à partir de méthodes quantitatives et qualitatives ; ils sont eux-mêmes les objets d'étude. Pour donner un exemple, pensons aux « *software studies* », aux « *digital studies* » et aux « *digital methods* ». Les premiers s'intéressent à la manière dont les logiciels influencent la culture, ainsi qu'aux rapports de pouvoirs entre systèmes, concepteurs et humains [FUL 12]. Les

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<sup>15</sup> Nous suivons l'idée de [MAN 13]. Le langage d'un médium est en rapport aux « manières dont celui-ci organise les données médias et l'accès et modification de ces données » (p. 169).

deuxièmes mettent l'accent sur les modes d'échange, production et travail, mis en place par les nouvelles technologies d'information [STI 14]. Les derniers prennent les éléments caractéristiques du Web (les liens, les sites, les moteurs, les réseaux sociaux) comme une empreinte et ressource pour étudier la culture sociale [ROG 15]. En somme, ces perspectives peuvent s'associer à celle des humanités numériques [BER 14] où l'aspect qui devient central est la nature incertaine, polysémique et en état transitoire permanent des interprétations, fonctionnements et représentations des technologies numériques.

Cet ouvrage se situe dans ce contexte. Plus qu'une analyse technique de l'implémentation des algorithmes ou des environnements de développement, cet ouvrage propose au lecteur un ensemble de textes où ce sont les auteurs des systèmes eux-mêmes qui montrent la complexité des facteurs derrière la conception, mise en œuvre et maintenance des outils. Au travers ces réflexions, nous approchons les questions qui mettent non seulement l'« utilisateur » au cœur des systèmes, mais aussi la société, les enjeux modernes, les disciplines scientifiques et la culture. Autrement dit, étudier les hypermédias par la conception des outils et fonctionnalités c'est aussi une manière de comprendre l'homme du présent et du futur.

### **Présentation des auteurs et chapitres**

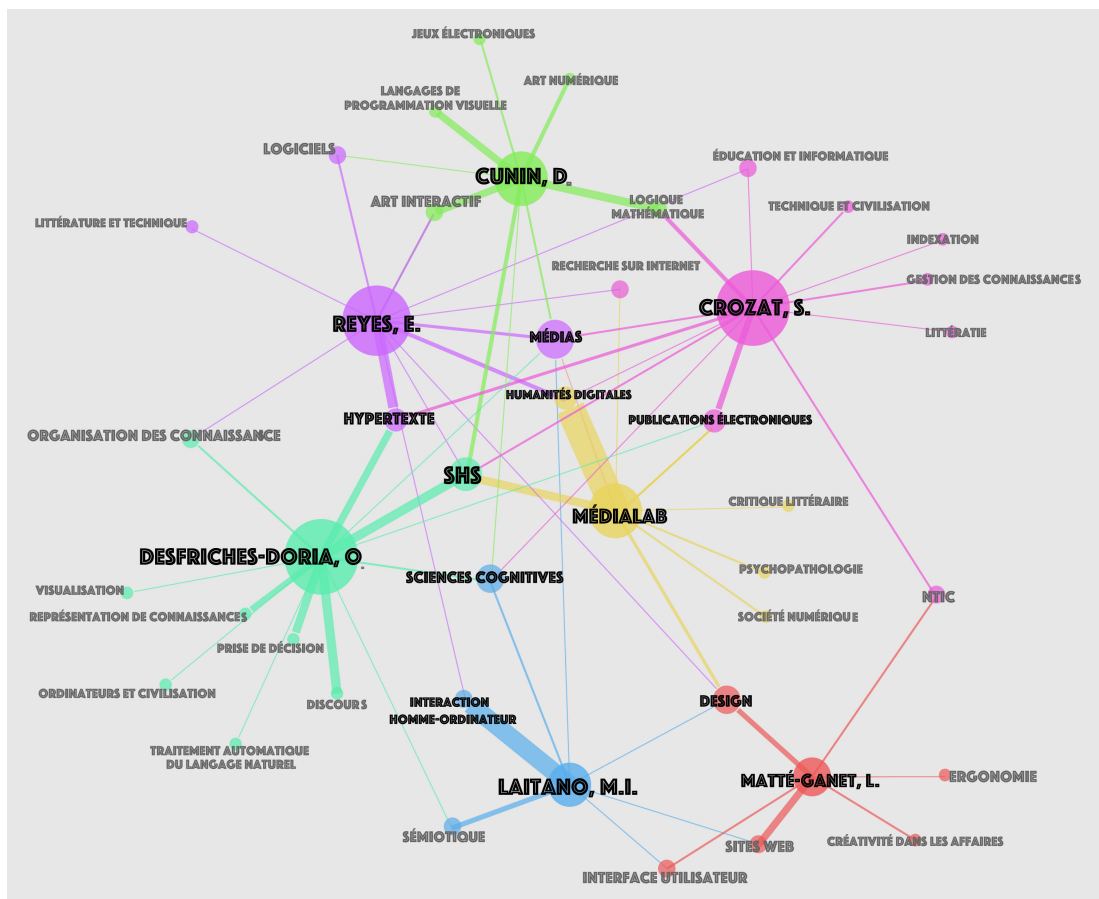
Les textes conformant cet ouvrage ont été sélectionnés par leur richesse, originalité et rigueur scientifique. Ils partagent tous la particularité d'aborder les systèmes hypermédias du point de vue théorique et pratique. Les auteurs ici réunis ([CRO 15], [CUN 14], [DEM 15], [DES 15], [LAI 15], [LAT 12], [LEC 11], [MAT 14], [RIC 15]) ont participé, conduit, développé et/ou testé leur propres outils et méthodes. Ces systèmes hypermédias font partie également des thèses de doctorat ou des recherches bénéficiant d'un financement publique ou privé.

Dans cette partie, au lieu de présenter chaque chapitre de manière traditionnelle, nous proposons au lecteur trois schémas qui montrent graphiquement des relations entre les textes. La figure 0.1 est un diagramme de réseau des auteurs et leur références bibliographiques. Nous classifions les nœuds en quatre catégories : auteur du chapitre, auteur cité, co-auteur (du chapitre ou de l'auteur cité), et sujet (le domaine d'étude selon le Système universitaire de documentation<sup>16</sup>). L'idée du diagramme est d'adopter une vue d'ensemble de l'ouvrage à partir de ses méta-textes, c'est-à-dire des textes qui renvoient à

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<sup>16</sup> <http://www.sudoc.abes.fr/>

d'autres textes. Dans la figure, on peut localiser les nœuds qui font le rôle implicite de « pont » entre d'autres nœuds. On peut également observer les liens (et la complexité qui se génère), qui prennent leur couleur du nœud de départ. Nous pensons que si le lecteur identifie un auteur ou discipline qui lui est familier, il peut ensuite se diriger plus facilement au chapitre de l'auteur où il est cité.



**Figure 0.1.** Carte des auteurs et les domaines mobilisés dans les chapitres.



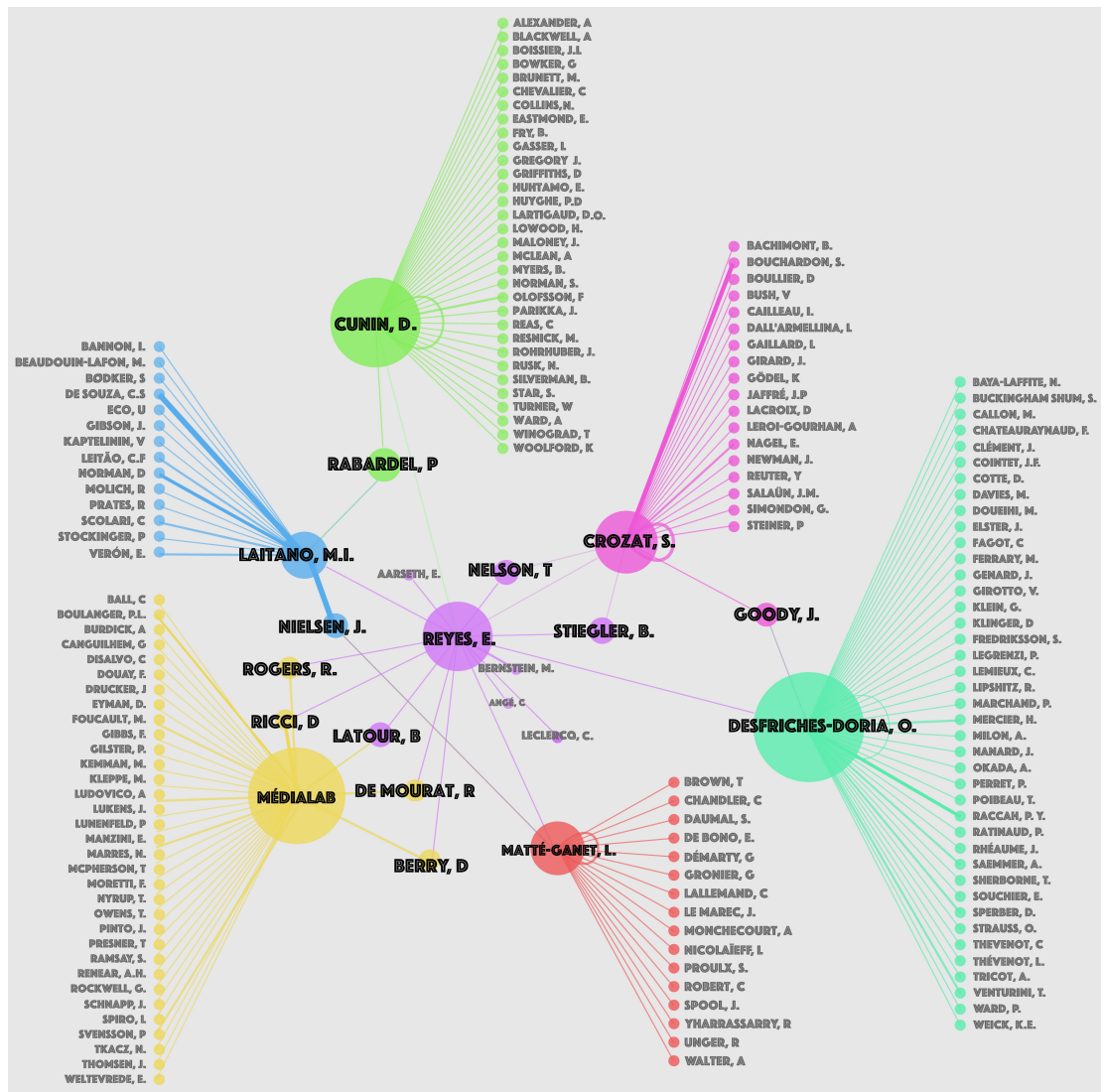
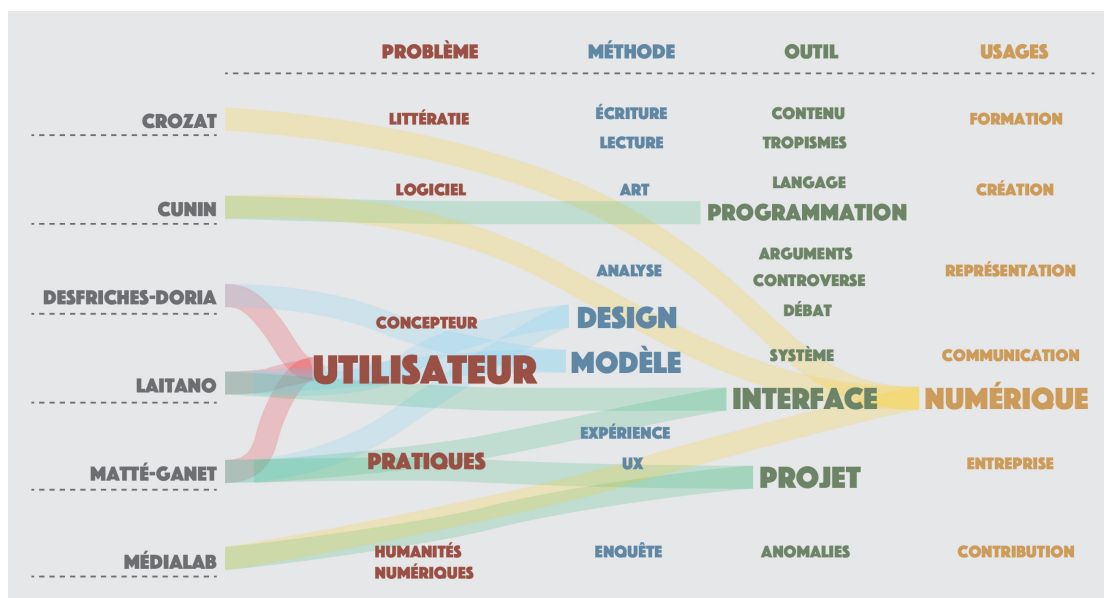


Figure 0.2. Carte des auteurs et les noms des auteurs cités.

Le deuxième schéma, figure 0.3, est une proposition graphique pour mettre en relation les mots clés des textes avec les auteurs qui les traitent. Pour ce faire, nous avons d'abord analysé tous les textes selon l'outil lexicométrique de fréquences de mots. Un poids est donné à un mot en fonction du nombre de répétitions (dans un chapitre et dans l'ouvrage complet). Cette quantification est réalisable de manière basique avec des logiciels comme Wordle et Voyant, mais d'autres analyses plus complexes peuvent se conduire avec des outils « *topic modeling* » comme Mallet. Après les quantifications, nous obtenons un classement des mots les plus fréquents, sachant que l'ensemble de mots contenus dans cet ouvrage est d'environ 57 mille (320 milles signes). Dans la figure, le code de couleurs est : rouge pour les « problématiques générales » ; bleu pour les

« méthodes » utilisées par les auteurs ; vert pour les « outils théoriques et/ou pratiques » qu'ils utilisent ; et jaune pour les « usages » dans lesquels la problématique s'insère. D'une certaine manière on peut lire les colonnes comme suit : L'[auteur(e)] aborde le(la, les) [problématiques] depuis une perspective de (la, des) [méthodes] en utilisant le (la, les) [outils] dans le contexte de(la, les) [usages].



**Figure 0.3.** Mots clés de cet ouvrage organisés par colonnes. De gauche à droite : nom de l'auteur, problématiques, méthodes, outils (théorique ou pratique), usages. La taille du texte correspond au nombre d'occurrences du mot dans le texte entier. La position verticale des mots correspond à son auteur.

Nous espérons que ces représentations aideront le lecteur à repérer des relations entre la bibliographie, les problèmes, méthodes, outils et usages des systèmes hypermédias tels qu'ils ont été abordés par les auteurs de cet ouvrage. L'interprétation finale reste bien sûr du côté du lecteur et l'idée est qu'il puisse la compléter, l'actualiser, la modifier, la questionner constamment.

## Remerciements

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### 1.3 Conception de monde virtuels ubiquitaires



**Figure 3.** Couverture de l'ouvrage *Handbook of Research on Digital Media and Creative Technologies*. Edité par Dew Harrison. Hershey, PA: IGI Global, 2015. ISBN : 978-1-4666-8205-4 et de la couverture du chapitre 10 « Designing Pervasive Virtual Worlds », pp. 224-247

#### 1.3.1 Résumé en français du chapitre 10

Les mondes virtuels peuvent être conçus au-delà le sens classique de réalité virtuelle et environnements immersifs. Ce chapitre explore la conception de monde virtuels au moment où les médias contemporains sont accessibles et simulés par des logiciels. De nos jours, les principales extensions de l'homme sont des capacités et expériences cognitives. Le software est une manière de voir le monde ; il joue un rôle central dans le design des médias et leur distribution. Le software et la perception de la réalité sont entrelacés et ubiquitaires : les média n'existent pas seulement sous forme de logiciel, mais leur propriétés et aspect sont créés avec d'autres logiciels. Dans le but de comprendre les implications du média computationnels, il est nécessaire de réarticuler les problèmes de manière créative et virtuelle. À la fin du chapitre, l'auteur offre des scénarios spéculatifs pour approcher le design et discute quelques exemples développés par lui-même.

### 1.3.2 Texte intégral du chapitre 10, pp. 224 - 247

#### Introduction

Today, many types of media have been translated into electronic forms and formats. One of the main consequences of this situation is that most forms of media are now created, accessed, distributed, shared and modified by electronic means. In this scenario, the computer has become one of the most important media because it allows not only to simulate old media but also to extend and virtualize them. The interrelationships of hardware, software and code are the fundamental basis of modern media.

But mastering a computer is not the only necessary skill for media design. It does not fully encompass the complexity of the medium. In a reverse direction, the challenges for designers of media have broadened. Among other complexities, we mention three. First, media is designed with software, which implies to learn how to use software but we also need to understand how the computer works in order to create our own software and different manners to design media. Second, as the massive adoption of computing and human-computer interaction evolve, it also comes with the establishment of conventions, i.e., determined structures based on patterns and practices. To what extent is it useful to move outside these conventions? How can we identify conventions? How can we embrace and criticize them for the sake of creativity? Third, software shares some features with natural language and culture, specially regarding its evolution. It happens that some changes can be observed easily but some others are more difficult to notice. For instance, in the fashion industry trends can be celebrated from year to year, but this is not the case in natural language where changes occur at the level of idioms, jargon, syntactic and semantic models of language (new words, new meanings, new languages, etc.). In software, we can observe new features and styles from one version to another, but it is more difficult to detect evolutions in data structures, programming paradigms, algorithms or abstractions.

In this chapter we revisit the notion of pervasive virtual worlds, as previously investigated in 2011 (Reyes, 2011). Our intention with this notion was to understand the emerging environment that combines analog and electronic media. Our focus was on everyday life, where we are constantly extended by portable devices but also by amplified objects in the environment. The ecosystem of connected objects and the processes and actions we can perform on them give rise to electronic realities, which are as real as the 'real world'. So the task is to take advantage of the coupling of analog with electronic in

order to design augmented experiences by creatively and constantly questioning the virtual and real worlds. The notion of 'virtual world' is approached in a broader sense of that which refers to common conceptions of virtual reality and immersive environments. We rather consider the virtual as a state of being, thus making reference to the philosophical strand.

In the following section we start by reviewing the notion of 'pervasive virtual worlds'. Then we discuss software as medium, taking as a departing point the definition of media elaborated by Marshall McLuhan, which observes them as technologies that extend or restrain man. From here, we will then put particular attention on media within the continuum of technological evolution and innovation. And to conclude the first section of this chapter we present and discuss two analytical maps of the computing medium, which were created from of its main forms and structures. Through these maps, we try to identify patterns and trends in the era of cultural computing.

The last section of this chapter explores a couple of examples inspired by the idea of pervasive virtual worlds. Our examples are informed by research on digital humanities, speculative computing, aesthetic provocations, design by disruption, experimentation and media art. The projects and experiments selected for the discussion serve also as conceptual tools to think about the virtualization of man.

### **Background: Pervasive Virtual Worlds**

The classic definition of virtual worlds, also referred to as 'artificial worlds' or 'virtual environments', comes from research on computer virtual reality. The first innovations in this field started during the 1960s. Prominent examples of pioneering systems include the "Sensorama Simulator" by Morton Heiling in 1960, and the "Ultimate Display" by Ivan Sutherland in 1965. Short after, the first artistic virtual worlds were developed. David Em, while artist in residence at NASA, created "Aku" (1977), "Transjovian Pipeline" (1979) and "Persepol" (1985). From this tradition, a virtual reality system has been defined as *an interface between a man and a machine capable of creating a real-time sensory experience of real and artificial worlds through the various human sensory channels. These sensory channels for man are: Vision, Audition, Touch, Smell, and Taste* (Burdea 1993, cited by Boulanger 2008).

From the context of our contemporary ecosystem of electronic media and devices, we believe it is necessary to understand virtual worlds as something more like 'pervasive virtual worlds'. The term 'world' should be understood in a broader sense, both physically and metaphysically, as a reality, a context and an environment; as it is known

and experienced by a series of actors; as a unit or whole containing its own forces and rules in a transcendental way. As we will develop further below, the world exists independently of humans. Following recent works on the philosophical tradition of 'realism', humans are only one actor among others in the world. There are also things, objects, ideas, in the world, and all should be granted equal ontological status, what has been called 'flat ontology' (Bryant cited by Bogost, 2013). This approach to the world is valuable because it tries to move beyond a human-centered tradition where the world is only seized and understood by humans and its possibilities (sensory channels, language, cognition), what has been called 'correlationism' (Meillassoux, 2012). If we humbly accept that the world is more than we know, 'realism' allows to speculate on the phenomenology, ethics, politics and aesthetics of all things in general.

Regarding the term 'virtual', we use it from a philosophical perspective, that is, as one of the four states of being that coexist together: the real, the possible, the actual, and the virtual. The notion of virtual derives from the work of Gilles Deleuze, inspired by Henri Bergson. Pierre Lévy has summarized and discussed, through examples of digital culture, the virtual mode of being in the world. First of all, the virtual is not opposed to the real, however the former is latent and the latter is manifest. The four different states of being are noted as manifest or latent. The real and the actual are manifest; they are the result of events. The possible is the latent state that tends to the real (realization) and the virtual is the latent state that tends to the actual (actualization). The opposite direction, from the manifest to the latent state also exists. From the real to the possible it is the potentialization and from the actual to the virtual is the virtualization.

The relevance of considering these four states of being resides in identifying two different modes of creation. For example, when something is created, it can be done either in: first, a more innovative or, second, in a more standardized form. This is not to say that there is no creativity in the standard, but only that its focus is on the practical achievement of something and not in the questioning of the existent. Of course, innovation may rise from standards and when the standard was first invented it was once a creative type, but as it is widely adopted it becomes more and more a repetition and not a difference (Deleuze, 1968). However, when something is created in a creative manner, it explores and approaches a solution in a different way. This is the actualization. The creative thinking implies to refashion, modify, remix and combine elements. And when this creative solution is questioned and re-articulated it is being virtualized.

The given example might suggest that the virtual state is an exclusive feature of the human specie. However, we believe it is not. In that case, it would be a contradiction with the realist perspective of the world. We are rather inclined to think that other actors perform virtual processes that indeed cannot be fully understood by humans due to the fact that we perceive them only through our senses and capacities. For instance, consider biological evolution, which studies how new species appear and evolve to better adapt to the environment (Darwin, 1859). Perhaps the natural process acts instinctively and modifies ADN accordingly, but it certainly cannot foresee in advance which changes will happen in the environment. It is difficult for a human to perceive and note directly when and how such changes occur. The scale is very small (molecules, cells, atoms) and the time is very slow (millions of years) for the human senses. But, can evolution of species be related to virtuality? It is not our intention to speculate on answers about this question, we only want to recall the importance of the philosophical questioning of virtuality from a realist perspective. In this direction, we point the reader to the work of Manuel De Landa. He identifies himself as a 'realist' and has devoted a book on virtuality based on Gilles Deleuze (De Landa, 2002).

The notion of 'pervasive virtual worlds' is also an attempt to describe the analogical and electronic world that is mixed, extended and mediated through media. As we will see later, media will also have to be understood broadly, something more related to techniques and technologies than to mass communication media. Pervasive virtual worlds are made of concrete and simple forms, but also of abstract and complex ones, produced by the interaction of heterogeneous actors: individuals, things, objects, machines; these forms can be physical but immaterial as well. Furthermore, recalling the idea of the world as larger than human perception and understanding, some forms can even be unknown for some actors of the world.

An example of pervasive virtual world could be all those projects that rely extensively on the ecology of portable devices and communication networks. As it has happened, the explosion of cell phones has overpassed personal computers, so there is a portable device with almost everyone, everywhere. These devices do not only function as telephone but also as text machines, typewriters, game platforms, multimedia centers, to mention some. Such ecology of media has virtualized actions of individuals and places. We can extend our presence into several places simultaneously: while we are physically in a geographical location, we can be acting in a remote place at the same time. Accordingly, the type of action we perform remotely can be very similar to those we perform in the



physical space. Of course, the type of presence is electronic, however this is as unique feature of computer virtual worlds. Pierre Boulanger has identified 'virtual reality systems' as general-purpose presence-transforming machines. The importance of presence, says Boulanger, deserves greater attention as recent psycho-physiological studies show that participants exhibit similar reactions to presented situations as they would in similar situation in real life, e.g., they behave the same: show fear reactions, perform tasks in 'normal' manner, show socially conditioned responses (Boulanger, 2008).

In a pervasive virtual world, presence can be simulated through media or experienced physically. One of the fundamental changes in media design (of both content and interfaces) has been precisely to translate old media into digital formats, but at the same time new kinds of media are invented in the process. At the center of this turnover, software, hardware and code play a decisive role in the materialization, perception, understanding, creation, evolution and virtualization of media.

Media, as we mentioned earlier, needs to be studied in the largest possible sense and allowing different entry points for their analysis. For example, media has proven to be a rich objet of study through the seminal notion of 'remediation' (Bolter and Grusin, 1999), a term inspired by Marshall McLuhan's understanding of media as 'extensions of man' (McLuhan, 1964). But there are other interesting notions related to media: 'artifacts' and 'devices' in the sense of Michel Foucault and Gilles Deleuze; 'artwork' or 'text' for semioticians like Roland Barthes and Umberto Eco. And what about virtuality? Indeed, Pierre Lévy has revisited McLuhan's notion and formulates that media are really virtualizations of actions, organs and things (Lévy, 1998).

To discuss an example let's take the act of hammering, also commented briefly by Lévy. Hammering is a virtualization of the act of pushing or pressing a surface against another one. From the point of view of McLuhan, the stone could be seen as an extension of the fist and the hammer as an extension of the arm. Once the action has been virtualized, it can be accomplished with other things and communicated even in the absence of stones and hammers. To adventure in a further step, we can advance that hammering has influenced the act of 'buttoning', i.e. pressing buttons as implemented in machines and their following remediations in digital user interfaces. These two actions are both related to 'contact' and we will explore them in more detail in following sections. For Lévy, he observes that in the history of virtualizations there is a small

number of virtualizations but a large number of realizations: How many times the act of hammering has been discovered in opposition to how many times people have hammered throughout history? For those readers familiar with semiotics, this idea finds echo in the distinction between type and token; the invention of a word and its utterances. Moreover, it is also related to the concept of ‘technical object’ as elaborated by Gilbert Simondon: *the technical object is specified by the convergence of structural functions because there is not, at a given epoch or time, an infinite plurality of possible functional systems. Human needs diversify to infinity, but the directions of convergence of technical species are of a limited number* (Simondon, 1969:23, our translation from French).

To conclude this part we want to argue that the notion of pervasive virtual worlds offers a different view for designing media simulations and exploring new communication models. Virtual worlds are pervasive because there is an ever-increasing quantity and types of devices connected between them: from mobile handhelds to ambient intelligence to the internet of things. But simulation, communication, extension and virtualization do not depend on those artifacts to flourish because they are latent. As we have seen, organs and actions are being virtualized in artificial worlds from the perspective of human beings (such as teleporting in Second Life or changing perspective in physical world through an Oculus Rift), but there is still a lot of work to do if we approach virtualization from the vantage point of things, objects and ideas for example. This is to suppose that we could speculate on virtualizing acts done by things and then to apply them or combine them with human or object actions. Moreover, actions have become more and more simulated in digital environments (representations and digital restitutions), and it is interesting to note that these virtualizations can in turn re-enter the process of virtualization and be actualized again; something like an n-degree of virtualization. In these terms, potentially anything can be used as media: either to communicate with it or to study its communicative possibilities or to analyze its effects at other human and non-human levels. If we come back to some claims from the speculative realism, an actualization of these acts would follow a similar path of what Ian Bogost has called ‘alien phenomenology’ or to approach what is like to be a thing (Bogost, 2013). In a more modest endeavor, we can start by understanding media and techniques as the result of visions of actors and events that were influent at their origin and through their evolution. These visions have often had different and multiple sources of inspiration, such as a passions, needs, problem-solving. In the end, media and techniques represent modes or ways of seeing and acting in the world, they shape *ways of*

*being* (Winograd and Flores, 1986). The invitation is to start tracing and documenting media, technologies, sciences, and art by taking into account aesthetics, politics, ethics, technics and material aspects. If a catalog of virtualizations of organs, actions, and things could exist we could not only understand media better but also consider different approaches to creative innovation.

### **Software As Media**

In the evolution of digital computers there has been a major revolution regarding their social and cultural role: the development of human-computer interaction, mainly led at Xerox PARC in the 1960s. It is safe to situate at that time various inventions still in use today: among the most popular, the mouse, the pointer, hypertext, videoconferencing and graphical user interfaces. It is interesting to recall the fast pace at which computers evolved afterwards. In the following decade, during the 1970s, two of the most influential programming languages were developed: first, Pascal, designed by Niklaus Wirth between the universities of Stanford and Zurich, influential in procedural programming; second, Smalltalk, at Xerox PARC, influential in object-oriented programming. These languages, together with the advancements in hardware and operating systems, allowed computer designers to create another kind of software: software to design media. For instance, one of the most influential software in cultural digital imaging has been Photoshop, developed in 1987 mainly with Pascal (at least 75% of the source code was written in Pascal) for the Apple Macintosh by Thomas and John Knoll.

By the 1990s the computer was already seen as a media machine and a variety of media software started to be used and sold (Manovich, 2013): Aldus Pagemaker (1985), Adobe Illustrator (1987), Director 1.0 (1988), 3D Studio (1990), Pro Tools 1.0 (1991), After Effects (1993), Maya 1.0 (1998), etc. Nowadays, we believe there are at least two greater impacts of this cultural computation turn. First, media is primarily designed with software, which implies that media designers must learn how to use computers and software, and even at to some point to write scripts and to install plugins to extend the basic options of software applications. Second, if media is designed with software, what about the design of software to design media? Why does software includes this or that function? Why should it be used in the way it exists? Indeed, as we mentioned before, media, software and technologies in general, represent the actualization/realization of the visions of actors (a complex that includes humans, things, worlds, simulations, events,

technical objects) that identified and developed a way of seeing the world and acting through it. Software is thus what needs to be learned if we want to go further in the design of new media.

In this section, we explore these two impacts: the design of media with software and the design of media software. This task is of course enormous, thus the scope of the present chapter will only be to sketch some directions that require further research and development. In some cases we will be able to give empirical examples from experimental projects in digital humanities. So instead of describing a design methodology, we rather discuss four main dimensions that should be taken into account in the design of pervasive virtual worlds: 1) technical-archaeological; 2) standard-conventional; 3) cultural-cognitive; 4) computational-digital. We need to remark that there is no hierarchical value behind this list, all items are equally important.

### **First Dimension: Technical-Archaeological**

The first dimension sees media as technology. The aim of this approach is to adopt a similar perspective of media archaeology, which has been elaborated by academic researchers such as Siegfried Zielinski, Jussi Parikka, Friedrich Kittler and Oliver Grau, among others. Media archaeology attempts to uncover histories of media *through insights of past new media, often with an emphasis on the forgotten, the quirky, the non-obvious apparatuses, practices and inventions* (Parikka, 2012:2). In our current context, the importance to consider media archaeology is to investigate the several virtualizations of actions, organs and things as well as their implementation through technological means.

As we mentioned earlier, in this chapter we consider media in its largest possible conception, which is necessary to analyze it from different angles. In relation to technology we have already remembered that Marshall McLuhan defined media as extensions of man. In his famous book “Understanding Media” (McLuhan, 1964), he analyzed television, radio and comics, but also the wheel, garment, money and fashion. So media is a vast field which most of the times cannot be seized in its totality because we are immersed into it, both physically and cognitively. As media archaeologist Siegfried Zielinski suggests: *all we can do is to make certain cuts across it to gain operational access* (Zielinski, 2006). For him, these cuts are of two kinds: built constructs (interfaces, devices, programs, technical systems, networks) and media forms of expression and realization (film, video, books, websites, machine installations).

To discuss the relationship of media and technology, we will mainly concentrate on those 'built constructs'. The design of media with software has been largely inspired by previous media, but also by general-purpose devices and techniques. The software available to design media has envisioned the functions of previous media. For instance, a software like Photoshop has remediated operations from the field of painting, drawing and photography. Of course, we cannot say these functions are mere simulations of ancient techniques, they have been translated into computational forms where they interact with techniques from other domains. For instance, while an artist who uses analog tools may paint and draw on canvas using brushes, pencils and other inscription technologies, in the computer environment she disposes of simulations: icons representing those tools that can be customized with parameters. Both domains create a new hybrid medium: multiple types of brushes in a single software application, accessed through buttons, sliders, menus, panels and other conventions.

To conduct media archaeology with the intention of analyzing the design of media with software requires looking back at representations of previous tools and techniques but also the virtualizations of actions, organs and things. In other words, it assumes that there are actions that have already been virtualized and that those virtualizations have been translated into technical objects and then to computing forms. It will be interesting to put special attention in turnover cases, i.e when a radical new tool and/or a way of being is introduced, because it points to a state of actualization of a virtual idea. The evolution and analysis of media software is a complex matter because those virtualizations arrive when new problems are explored that, in turn, could only emerge through the translation of past new media into computational forms.

To exemplify the complexity of layers intertwined inside a media software, let's come back to our previous case of hammering. As we said, the act of hammering is a virtualization that, in terms of McLuhan, extends the fist and the arm. We mentioned earlier that hammering is related to buttoning, given that both actions are based on contact. Allow us now to reveal some situations that should be considered if we want to study push-buttons as elements of the graphical interface in media software.

It seems we need to start by addressing the hand. Sigfried Giedion has made important observations about the human hand, which can point, *seize, hold, press, pull, mold with ease. It can search and feel. Flexibility and articulation are its key words* (Giedion, 2013:46). However, the hand has limitations and, above all, the main limitation is it cannot act

endlessly. For Giedion, *the first phase of mechanization consists in transforming the pushing, pulling, pressing of the hand into continuous rotation* (Giedion, 2013:47). One may wonder about the reason why motion is evoked. In fact, Giedion makes the argument that ‘movement’ is closely linked to ‘rationalism’. He stresses how often contradictory visions of the world have influenced our understanding of science and techniques: temporal vs eternal, rational vs irrational, internal vs external. For a society in the quest of progress, the last state to reach is perfection, so it is in a temporal mode rather than in an eternal one. In order to reach this goal, it needs to capture and dominate movement, to control it and to fix it, not to liberate it.

Would it be possible to say that our graphical user interfaces are virtualizations of pushing, pulling, pressing? The case of push-buttons might tell us some clues. As we know, push-buttons are almost ubiquitous in today’s GUI. Buttons function along with pointers. The basic case of use is: the user manipulates the pointing device, she moves it and clicks on it (press, hold, release). These actions are represented on the screen: the pointer moves around the screen and, if it is accordingly positioned over an electronic representation of a button, it launches an action in the system. We believe one of the first virtualizations behind this simple scheme is the action of switching states and their associated processes.

The virtualization of pushing, pressing and pulling is at the heart of inventions such as the hammer and the bow. Many implementations of these actions can be found in objects such as springs, which were adapted for first mold-based locks in XVIII century. Other virtualizations can be found in pipe organs. During the XIV century, organs constituted one of the most complex inventions of that time. The basic components of pipe organs are very telling for us: the arrangement of pipes, a wind system and a key desk. The place where the user controlled the whole system was the key desk, and comprised manuals, pedals and stop controls. In order for the organist to perform a musical piece, some actions were performed. First there was a secondary user who fed the system with wind. Then the organist relied on the tracker action, which is the mechanical connection between the key desk and the wind system. The series of acts of pressing and pushing on manuals and pedals functioned along with the combination of stops, which was basically turning on or off the passage of air.

Yet another virtualization in the history of push-buttons can be seen in first electric telegraphs, which virtualized some operations and mechanisms of the pipe organ. Not

only the user interface of the first telegraphs resembled pedals and manuals, but also the basic principle of switching on and off, however in this case the detection of electric current.

Switching states is one of the virtualizations behind push-buttons. But now let's consider the 'play button' as it exists in media players such as Apple Quicktime, in media authoring software such as Adobe After Effects, Autodesk Maya, Adobe Acrobat, and in programming environments such as Processing. It is possible to identify the play button as a remediation of previous buttons that appeared in recording devices that required to playback recorded signals. In this case, the act of switching on/off conveys movement from different angles: play a movie (QuickTime), preview a film montage (After Effects), go forward or go next (Acrobat) or compile a programming code (Processing). What happens now is that the action of pushing a button in an electronic environment is associated with larger series of processes and algorithms. This means that switching between 0 and 1 corresponds to modifying the entire system, from state A to state B, which may alter state C, and in turn state D.

To pursue our example, the task now would be to identify those processes and the virtualizations of actions, organs and things. But to do that it is necessary to conduct more research and to document empirical results. Today, media archaeology is still in its early stages. We need more projects that tackle the relationship between media and technology in an evolutionary perspective. We need to interrogate where do our tools come from? How are they related to past new media? What was at stake at the origin of the invention? How the invention altered other technologies? How media virtualizes us and things? An example of such endeavor is the Media Archaeology Lab, presented in 2011 by Lori Emerson. The project aims at documenting hardware, software, peripherals and individual collections that explain how tools were used in the past (MAL, 2013).

### **Second Dimension: Standards-Conventional**

There are a series of passages that occur in the life of inventions. The time in which those passages is accomplished could take years or even decades, and sometimes the passage might not take place until centuries later. Those passages go from the latent state to the manifest, from the virtual to the actual. The process starts in small scale. Gilbert Simondon has called the 'abstract object' to that moment of technical species when they are only known to their direct actors involved with the invention. Then, as the object

interacts with others and the actualization of actions and transformations gets recognized, it could be that technical objects tend toward its 'concrete' phase. To be 'concrete' means that the object has evolved intrinsically and externally, within its parts and to its users and ecosystem. In the concreteness, the technical object couples in equal ontological manner with the user. No one is manipulated by the other, rather both cooperate for the same purpose.

The case of media design of course does not escape standardization and conventionalism, however we believe we are still far from the concreteness state of digital media. Standards and conventions allow media to consolidate a vocabulary, its syntax, its rules, its semantics; that allow to be communicated and foster the exchange of parts and modules. On the other hand, if pervasive virtual worlds would tend to full concreteness they would no longer be virtual, but possible, from the philosophical perspective that we discussed before. The point of virtual worlds is precisely to remain in constant dynamism and to motivate creative questions about them.

In the last section we borrowed from Zielinski the terms 'built constructs' and 'media forms of expression and realization' with the intention to make evident the distinction between media container and media content, respectively. As we will see, conventions and standards exist for both forms.

Let's take a brief look at conventions in media content. The investigation about conventions in film, radio, TV, games and other kinds of mass media has been done mainly in the field of humanities and social sciences, particularly in media studies, communication, information, humanities, literature, etc. From the moment a technical object or a new media is released to public at large, there has been noted a gap of thirty years until the first conventions appear. Alexander Galloway calls this gap the 'thirty-year rule', *starting from the invention of a medium and ending at its ascent to proper and widespread functioning in culture at large* (Galloway, 2006:85). In film studies, to mention an example, we can observe this gap between the introduction of the cinématographe, by Louis and Auguste Lumière in 1895, and the use of visual narrative techniques by David W. Griffith in a film like "The Birth of a Nation" (1915) or in rules of montage posited by Sergei Eisenstein in films such as "The Battleship Potemkin" (1925).

We use the notion of convention in similar terms as Janet Murray does: *social practices and communication formats shared by members of a culture or subculture, as well as media formats shared by artifacts within the same genre* (Murray 2012:415). This definition also considers the



distinction between media content and media containers. For Murray, digital media is still in its immature phase, so its conventions have not yet fully been settled. As it has not yet passed the thirty-year rule. While other more established fields look for refinement, media designers deal with invention: *inventing something for which there is no standard model* (Murray 2012:3).

According to Murray, the move towards convention must follow a direction in which the four affordances of digital media are best exploited. These affordances are: encyclopedic, spatial, procedural and participatory. The method to follow is to design media by doing new media and, at the same time, to search for an increase of awareness in design choices, cultural traditions, cultural values, human needs and media specific conventions. While all these questions are deeply important, we also suggest that pervasive virtual worlds should adopt an open point of view in regard of conventions. Virtualization and actualization require to be informed by actions, organs, components of the widest range, even going further than human perception.

Murray is right in adopting a more professional standpoint where conventions need to solve human needs. Do we really have needs? Instead of debating around questions that go beyond the scope of this chapter, we prefer to review three existent models that seem oriented toward the installation of conventions in digital media, if not fully in content and container, at least focused on the latter, the 'built constructs'.

First, perhaps the most advanced efforts on standardizing digital media come from software guidelines and specifications, best-practices, international recommendations, consortiums and, more recently, design patterns. Among the most acclaimed software guidelines we may cite the Macintosh Human Interface Guidelines, later changed to Apple's Human Interface Guidelines and more recently also making available the iOS Human Interface Guidelines. In those documents, Apple describes the notions of WYSIWYG, metaphors, direct manipulation and how to use the interface elements (i.e. menus, windows, dialog boxes, controls, icons, colors, behaviors and language) the Mac way (Apple Computer Inc., 1993). Regarding specifications, in 1993 the International Organization for Standardization released the ISO 9241 titled Ergonomic requirements for office work with visual display starting with requirements for Visual Displays and Keyboards. Today, ISO 9241 covers ergonomics of human-computer interaction around eight levels, going from software ergonomics to environment ergonomics and tactile and haptic interactions (ISO 2014). Another example of standardization is the World Wide

Web Consortium (W3C), initiated by Tim Berners-Lee in 1994, and which is focused on standards for the world wide web: languages, technologies, protocols and guidelines (W3C 2014). Finally, in a more user-oriented and content-oriented fashion, we have seen recently the development of design and programming patterns. An example is the online repository Yahoo Design Pattern Library which categorizes user interface patterns around layout, navigation, selection, rich interaction and social categories. A pattern, in terms of Yahoo, *describes an optimal solution to a common problem within a specific context* (Yahoo! Developer Network, 2014). Any pattern is defined by a title, a problem, a context and a solution. Although Yahoo gathers and promotes the resources, it is a social-driven catalog, where users can submit and contribute with their own discoveries.

Second, one of the underlying principles that has allowed media software to flourish and expand is the availability to interchange files and data between applications and operating systems. This is possible because data structures and data formats are common in several environments. For example, although the Graphics Interchange Format (GIF) started as a proprietary technology developed and owned by CompuServe in 1987, it can be used free today, that is to say that the technique of data-compressing with the algorithm LZW and its packaging in a GIF file can be freely used by developers. As we know, GIF animated images have gained popularity with the explosion of web-based social networks so they can be opened, distributed, embedded and produced with many different software. Conversely, the MP3 format (MPEG-1 Audio Layer III), popular for compressing audio files, is not free and media software developers would need to pay a license to the Fraunhofer Society in order to distribute or sell encoders/decoders. This is one of the reasons why, for instance, a web browser like Mozilla Firefox does not support MP3 files. Instead, Firefox relies on the open format Ogg Vorbis.

Third, it seems that many required professional skills to access to job positions influence on the establishment of 'de facto' standards. This is also true for other cultural and conventional factors such as popularity and acceptance. We can refer once again to Adobe Photoshop as an example. Despite de fact that it is proprietary and commercial media software, it remains the number one choice among graphic designers, photographers and visual artists. Recently we have witnessed that alternative solutions exist, tools developed by the open-source community: the GIMP or the online Pixlr editor. However, the Adobe culture is still dominant.

The importance of taking a look at conventions and standards from the point of view of the design of pervasive virtual worlds is to embrace a reflexive thinking about our practices and tools. If we make the effort to detach ourselves from the continuum of everyday life and conventions, we can reinvigorate a critical and creative posture of our media. This is like natural language in culture, we don't often realize when a change was produced and suddenly we are using the same convention.

We would like to observe a final case that we believe makes the bridge with the following section. A large part of contemporary web design is done through content management systems (also called by the acronym CMS), for example WordPress; they can be extended with frameworks, plugins and libraries like Bootstrap. In the end, it seems like the design of web sites is based extensively on models and de facto standards. As a result, the web experience is more or less the same in a navigation session. Against the use of conventions, we react sometimes delighted when we see a piece of net art while navigating the web. As it occurred in the twentieth century with the installations by artists like Marcel Duchamp and Nam June Paik, who questioned and rearranged everyday objects, technologies and media, today media artists constitute an important community that questions the conventions of our electronic worlds.

### **Third Dimension: Cultural-Cognitive**

In this section we adopt an approach more centered on the design of media software, and not on the design of media with software. The main focus is now on tools to create software. As we have seen, media is designed with software and this software constitutes the vision of actors that conceive a way of acting and accessing the world. We will now explore the design of software especially created for media production.

Media software can be broadly divided into media player software and authoring media software (Wardrip-Fruin, 2009). In this section we will focus on the latter and more specially in those systems designed for desktop computers, instead of portable devices. The reason of this choice is twofold. On the one hand, software applications for desktop computers have existed for a larger time, so there are more lessons that can be learned from the implementation of computing forms, processes and interfaces. On the other hand, we believe mobile applications is an exciting field that requires a deeper investigation and we should accord it its own space in a further contribution.

Authoring media software, as we mentioned, inherit visions from pioneers who understood the computer as a media machine. We have also said that media software is a combination of conventions from past new media with properties exclusive of digital treatment of signals and information. In that manner, not only the established conventions should now be accessed and manipulated through graphical user interfaces, but also those conventions are informed by techniques from other domains and create new forms of designing media. Lev Manovich, in his recent book “Software Takes Command” (Manovich, 2013), observes how filters in Photoshop are varied and combined techniques from photography, painting and drawing such as blur and artistic effects. And there are also other filters that borrow actions developed in electrical engineering such as noise.

The design of media software is complex because there is always a dialectic relationship between conventions and new features. For instance, if we create a plugin, a script or a new menu for an experimental feature in already existing software, we must make it available through the given arrangement of the software. Conventions such as menus and submenus, property panels and inspectors, buttons and icons, are closely related to the operating system and middleware available to access components of the computer.

The case of software for media art is appealing because we have seen different conceptions of how to be in the world. The cooperation between digital artists and software developers has produced prominent examples of how to remediate past new media, to access to their features and to add new combinations, actions and processes. Software like Pure Data (1996), SuperCollider (1996), Processing (2001), Cinder (2010), NodeBox (2010), qualify in this category. Reas and Fry account for the importance of software in arts: *software holds a unique position among artistic media because of its ability to produce dynamic forms, process gestures, define behavior, simulate natural systems, and integrate other media including sound, image, and text* (Reas & Fry, 2007). Reas and Fry not only talk about media and software but they are also the beginners and main developers of Processing, a programming tool specifically created for artists and designers.

In their book, Reas and Fry dedicate a useful appendix to present other development tools oriented toward art and design; and they are all programming languages. Media art software could be then better seized if understood as an authoring system where software applications and programming languages interrelate and cooperate. As we

know, the great majority of software applications users mainly communicate with it through its GUI, but a lot of those programs can also be extended with scripts and computer code. This means that GUI and programming languages lay in the same container; they are like two creative modes and/or layers that can be used separately or integrative.

We must add another remark regarding this particular software dedicated to create media art. Artists have always explored and combined new materials (Shanken, 2009). In the digital terrain this often means hacking, modifying, disrupting, connecting, and remixing software components, scripts, source code and binary files (besides hardware and devices). In that form, media artists may consider any software as a potential environment and laboratory to create media artworks, even if it is an accounting application or an office suite.

What are the effects of media art software? One of the pioneers of digital art, Jack Burnham, curated in 1970 one of the first exhibitions devoted to digital art: “Software, Information Technology: Its New Meaning for Art”. As Edward Shanken points out, Burnham’s idea of software was of a metaphor for art: *He conceived of ‘software’ as parallel to the aesthetic principles, concepts, or programs that underlie the formal embodiment of the actual art objects, which in turn parallel ‘hardware’* (Shanken, 1998). We agree. Most studies on art movements understand art mainly from the aesthetics standpoint, concentrating on the experiences from the visitor side, on the dialogue that was established, and the altered effects that remain at the end of the day (most of the time in the viewer, and for Burnham, also in the manipulated artwork).

Is it possible to say the similar about media art software? Is there something like an aesthetics of media art software? To tackle this question we have to direct our discussion towards ‘software criticism’, which completes the aesthetic approach. Software critics reflect on ethical, political and socio-historical questions.

For example, Matthew Fuller understands software as a form of digital subjectivity (Fuller, 2003). The accent is put on the human-computer interface as the window and mirror of software, but also of a series of ideological, historical, and political values attached to it. To study the HCI implies to investigate power relations between the user and the way the software acts as a model of action. This idea goes along, although not exactly formulated as software criticism, with Winograd and Flores: *We encounter the deep*

*questions of design when we recognize that in designing tools we are designing ways of being* (Winograd & Flores, 1986).

In a recent essay, Alexander Galloway thinks about the question of interfaces and claims that they are not objects, but rather processes and effects (Galloway, 2013). He observes the computer as a set of actions that relate to the world, so he embraces the philosophical standpoint of ethics to develop his arguments. For the author, the interface is a functional analog to ideology. Hence, the interface is not the object, but it is within it. It is manifested at the surface level of digital media, devices, and graphical representations.

Later, Galloway claims that software inherits some properties from interfaces. Software would be an allegorical analogy to ideology, i.e. more a simulation than a vehicle of ideology: *What is crucial in software is the translation of ideological force into data structures and symbolic language* (Galloway, 2013).

These brief insights into software criticism allow to think about ‘media art software’ differently. First, following Galloway, software functions in a dialectical fashion that requires visibility and invisibility. While computing code might be hidden as it is, only to be interpreted and parsed, at the same time, the artist/developer has a high degree of declarative reflexivity (variables, functions, etc.). This resonates with our earlier coupling of software applications and programming languages: media art can also have two entry points for software criticism and should take into account the dialectical logic between invisibility and syntax formalism.

Second, following Fuller, our practice as media artists could also be thought in terms of ‘speculative software’. If software simulates ideology, then such simulations might be interrogated. Speculative software would be software that reveals its processes as it enacts them: *What characterizes speculative work in software is, first, the ability to operate reflexively upon itself and the condition of being software (...) to make visible the dynamics, structures, regimes, and drives of each of the little events which it connects to. Second, (...) to make the ready ordering of data, categories, and subjects spasm out of control. Third, it is to subject the consequences of these first two stages to the havoc of invention* (Fuller, 2003).

Finally, let’s come back to digital subjectivity. Nike and Grabowski seem to summarize Fuller and Burnham. They see ‘aesthetic computing’ as the introduction of subjectivism into computing... with all its consequences. They recall a very important aspect of software and computers: *the computer does not directly operate on the pixels on the*

*screen. It operates on their representations in the display buffer, and further down on this scale of manipulability are representations of other entities that form the real stuff of programs* (Nake & Grabowski, 2008).

For any speculative effort on software, it seems necessary to go further down the GUI. The more we know the software, the more we can interrogate its simulations. But before simulations, there are bits and bytes, functions and classes, visual representations, etc. How can we access to them? How they relate between them? These are some questions that need to be addressed by designers of digital media and media software.

To summarize, the design of pervasive virtual worlds demands to ask deeper questions about the selection of processes and data formats that we implement in any project. Software is the reflection of cultural choices by its designers, who often take into account the cognitive framework of the final user. As we have showed with the example of media art software, the development of our tools should be accompanied by a reflective thinking that looks at ethical, political and aesthetical considerations. Furthermore, it is also pertinent to be aware of recent research on cognitive sciences and cognitive semiotics because they consider the coupling of meaning, mind and perception. Unfortunately we are not aware of any empirical project that links software design and cognitive semiotics, however we can point to studies that are interested on ‘translations’ from the visual to the audio realm by using software (AGI, 2014).

#### **Fourth Dimension: Computational-Digital**

The fourth dimension in the design of media software puts attention on software and its computational aspects. It is about understanding software and computation themselves, as an object of study. So far we have traced a line of study that goes from the archaeology of media to conventions and standards to cultural and ideological aspects of media software. In this part the focus is on material properties of software. If media is created with software and if we must regard how media software is designed, then a further step is to investigate which are the components of software and how they work.

Traditionally, this area has been the subject of computer science, which explores the theory and practice of computer systems, methods, languages, structures and processes. Most of the efforts in computer science have been directed toward the optimization and performance of computer systems. However, the implication of humanists and artists has also motivated creative innovations. The case of artists in residence, like David Em at

NASA in the 70s, is an example of advances and uses from the creative and artistic standpoint.

For humanists and social scientists, perhaps one of the most notable crossings between computer science and history, literature, philosophy, and cultural studies, has been the emergence of the ‘humanities computing’, or as it is known today: digital humanities. The first practices that emerged from this interdisciplinary convergence were based on text and its statistical processing in order to distinguish patterns and features that could assist in issues of stylometry and lexicography. More recently, digital humanities increasingly use computing methods to produce information visualization, network analysis, text mining, databases, digital publishing and even the design of software especially dedicated to assist the work of digital humanists.

As it can be perceived, art, social and human sciences hold a close relationship with computer science. Humanities have made contributions in the sense of reflecting on the human effects and consequences of computing. Recently, Bruno Latour has insisted on considering the effects of the digital on the environment (Latour 2014). For Latour the materiality required by digital data has often been neglected and created a myth around the immateriality of the digital. Digital media is very material. To put it simply, software and data are stored in devices that process information. This information can be digital, saved as binary data, but in the end it needs to be rendered analogically for human consumption. The acquisition, processing and restitution from digital to analog requires electricity to power up computers and this source of energy has direct incidence in the environment: nuclear plants, massive hangars to store hard drives and servers, together with all infrastructure necessary to maintain our current state of affairs. Materiality cannot be disregarded any longer, but in this section we will inspect another type of materiality of software, the ‘real stuff’, in terms of Nake and Grabowski. These material properties are their constituent elements.

Where to start in order to grasp the complexity of software and its place within the computer sciences? As an entry point we will use the Computing Classification System elaborated by the Association for Computing Machinery (ACM, 1998) with the objective to index articles and publications in conferences, journals and books edited by the ACM Press. The ACM has a three-level classification system and their descriptors. At the top level there are eleven domains: A. General Literature, B. Hardware, C. Computer system organization, D. Software, E. Data, F. Theory of computation, G. Mathematics of



computing, H. Information systems, I. Computing methodologies, J. Computer applications and K. Computing milieux.

As the computing machinery field has evolved and as researchers have published and documented their results, the categories and subcategories have grown. Is it possible to say that subcategories represent refinement in the domain? Can we say that the computing field is dynamic instead of static, i.e. in continuous expansion? Which are those categories where refinement has taken place? Figure 1 shows a flow diagram connecting the first level with the second.

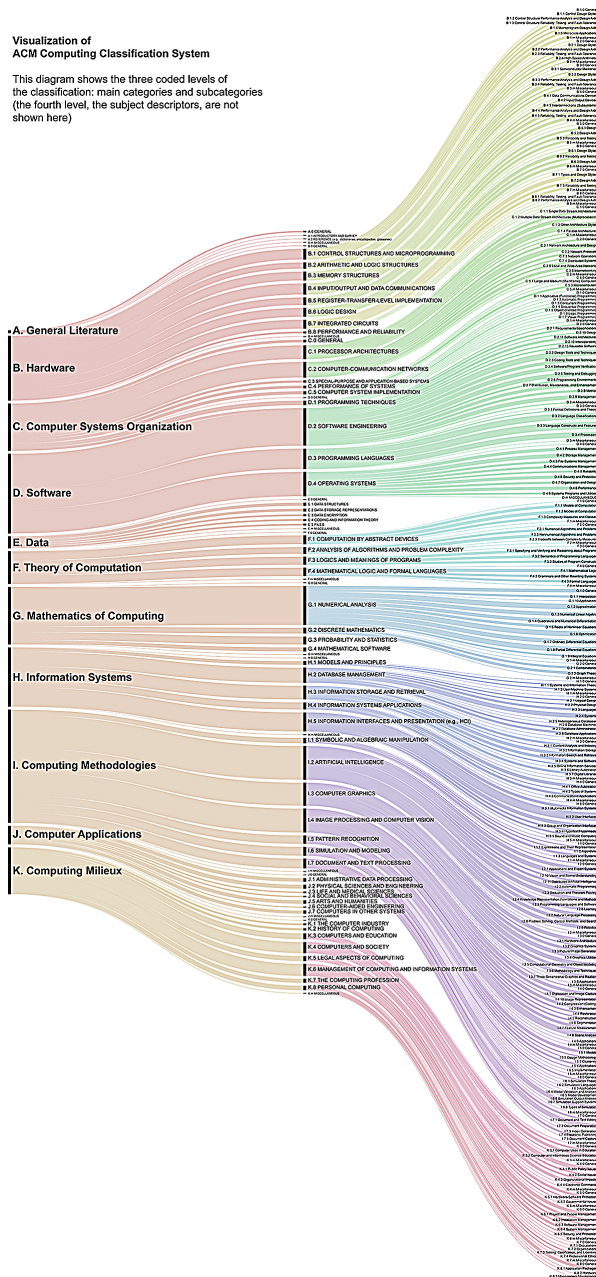


Figure 1. Flow diagram of first two levels of ACM Classification System (Everardo Reyes, 2014)

As we can see, I. Computing methodologies is the largest region and has 7 subcategories at the second level. From these subcategories, the most abundant are I.2 Artificial intelligence, I.4 Image processing and computer vision, and I.3 Computer graphics. The second largest category is D. Software, with 4 stronger subcategories within D.2 Software engineering. The third largest is B. Hardware, which has 8 subcategories mainly concentrated in B.4 Input/output and data communications, B.1 Control structures and B.6 Logic design.

In figure 2 we show a network map with the connections between the first level and the last one, that is the descriptors. In this diagram it will be interesting to note how descriptors appear in several different categories. For example, Interactive systems, Nonprocedural languages, and Standards exist both in I. Computing methodologies and D. Software. The link between I. Computing methodologies and B. Hardware is given by the descriptors Algorithms and Parallel. D. Software and B. Hardware are related by Diagnostics, Simulation, and Virtual memory. It would be curious to note there is no single descriptor that relies the three largest domains (I, D and B). The only descriptor that relies more than two domains is Standards, which is the link between C. Computer system organization, D. Software, I. Computing methodologies and K. Computing milieux. A deeper analysis will have to investigate what and why are those relationships? What are the topics and problems that scientific papers regard? Or, is it possible that more links between domains appear in the future?

While a brief analysis like this can help approaching trends in computer science, we can also try to explore a different angle directly related to media software. For this matter we will follow Manovich's definition of media: *media = data structures + algorithms* (Manovich, 2013). For him, the most fundamental constituents of media software are algorithms and data structures. For his formula, Manovich declares inspiration from Niklaus Wirth, designer of the programming language Pascal, and particularly from his book "Algorithms Plus Data Structures Equals Programs" (1975). Our intention at present will be precisely to explore data structures and algorithms in more detail.

Which are the major algorithms? And which are those algorithms particularly dedicated to media, for example images? Which techniques have been introduced by those algorithms? What kinds of data structures they use? What is the relationship between data structures and algorithms for digital imaging? How have they influenced

our conception of digital media and the operations we can perform with them? Is there a place for virtualization of digital media?

#### Visualization of ACM Computing Classification System

This diagram shows relationships between the first and the fourth level of the classification system, i.e. between the main categories and the subject descriptors

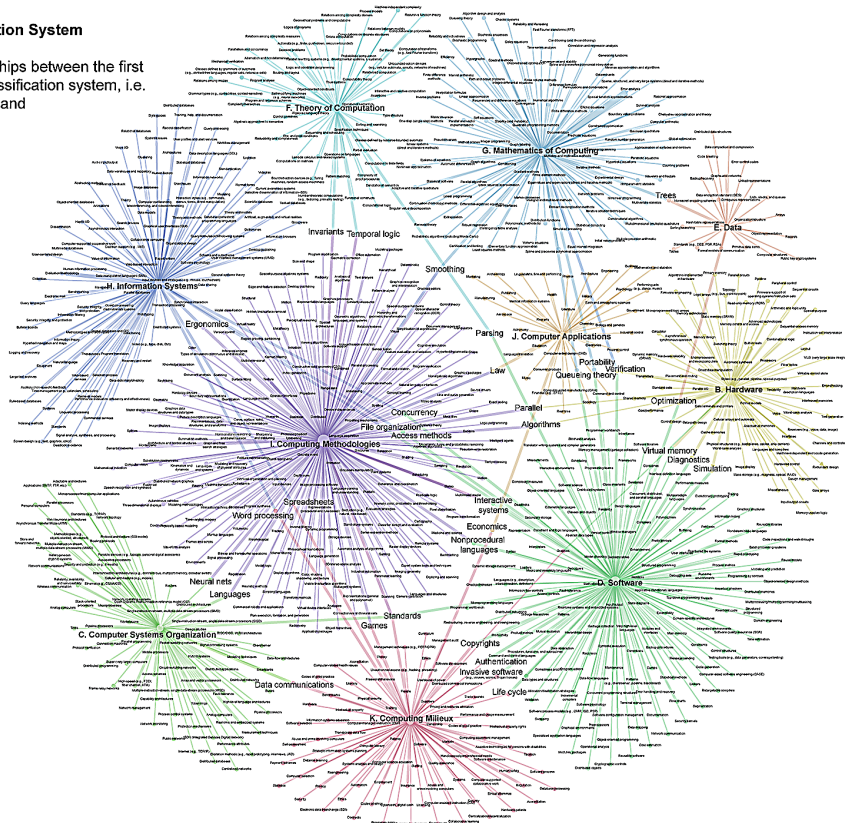


Figure 2. Network diagram of ACM Classification System (Everardo Reyes, 2014)

Algorithms and data structures are in constant development. A field such as computational geometry, for instance, considers among its interests the systematic study of geometry algorithms, observing the *realization that classical characterizations of geometric objects are frequently not amenable to the design of efficient algorithms (...)* computational geometry must reshape –whenever necessary– the classical discipline into its computational incarnation (Preparata & Shamos, 1985). So far, we can say that the existing types of data structures are more reduced in number than the amount of algorithms. For computational geometry, Preparata and Shamos recall that the most common complex objects in the design of geometric algorithms are sets and sequences, so they must use data structures particularly suited for these objects. This situation can be explained in a similar manner as the relationship between letters and words in natural language. There is a limited number letters and words, but a relatively infinite number of combinations and techniques to use them.

According to the ongoing classification by Wikipedia's users and editors, there are five major kinds of data structures: data types, linear data structures, trees, hashes, and graphs (Wikipedia 2014a). (Although the information available in Wikipedia is in constant change, we believe it is pertinent for the sake of our argument because it reflects the current understanding of the field by a community constituted by both specialists and non-specialists.) The primitive types of data types are perhaps the most well-known types to beginners and first-comers into computer science: Booleans, integers, floats, strings, arrays, matrices, bitmaps. Other lesser-known structures are: trees, heaps, tries, hashes and graphs. It is important to notice that data structures determine how information is structured and stored, in order to be processed by algorithmic techniques.

Algorithms, as it can be guessed, have larger types and classifications. Following Wikipedia, algorithms are classified in five types: 1) combinatorial (network analysis, routing for graphs, graph search, string metrics, etc.); 2) computational mathematics (collision detection, triangulation, discrete logarithms, computation of PI, eigenvalues, etc.); 3) computational science (algorithms of astronomy, bioinformatics, geoscience, linguistics, medicine, physics, and statistics); 4) computer science, and 5) software engineering (database, operating systems, memory allocation, distributed systems -all of them are interesting entry points to search deeper the relation between the ACM's categories B. Hardware and I. Computing methodologies evoked before) (Wikipedia 2014b).

The fourth category of algorithms, called computer science, is particularly exciting to study because it contains many operations behind techniques in software for media design. Within the subcategory of 'digital signal processing', for example, we find image processing algorithms: contrast enhancement, dithering and half-toning, feature detection, segmentation, which are familiar in digital graphic design and scientific visualization. Other media techniques can be found in different subcategories, computer graphics algorithms (clipping, ambient occlusion, beam tracing, ray tracking), shading algorithms, coding theory algorithms (image and video compression).

The manner in which these algorithms act and are implemented in software is varied: it could be through the graphical user interface; or it could be in parallel or in sequential series; or they can be invoked by the click of one or a combination of buttons; or by parametric adjustments; or even automatically programmed upon an indirect action. Within this context, virtualizations of media may arrive by combining different

algorithms and data structures. But at another level, virtualizations might also occur in the creation of new data structures and new algorithms. To put an example, let's imagine an engine to visualize the fourth spatial dimension. How to represent something that goes beyond the grasp of our senses and cognition?

## **Two Exercises In The Design Of Pervasive Virtual Worlds**

In this part we present a couple digital works developed by us. The intention is to inform the reader on the creative strategies put in practice behind our productions. In all the cases, we have tried to question standard and conventional paradigms of information visualization. Our practice is thus more related to speculative computing, aesthetic provocations, design by disruption, experimentation and media art.

### **Messages vers le Futur**

'Messages vers le futur' was an installation presented at the event 'La nuit de chercheurs' at the IUT Bobigny, Paris, in September 28, 2012. The main intention of the event was to introduce science and technology to public in general. We decided to propose an installation consisting on a video projection and a computer station. In the projection the visitor saw the representation of a hyperbolic figure floating in a dark digital 3D environment. This figure was inspired from the theoretical concept of 'wormhole' in physics, coined by John Wheeler in 1967, also known as the Einstein-Rosen bridge, described as *a hypothetical shortcut for travel between distant points in the Universe* (Thorne, 1994:484).

The idea of 'Messages vers le futur' was to invite visitors to metaphorically send a message to the future. Through the computer station or through their mobile devices, they could send a message about their feelings or sensation of the present time: something appealing to them, or a recent event they lived, or something they would like to do in the future. This message could contain the hashtag #messagesfutur and so it appeared on screen in form of a 3D sphere along with the text of the message. The sphere crossed the wormhole and then disappeared from the projection. For every message sent, the user registered her email address and received the message sent one year later into her email inbox. Figure 3, shows a screenshot of the electronic wormhole and a message passing by.

Technically speaking, the projection was made with Processing, enhanced with the libraries Twitter API, TwitterStream, PeasyCam and Box2D. For the design of the hyperbolic figure we translated into the Processing language the mathematical formula of super-quadratic figures. We started from the main algorithm by Kostas Terzidis (Terzidis, 2009), who kindly agreed to be used as the base for 'Messages vers le futur'. Some assistance should also be credited to Eleanor Dare, who made suggestions to refine the algorithm and implementation in Processing.

The metaphor of space-time traveling was interesting to be studied. During the exhibition, it was well-received mainly by young visitors (teenagers and younger) who got the idea immediately. We received few questions about the graphical rendering. Instead, the questions were about the content of the message: what can I write? As the answer is open, users evoked the fact of messaging to a future self.

Another thing to note was the implementation of mathematical formulae. Because Processing does not have a function to draw a one-sheet hyperboloid, it was necessary to code the figure. This single aspect led to think on what other mathematical figures and surfaces does not have a computational representation through software. What are we missing because there is no access through software? Where can find alternatives to standardized software which already proposes different figures than those in Euclidean geometry? And ultimately, can we represent a fourth spatial dimension? This has been a real question in science and astronomy. Recent research at UC Santa Barbara demonstrated that, at very small nano scales, there are particles that exist in two places at the same time (Cho, 2010) or that time moves slower as we separate from the Earth's surface (Reinhardt, 2007).

In any case, what is interesting to evoke at this point is that virtualization of digital media has an opportunity with computers and electronic representation. Designers can obtain inspiration from the vantage point of objects and environment. How do objects perceive? What is like for an environment to be connected with multiple devices at the same time? How does the environment perceive the transmission of signals?

### **Disrupting 3D Models**

3D models are generally considered as digital objects made of geometry that simulate width, height and depth inside a computational environment. Although their origins can be traced to computer graphics during the 60s, when pioneers created computer simulations, virtual reality, virtual worlds and visual effects in film, nowadays we

encounter them in graphic design, video games, architecture, art, advertising, Web, industrial design, scientific visualizations, and digital humanities.

In 2012 we have developed a simple application that allows users to interact with 3D models. Technically speaking, we used Processing with ModelBuilder and ControlP5 libraries. The application basically takes a STL model and renders it in the 3D digital environment. For us, the importing process implies to read the original geometry in the STL file and to render it in its organized 3D spatial layout in form of a series of points or a formation of polygonal shapes (triangles). Once a file has been loaded, the user is able to interact inside the 3D view environment. A series of GUI sliders indicate modifications upon three factors. Additional buttons apply transformations, change mode view (points or triangles), and reset the model to its original state. Figure 4 shows an original model, the user interface and the resulting transformation.

The idea of the system is to invite users to perform transformations on the models. The resulting images from transformations are basically non-figurative. Some would be appealing but disrupting at the same time. They show how the same quantity of triangles in a model may be recomposed. Of course because STL relies heavily on tessellation, triangles are never broken apart. That means, geometry is not spread, they rather create new solid forms. If a transformation is made on the view mode of POINTS, then the result looks like a particle explosion.

As we mentioned earlier, we used Processing to develop our viewing/transformation system. Regarding the acquisition of 3D models, we used several different software applications depending on the input kind of model. Before developing our own application, we asked ourselves if it was possible to produce our generative transformations with existing software. Although Maya and Blender, among others, allow to enhance their functionalities with scripting code, we decided to create our own system mainly because we wanted to deploy a simple user interface to interact with objects. Indeed, Maya and Blender are complex environments that cover topics from modeling to animation and rendering. Furthermore, they handle their own file formats. It is possible to export/import to other formats but the main workspace remains the same. For us, we used STL format, which is widely adopted for 3D printing and would accordingly satisfy the desire of printing a complex and disordered model. But perhaps the main reason behind the production of this experimental system was the cultural practices that it supported. A complex and integrated environment, such as Maya in the case of 3D

modeling, is suited for many tasks required by cultural industries but not precisely for a particular artistic approach and research need.

How could the approach on disruption be used for virtual worlds? We believe disrupting software could foster creative practices, but in a virtual world we can also disrupt reality, or the simulations of the physical world, or even fictions, plots and sequences of events. The task would be to challenge human perception, to adopt existing processes from other fields (science, astronomy, neurology, archaeology, etc.). But because software and digital media have the inherited intention of extending our senses, we have to consider the world at large, beyond our senses and experiences, from the transcendental perspective.

## **Conclusion**

In this contribution we have explored the notion of pervasive virtual worlds in order to describe the analogical and electronic world that is mixed, extended and mediated through media. Media was understood in its largest sense: as technique and technology. Pervasive virtual worlds are composed of concrete and simple forms, but also of abstract and complex ones, produced by the interaction of heterogeneous elements: individuals, things, objects, machines; these forms can be physical but immaterial as well. Furthermore, recalling the idea of the world as larger than human perception and understanding, some forms can even be unknown for some actors of the world.

Pervasive virtual worlds is an idea aiming at opening opportunities for new design and communication processes. Virtual worlds are pervasive because there is an ever-increasing quantity and types of devices connected between them: from mobile handhelds to ambient intelligence to the internet of things. But simulation, communication, extension and virtualization do not depend on those artifacts to flourish, principally because they are latent. As we have seen, organs and actions are being virtualized in artificial worlds from the perspective of human beings, but there is still a lot of work to do if we approach virtualization from the vantage point of things in general, for example.

We proposed to study the design of media with software and the design of media software by taking into account four perspectives: 1) media archaeological; 2) standards and conventions; 3) cultural; 4) computational. The main intention was to rethink media within a larger context and to point to design strategies for new media in creative manners. Media are the result of the vision of as series of actors, they are manifest in the



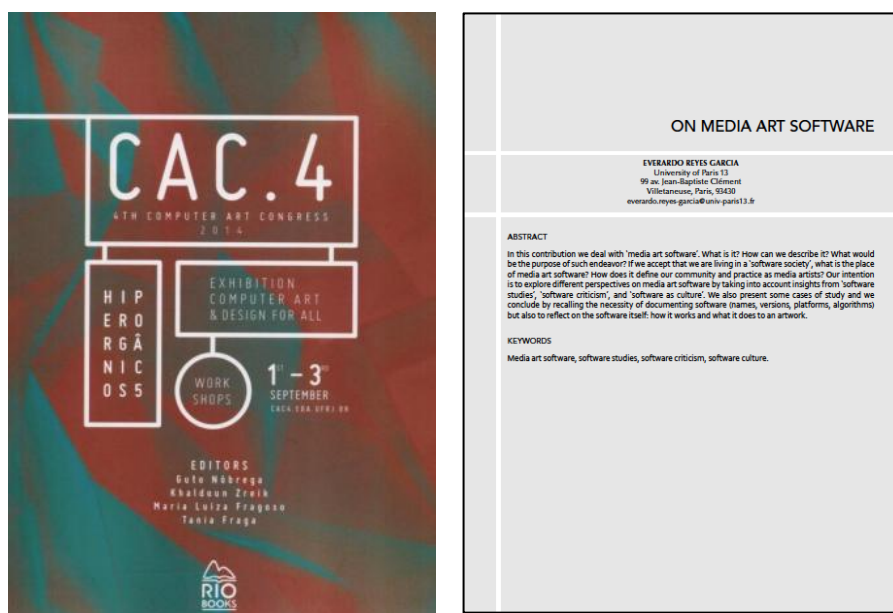
form of representations, simulations, devices, graphical interfaces. These are for us examples of pervasive worlds that can be virtualized and actualized.

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## 1.4 Sur les software orienté média art



**Figure 4.** Couverture de l'ouvrage *Computer Art & Design for All Proceedings of the 4th Computer Art Congress*. Edité par Guto Nóbrega, Khaldoun Zreik, Maria Luiza Fragoso & Tania Fraga. Rio de Janeiro : RIO Books, 2014. ISBN : 978-85-61556-64-8 et de l'article « On Media Art Software », pp. 39-48.

### 1.4.1 Résumé en français de l'article

Dans cette contribution nous traitons du software orienté média art. Qu'est-ce que c'est ? Comment peut-on le décrire ? Quel serait le propos de cette entreprise ? Si l'on accepte que nous vivons dans une « société du software », quelle est la place du software orienté média art ? Comment trouve-t-il sa place dans la communauté et les pratiques artistiques ? Notre intention est d'explorer plusieurs perspectives sur ce type de software, en prenant en compte les approches de « software studies », « critique du software » et « software comme culture ». Nous présentons également quelques cas d'étude et nous concluons en soulevant la nécessité de documenter nos logiciels (noms, versions, plateformes, algorithmes), mais aussi de réfléchir sur le logiciel lui-même : comment fonctionne-t-il et qu'est-ce qu'il fait aux œuvres d'art ?

### 1.4.2 Texte intégral de l'article, pp. 39 - 48

#### Introduction

The field of 'media art' represents a vast and exciting territory to investigate the role of software as object, as ideology, and as semiotic apparatus. The pioneers of the

relationship between art, media, science, and technology experimented early with new materials and devices, realizing that computers provided huge potential to sketch, add, and modify parametric, stochastic or generative processes. Artists have always created and adapted their own tools and, in the digital era, part of those tools can be recognized as ‘media art software’.

The literature available in our domain already covers valuable reflections on software and art. There exist studies on the history of media art, exploring concepts, ideas, visions, and styles. Moreover, our field has several dedicated conferences and exhibitions that publish catalogs and document the variety of artists, artworks, techniques, and materials. Of course, we are still far from accepting that media art benefits from the recognition it deserves among other communities and the general public, but it seems that the increasing presence of software in every aspect of the culture will motivate the change. We are optimistic.

In this scenario, we want to contribute with some thoughts on ‘media art software’. Our intention is to evoke some questions that have not been fully explored related precisely to media art software as object and as ideology. The notes and insights we present emerge from our own ongoing practice in the field: as experimental media artist, as scholar, as organizer of congresses, as curator, and as program director of graduate and undergraduate academic programs.

### **Media Art Software as Media**

How can we define ‘media art software’ as media? First of all, we suggest a distinction between this term and other related forms: media art software is not artistic software, at least not in the sense of Gourinova and Shulgin: “artistic software is, first and foremost, software created for purposes different than traditional pragmatic ones. Such programs are not seen as tools for the production and manipulation of digital objects - from online bank accounts to works of art - they are works of art in their own right” [4]. As we can see, artistic software is more related to software art. It is an artwork in form of software. Technically speaking, this kind of software is, most of the times, the source code and its compiled result. As any other software, it can be distributed, accessed, installed, used.

Software art is exhibited and curated, and KURATOR has been one platform interested on software curating. For its members there is a difference between software as art and software in general: “software is defined as a set of formal instructions, or,

algorithms, a logical score that can be translated into a computer program and executed by a machine. It also includes associated documentation concerned with the operation of a data processing system (e.g. compilers, library routines, manuals, and circuit diagrams)” [5]. We believe it is important to distinguish between ‘art as software’ and ‘software to create media art’, even though in everyday practice the distinction may become difficult. Some artists, for example, often use a piece of ‘software art’ as an authoring tool to produce her original work. However, we can also notice that much of the artwork already resides in the software; as if the generated work would be a descendant.

Also related to media art software is the tag ‘media software’: “programs to create and interact with environments and media objects (...) They are a subtype of ‘application software’ (...) Media software allows creating, publishing, accessing, exchanging and simulating different types of media such as images, animated sequences, 3D models, characters, spaces, texts, maps, interactive elements, as well as various projects and services that use those elements” [6]. Media software can be seen much like authoring tools and social networks. Although media art software acts as an authoring system, the term ‘media software’ seems better suited within the context of personal and professional production of media content. The outcomes are expected to fulfill a function and not ‘for purposes different than traditional pragmatic ones’.

Reas and Fry account for the importance of software in arts: “software holds a unique position among artistic media because of its ability to produce dynamic forms, process gestures, define behavior, simulate natural systems, and integrate other media including sound, image, and text” [8]. Reas and Fry not only write about media and software but they are also the beginners and main developers of Processing, a programming tool specifically created for artists and designers that is exemplary of media art software.

In their book, Reas and Fry dedicated a useful appendix to present other development tools for art; and they are all programming languages. Media art software could be then better seized if understood as an authoring system [10] where software applications and programming languages interrelate and cooperate. As we know, the great majority of software application users mainly communicate with it through its GUI, but a lot of these programs can also be extended with scripts and computer code. This means that GUI and programming languages lay in the same container; they are like two creative modes and/or layers that can be used separately or integrative.

A final remark. Artists have always explored and combined new materials. In the digital terrain this often means hacking, modifying, disrupting, connecting, and remixing software components, scripts, source code, and binary files (besides hardware and devices). In that form, media artists may consider any software as a potential environment and laboratory to create media artworks, even if it is an accounting application or an office suite.

### **Media Art Software and Culture**

What are the effects of media art software? One of the pioneers of digital art, Jack Burnham, curated in 1970 one of the first exhibitions of our field: *Software, Information Technology: Its New Meaning for Art*. As Edward Shanken points out, Burnham's idea of software was of a metaphor for art: "He conceived of 'software' as parallel to the aesthetic principles, concepts, or programs that underlie the formal embodiment of the actual art objects, which in turn parallel 'hardware'" [9]. We agree. Most studies on art movements understand art mainly from the aesthetics standpoint, concentrating on the experiences from the visitor side, on the dialogue that was established, and the altered effects that remain at the end of the day (most of the time in the viewer, and for Burnham, also in the manipulated artwork).

Is it possible to say the similar about media art software? Is there an aesthetics of media art software? To tackle this question we have to direct our discussion towards 'software criticism', which completes the aesthetic approaches. Software critics reflect on ethical, political, and socio-historical questions.

For example, Matthew Fuller understands software as a form of digital subjectivity [2]. The accent is put on the human-computer interface as the window and mirror of software, but also of a series of ideological, historical, and political values attached to it. To study the HCI implies to investigate power relations between the user and the way the software acts as a model of action. This idea goes along, although not exactly formulated as software criticism, with Winograd and Flores: "We encounter the deep questions of design when we recognize that in designing tools we are designing ways of being" [11].

In a recent essay, Alexander Galloway thinks about the question of interfaces and claims that they are not objects, but rather processes and effects [3]. He observes the computer as a set of actions that relate to the world, so he embraces the philosophical

standpoint of ethics to develop his arguments. For the author, the interface is a functional analog to ideology. Hence, the interface is not the object, but it is within it. It is manifested at the surface level of digital media, devices, and graphical representations.

Later, Galloway claims that software inherits some properties from interfaces. Software would be an allegorical analogy to ideology, i.e. more a simulation than a vehicle of ideology: “What is crucial in software is the translation of ideological force into data structures and symbolic language” [3].

These brief insights into software criticism allow to think about ‘media art software’ differently. First, following Galloway, software functions in a dialectical fashion that requires *visibility and invisibility*. While computing code might be hidden as it is, only to be interpreted and parsed, at the same time, the artist/developer has a high degree of declarative reflexivity (variables, functions, etc.). This resonates with our earlier coupling of software applications and programming languages: media art can also have two entry points for software criticism and should take into account the dialectical logic between invisibility and syntax formalism.

Second, following Fuller, our practice as media artists could also be thought in terms of ‘speculative software’. If software simulates ideology, then such simulations might be interrogated. Speculative software would be software that reveals its processes as it enacts them: “What characterizes speculative work in software is, first, the ability to operate reflexively upon itself and the condition of being software (...) to make visible the dynamics, structures, regimes, and drives of each of the little events which it connects to. Second, (...) to make the ready ordering of data, categories, and subjects spasm out of control. Third, it is to subject the consequences of these first two stages to the havoc of invention” [2].

Finally, let’s come back to digital subjectivity. Nike and Grabowski seem to summarize Fuller and Burnham. They see ‘aesthetic computing’ as the introduction of subjectivism into computing... with all its consequences. They recall a very important aspect of software and computers: “the computer does not directly operate on the pixels on the screen. It operates on their representations in the display buffer, and further down on this scale of manipulability are representations of other entities that form the real stuff of programs” [7].

For any speculative effort on software, it seems necessary to go further down the GUI. The more we know the software, the more we can interrogate its simulations. But before simulations, there are bits and bytes, functions and classes, visual representations, etc. How can we access to them? How they relate between them?

### **Media Art Software as Unit Operation**

When adopting the point of view of objects themselves, questions like ‘what happens inside a media art software?’, ‘why it works the way it does?’, or even, ‘what is like to be one of it?’ rise. Although it is not our aim to answer these questions, we would rather like to discuss some ideas.

Nowadays, one of the philosophical perspectives that suits well for thinking about objects themselves is ‘speculative realism’ (SR). Thinkers of this area strive to go further the correlationist position, for which being exists only as a correlate between mind and world: if things exist, they do so only for humans. Philosopher Graham Harman has coined the notion ‘object-oriented philosophy’ to observe that “objects do not relate merely through human use but through any use, including all relations between one object and any other” [1]. Extending this idea, Ian Bogost calls for an ‘object-oriented ontology’ (OOO) which is interested on the existence of objects in general (including humans) and attributing to all objects the same ontological status: there would be no distinction between the types and they all should be treated equally.

A more appropriate term for Bogost to refer to objects and things, with a less heavier correlationist tradition behind these terms, is unit. The behavior of a unit (functions, interactions) are operations. Units represent three things at once: an isolated and unique unit; an enclosing universe; and a part of another system. In this sense, a unit can be described in different manners: analytical or synthetical; culturally or scientifically; but no one would be more important than any other because they have the same ontological status.

What is behind all units? Bogost dribbles deterministic critics by making reference to Alan Badiou. There is nothing behind or above units, no ur-structure. Units simply operate and they relate according to a configurational pattern.

OOO and unit operations might offer a glance into ‘media art software’ when we try to approach it as object. If we identify software applications and programming languages as units, the next analytical step should be to explore its constituent units in order to see



their relationships at a given moment. Or we could also take a synthetical path: creating domain categories to organize them. Or we could map its transversal properties and mode of existence into other domains such as history, social, political, etc.

But if we accept that all units have the same ontological status, there would be no ‘real’ or ‘definitive’ definition of media art software. It would not make any difference to define it from its technological specifications or from its role within the development of arts and sciences, or from any other point of view (for example, configuration of bits, visual representations, remixes and hybridizations, narrative and discourse, exhibition and distribution). Instead, the task would be to make evident its diversity: the multiplicity of objects and the complexity of their interactions with other objects (including humans).

One visually perceptible form of OOO are ‘ontographs’. Ontographs could be manifested with any media (words, images, sounds, scripts, etc.) with the intention of showing the variety of units (how much their are and how they exist). The main objective of an ontograph is to reveal objects and their relationships in a configuration “celebrated merely on the basis of existence” and not only from a human-centered strand.

### **A couple of brief examples**

We have been working with digital artist Jean-Pierre Balpe, pioneer in digital literature and well-known for his work on generated fiction and poetry. Recently, he migrated one of his Hypercard generators into a web platform: the ‘Poèmes Stein’ generator<sup>17</sup>. Artistically speaking, the generated poems invite a reflection on life in general. Sometimes texts might sound weird and conceptual but that is the point: to provoke images in the reader through different and even unrelated words.

Figure 1 shows two examples of graphical rendering. The figure to the left depicts a generated poem along with a parametric GUI. The figure to the right shows a different rendering of the same web service. In this case, the user generates a poem and she can also select, click, drag&drop any letter of the text. It is also possible to randomize the position of each letter and to restore the system to the original state.

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17 Samuel Szoniecky, associate professor at Paris 8, was in charge of the technical migration, translating code from Hypercard into a web database, a GUI based on Adobe Flex and a API for accessing the generated text. For us, our work has been mainly on the graphical rendering of text. The reader can interact with some examples at: <http://brooom.org/poemesStein/>

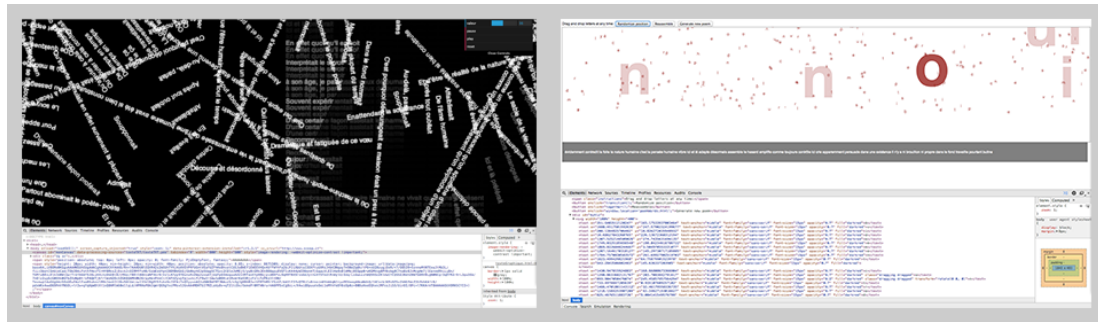


Figure 1: Graphic rendering of generative poems

These interfaces are significant because of their differences and similarities. They might look similar from the standpoint of accessing and handling information, but they are fundamentally different in the way the browser treats the information. The first case uses Processing.js 1.4.1 and dat.gui. The second relies uniquely on D3.js. A look at the web console panel of the web browser shows how different the elements are rendered. In the first case, the text is not rendered and all transformations occur in the graphic engine. In the second case, all the letters of a poem are created as independent SVG text tags.

Let's consider another situation: How would it look an ontograph of a 'media art software'? Where to start: Its GUI components, or the language reference, or the algorithms? Figure 2 shows different representations of Processing.

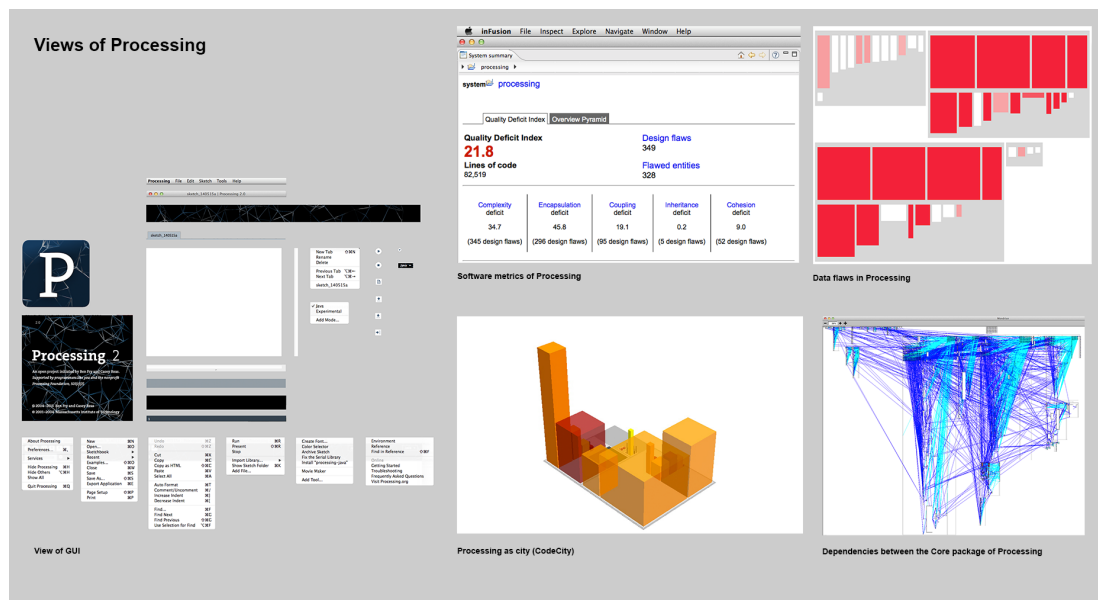


Figure 2: Views of Processing 2.0

In any case, we believe that considering ‘media art software’ as unit-operations might contribute with new perspectives. If media art is also an interrogation of our current tools and paradigms and, agreeing with Nake and Grabowski, the aesthetics of the interface gives us access to the algorithmic side of the program, then we ask: What else? Which are those algorithms? Can we access to them, analyze them or visualize them? Why are they implemented in such computing structure? Can we experiment with such structures? Can we propose new data structures (that is, moving besides, above/below or behind/beyond conditional statements, loops, variables, functions)? For media artists, these questions would imply making art into machine.

### **Conclusion: Questions and Proposals for Media Art Software**

In this final section, we want to present some ideas and proposals regarding our discussion on media art software. As the reader will see, there are more questions than answers. But, in the similar way to our discussion, we only attempt to sketch some parts that a larger study of media art software would consider.

#### **Questioning Media Art Software**

Should media art software...

- keep an open perspective in order to support different kinds of media, programming paradigms, mathematics, physics, visual styles?
- support one or more different UI programming paradigms, i.e. a GUI, OOP, visual programming?
- employ language metaphors from art itself into its user interface? Or from which domain: art, science, robotics, mathematics, cybernetics, biology, media?
- offer in itself an ontographical representation of its units-operations? Something like a software visualization?
- make evident its ideology (in the same way as a language reference makes evident its units-operations)?

Is media art software...

- currently considered itself as defining tool to become a media artist? Do media artists need to use one or more of them to be considered as such?

- defining us as community and field in front of other domains? Are we perceived through the software we use?
- synonymous of multiple (layers of) software for graphics and simulations, in the same way as cinema has been equated to Final Cut and photography to Photoshop?

## Proposals

1. We believe it is more and more important to document the traces of our software in order to theorize in the long tail. The media art community introduces innovative uses of software and also foster the transcoding i.e. exchanging, hybridizing, remixing, simulating, enhancing, media. We believe it is necessary to document rigorously the software used in the production, distribution, and exhibition of an artwork: at least the names of software, the platform on which were running, and the versions. For example, in the 2nd Computer Art Congress, in Mexico, there are only 24 mentions to software applications, where three of them were custom-made and the rest were open or proprietary. The most cited were: Flash and Photoshop, followed by Processing and Max/MSP [12].

2. We believe it is necessary to reflect on why we choose a particular media art software? How it communicates with our artwork? These questions can be tackled from the ethical, political, aesthetical, technological, historical, and/or philosophical point of view. The answer could be short or long, but not doing it should be rare.

3. We believe that any time we teach or participate in multidisciplinary artistic and scholar gatherings, it would be interesting, in the same spirit of recommending the best artworks, films, or books... to recommend the best 'media art software'. But to do that maybe we need first a pool of media art software, something like a Wikipedia entry of 'List of Media Art Software', which is non-existent today.

For us, software art is important because it shows how software could behave differently, mainly through ruptures of function. To understand such ruptures demands also to understand how the software operates (at the surface level but also deeper in the programming code).

There is an aesthetics of software when we discover and use new software. Not only it is appealing to see and to interact with its elements, it also represents the vision of another artist or designer (or an assembly of both): how she thought the names, icons,

functions, and which algorithms were implemented. Perhaps we all use similar functions and data structures and, like natural language, we do not perceive clearly changes over time, but it is interesting to observe how are they implemented differently. How does the semantic of meaning operate?

We think there is a deep and large effect underlying the best media art software. As fuzzy as these software might be -some users might see it in a software application, a videogame, or perhaps in the classic LOGO language-, the more we use it, the more we go deeper into its ecology and ideology. To fully adopt it shapes us as media artists, but at the same time it also means to challenge its paradigms and mode of existence. When we discover new software it happens that the mere production of 'Hello World' is satisfying, but it is also of the most significant importance precisely because it embraces engagement.

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## Partie 02. Interventions techniques d'un point de vue SIC

Les extraits réunis dans cette partie essaient de resserrer le lien entre l'informatique graphique (*visual computing*), l'informatique créative (*creative computing*) et leurs implications culturelles et communicationnelles dans les sciences humaines. Au sens global, les problématiques et les productions traitées s'inscrivent dans une logique des « humanités numériques ». Les types d'interventions techniques dont il est question ici correspondent aux différentes manières dont les logiciels modifient l'organisation et affichages des contenus médiatiques. Une intervention technique consiste donc, en règle générale, à comprendre les mécanismes matériels d'un support, à toucher ces parties, à régénérer des résultats novateurs et à documenter les processus d'expérimentation. Il s'agit d'une manière de susciter des résultats inattendus, mais aussi de mettre évidence le caractère subjectif imprégné dans la technique. En effet, pour parler des stratégies ou des cultures, on peut tout à fait commencer par une échelle modeste et montrer comment les choix des fonctionnalités est un geste individuel.

Le premier texte a été publié dans une revue qui trouve son public chez les spécialistes et professionnels de la documentation (notamment via l'ADBS, l'Association des professionnels de l'information et de la documentation). Par ailleurs, à l'issue de cette publication, j'ai été invité à donner un cours-séminaire-workshop de 4 heures aux adhérents. Mon approche à la datavisualisation a toujours été conduite par la visualisation des images et il reste encore un domaine minoritaire par rapport à la quantité de modèles et solutions techniques pour les données numériques et géographiques. Le deuxième texte a été publié dans un journal répandu dans la communauté d'artistes-chercheurs numériques. Le troisième texte, le seul en langue espagnole, a été présenté originalement comme communication de congrès. Par la suite, j'ai rédigé une première version pour une revue en ligne et la version ci-présente a été remaniée et amplifiée pour sa publication comme chapitre de livre.

## 2.1 La data visualisation comme image-interface



**Figure 5.** Couverture de revue *Documentaliste - Sciences de l'Information*. Dossier « *Datavisualisation : des données à la connaissance* » coordonnée par Béa Arruabarrena. Paris : ADBS, 2015. ISSN : 2428-2111 et de l'article « *La data visualisation comme image-interface* », pp. 38-40

### 2.1.1 Texte intégral de l'article, pp. 38-40

Dans cette contribution nous abordons la data visualisation comme un type d'image contemporaine. En effet, si nous nous intéressons à la représentation graphique de données, il est possible d'identifier quelques modèles visuels qui lui sont typiques, à savoir : les graphes cartésiens, les diagrammes de réseaux, la cartographie et les modèles expérimentaux (“treemaps”, “streamgraphs”, “diagramme Voronoi”). Nous savons que la diversité d'informations à visualiser comprend la quantification de dates, lieux, personnes, transactions financières, échanges sociaux, préférences personnelles, durées de connexions, etc. Une image de data visualisation combine régulièrement des éléments graphiques (lignes, points, couleurs) organisés dans une forme (une technique ou modèle visuel) et enrichie d'éléments pouvant aider à sa communication et compréhension (textes, légendes, images, figures).

La grande variété d'outils dont nous disposons actuellement pour la production et l'exploration dynamique d'images de data visualisation (logiciels comme Tableau et Gephi, mais aussi des bibliothèques JavaScript pour le web comme d3.js et sigma.js entre autres), met en évidence le caractère interactif de ces images. Nous pouvons désormais



effectuer plusieurs actions sur un élément quelconque ou sur l'ensemble graphique : sélectionner, cliquer, déplacer, masquer, regrouper, colorier, animer, etc. Nous pouvons parler à présent des images-interfaces car elles acquièrent des caractéristiques propres des logiciels. Elles virtualisent les possibilités de représentation des données en fonction des potentialités permises par les supports informatiques. Dans ce sens, une image de data visualisation peut être comprise comme un environnement : elle propose une vision du monde avec ses métaphores (esthétiques, étiques, politiques), ses opérations (algorithmes) et sa capacité d'évoluer et s'adapter à son contexte historique.

Pour exemplifier nos idées, nous allons présenter ici le cas de la visualisation de données provenant des médias visuels, c'est-à-dire des informations extraites de productions graphiques comme les photographies numériques, le design graphique ou les clips vidéo. Notre objectif est de souligner la nécessité d'adopter un point de vue multidisciplinaire face aux images-interfaces et d'identifier quelques pistes intéressantes pour des travaux à futur.

### **La visualisation de médias visuels**

Dans notre contexte historique, nous donnons une grande importance aux images. D'un côté, les dispositifs pour leur acquisition et visualisation sont devenus ubiquitaires : appareils portables, satellites, caméras de surveillance, écrans, capteurs. D'un autre côté, les images qui existaient auparavant sous format exclusivement analogique se numérisent et deviennent des bases de données à la disposition du public : livres, catalogues, peintures, photographies sur papier, films 35mm.

Dans les deux cas, les images numériques impliquent le traitement de propriétés visuelles. En effet, une image peut être décrite par ses métadonnées (auteur, date, lieu, technique de production) et par les figures reconnaissables sur sa surface (personnes, objets), mais quand on parle de propriétés visuelles nous faisons référence aux attributs et paramètres plastiques (couleurs, formes et textures)<sup>18</sup>. Au croisement de la sémiotique plastique et de l'informatique, ce sont les interfaces utilisateur les espaces qui mettent à la disposition les conventions de l'interaction homme-machine pour les traiter. Les boutons, les "sliders", les boîtes à outils et les panneaux donnent accès aux chromèmes (tinte, saturation, luminosité) et formèmes (dimension, position, direction) de l'image.

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<sup>18</sup> Greimas, A. (1984). *Sémiotique figurative et sémiotique plastique*. Actes sémiotiques. VI, 60. EHESS-CNRS, Paris.

Dans la typologie actuelle d'actions possibles sur les propriétés visuelles, nous observons le résultat de la tradition scientifique et technologique en analyse, extraction, classification, recherche et restitution des images numériques : augmenter le contraste, corriger les tonalités, ajouter un filtre, redimensionner, découper, compresser, etc.

Le défi que posent les médias visuels aux modèles typiques de la data visualisation relève du fait qu'ils sont des objets graphiques. On peut donc parler des visualiser des média visuels. De plus, cette situation se complique lorsqu'on s'intéresse à représenter une multitude d'images, que ce soit parce qu'elles appartiennent à une même production (une séquence d'images) ou parce qu'elles partagent un trait en commun (même auteur, même technique, même date, etc.). Pour les médias visuels, il s'agit donc de les faire intervenir comme un élément intrinsèque d'une image de data visualisation.

### **Modèles visuels pour la représentation du temps dans l'espace**

Nous avons évoqué plus haut quatre modèles typiques de la data visualisation. Ces modèles sont aussi le résultat d'une évolution : de la représentation graphique du mouvement. Il est possible de retracer rapidement les origines de cette évolution à partir du développement de mathématiques et de la géométrie, dont les principaux avancements ont été recueillis par Euclid vers 300 avant J.-C. Ensuite, en 1360, il a été attribué à N. Oresme la première représentation du mouvement, quand il a situé plusieurs barres de différentes tailles l'une à côté de l'autre<sup>19</sup>. Nous devons ensuite prendre en compte le rapprochement par R. Descartes de la géométrie à l'algèbre en 1637, et notamment sa contribution à travers l'invention du plan cartésien. Plus tard, dans le XIX siècle, avec l'introduction de la photographie, la représentation du mouvement est devenu aussi capture du mouvement. Les travaux de E. Jules-Marey sur la chronophotographie, de E. Muybridge sur la séquence de photographies et de F. Gilbreth sur la cyclographie en sont des exemples<sup>20</sup>. Ce parcours rapide peut s'arrêter avec le passage du papier à l'objet. Des représentations 2D aux objets 3D, comme les modèles physiques de Gilbreth et Jules-Marey.

Depuis 2005, la Software Studies Initiative (SSI) s'intéresse particulièrement à l'"analytique culturelle", qui étudie les images avec des procédés informatiques tout en gardant une approche des sciences humaines<sup>21</sup>. Au travers les projets de la SSI, nous

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<sup>19</sup> Giedion, S. (1948). *Mechanization Takes Command*. Minneapolis, MN : University of Minnesota Press.

<sup>20</sup> Gideon, S. Ibid.

<sup>21</sup> Software Studies Initiative. <http://lab.softwarestudies.com>

identifions l'émergence de modèles adaptés à la visualisation de médias visuels : pixellisation, mosaïques d'images, moyenne d'images, découpage d'images en tranches, traçage d'images dans un plan cartésien. Et plus récemment nous distinguons des modèles informés par la géométrie non-euclidienne ainsi que l'impression 3D<sup>22</sup> (figure 1).

### **Pistes pour des travaux à venir**

La data visualisation est un type d'image-interface contemporaine qui fait converger le état actuel de recherches et développements en informatique et en sciences humaines. Les nouvelles formes qui apparaissent, à l'issu de ce croisement, constituent une partie de l'aspect visuel de nos sociétés informatisées. Ces formes données à l'information représentent le domaine connu comme "info-esthétique"<sup>23</sup>.

Les images-interfaces de nos jours sont complexes et hybrides ; elles ne se réduisent pas à des données d'origine textuelle ou visuelle. Il y a aussi des médias sonores, olfactifs, haptiques, virtuels, quantiques, chimiques. Nous pensons que les projets à venir en data visualisation devraient nous montrer ces relations. Ils devraient aborder aussi la question de "ce qui reste dehors" : ce qui n'a pas été numérisé ni visualisé. Dans le continuum de la réalité, l'être humain devient un point de vue parmi d'autres : les animaux, les objets, les particules ont, eux aussi, leurs propres modes d'existence<sup>24</sup>. Faut-il les prendre en compte ?

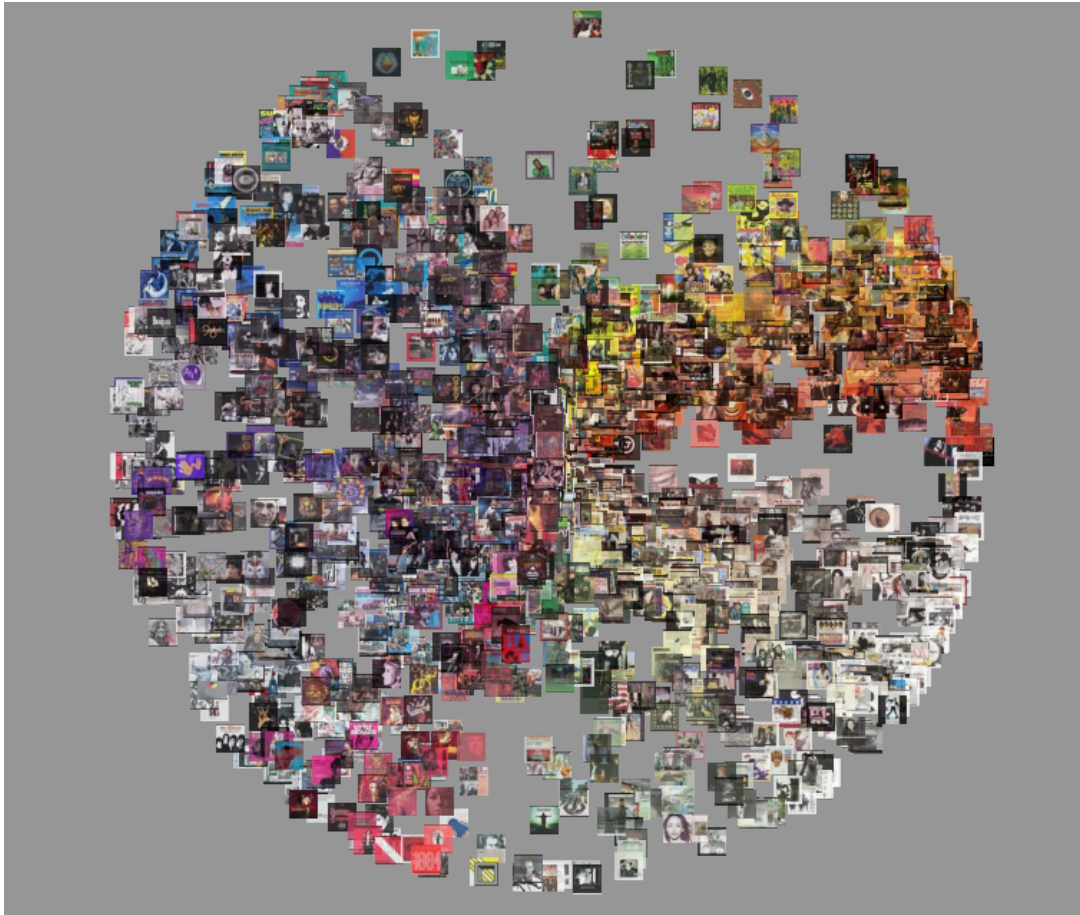
La variété d'approches qui restent à explorer est riche et nécessite, en grande mesure, d'une optique multidisciplinaire. Peut-être dans l'immédiat nous pouvons penser à un back-office pour la data visualisation. Cet endroit serait l'espace de documentation de pratiques et de motivations de producteurs. On pourrait y trouver les descriptions de contextes historiques (situations politiques, débats), de réflexions théoriques (raisons intellectuelles des choix de thèmes) et des passions artistiques (musique écoutée, influences graphiques) ayant contribué à la création d'une image-interface.

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<sup>22</sup> Reyes, E. (2014). "Explorations in media visualization". *Extended proceedings of the ACM Hypertext'14*. New York : ACM Press.

<sup>23</sup> Manovich, L. & Reyes, E. (2015), "Info-aesthetics", in M. Veyrat (ed.), *100 Notions for Digital Art*. Paris : Les Éditions de l'Immatériel.

<sup>24</sup> Harman, G. (2011). *The quadruple object*. Winchester, UK : Zero Books.



*Figure 1. Représentation de 2000 pochettes de disques selon une variation dans la formule du cercle chromatique.*

## 2.2 Esthétique des transformations temporelles et spatiales des médias numériques



**Figure 6.** Couverture de la revue *Metaverse Creativity*, Vol. 4. No. 2. sous la direction de E. Ayiter & Y. Sharir. Londres : Intellect, 2014. ISSN : 2040-3550 et de l'article « Aesthetics of temporal and spatial transformations in virtual environments », pp. 151 - 165

### 2.2.1 Résumé en français de l'article

La manière traditionnelle dont on interagit avec les médias à base de mouvement, du temps et de l'écran, comme le cinéma et la télévision, se fait par la visualisation des images, les unes après les autres. C'est-à-dire qu'un même espace visuel est réécrit continuellement. Néanmoins, il y eu historiquement des méthodes originales pour interagir avec une séquence d'images. On constate que des techniques pionnières comme la chronophotographie et la cyclographie partagent les mêmes inquiétudes que l'on trouve chez des œuvres artistiques et visualisations scientifiques contemporaines intéressées par la capture, la restitution et la représentation du mouvement dans l'espace. Dans cet article nous introduisons une approche expérimentale de la représentation des pièces vidéo art et des modèles 3D en environnements virtuels. Notre objectif est de contribuer aux possibilités offertes par les techniques computationnelles modernes en proposant des formes alternatives d'interaction avec les médias en mouvement.

### 2.2.2 Texte intégral de l'article, pp. 151-165

#### Introduction

Media based on motion, time and screen, such as cinema, television, video and animation often depict visual images one after another, which means the same visual space is rewritten continuously: one frame replaces the previous one. In general, the experience of viewing images in motion is achieved by replacing these images at different time rates: traditional cinema uses 24 frames per second (fps); television standards accord 30 fps; and, computer graphics made with software like Director or Flash mainly used 15 fps. At those rates, the human eye perceives motion because of the latency between the image imprinted in the retina and the new image appearing on screen. It could be said that motion media simulate movement as we know it in our physical world reality.

However, movement can be represented in different manners. As we will see, the first studies of movement used graphs instead of images. Later, as techniques developed, scientists employed photography to capture movement but then again there was a passage to graphs. Today, it seems images and graphs exist together and have opened the path to multiple techniques of digital processing of video with software applications.

Throughout history not only scientists have been interested in the study of motion, but also artists. The relationship between art, science and technology has been fruitful in the development of new techniques, devices, software applications, visual representations, language and symbols. In this article we review some of the main contributions in visual representations of motion as the background to introduce an experimental approach to represent video artworks as 3D models in virtual environments. Our aim is to discuss the possibilities offered by contemporary computing techniques in order to explore alternative ways of interacting with motion media.

The following article is structured as follows. First, I analyze historical and current approaches to the representation of movement and motion media. Then, I focus on my own approach, called Motion Structures, describing the principles and showing examples of productions. In the last part I discuss our experiences and I discuss further lines of research and experimentation.

## **Representation of Movement and Motion Media**

In the development of pictorial thinking, which includes drawing, writing, diagramming, painting and other forms of visual representation, sight and touch are perhaps the most important senses regarding the evolution of our understanding of space and time. Of course, this is not to say that the rest of our senses are not

determinant for us to consent that we live in a physical world reality, but we have learned to measure distances thanks to our sight and touch (Colérus 1957).

At the beginning of graphical methods there are mathematics and geometry, which allow one to make diagrams, measure far distances or even to draw theoretical figures. The development of mathematics and geometry is indebted to prominent thinkers that invented systems of measure and representation. Euclid, for instance, is acknowledged to have reassembled many geometric postulates into a logic and comprehensible form in circa 300 BC. Euclid proposed a theory for measuring distances, shapes, positions and sizes in a plane and in solid 3D figures. Later, during the seventeenth century, René Descartes saw geometry as algebra and invented the well-known Cartesian coordinate system.

In this section we review some of the most important representations of time and space. It will be interesting to note that most of these representations make evident the validity of Euclidean geometry and the Cartesian system. As computing techniques for data visualization and image processing developed, such postulates were also translated into computing forms: algorithms, interfaces, human-computer interaction, data abstractions and programming languages.

### **Early Representations**

The Swiss architect and historian Sigfried Giedion accounts for the first graphical representation of movement, which was concerned with depicting visually the variations of intensity of a given phenomenon (Giedion 1948). It was Nicolas Oresme who, in the fourteenth century, used a geometrical figure made of vertical lines. Each one of these lines had different sizes, according to the intensity of the quality, and were drawn repeatedly. The geometrical figure relies on the postulates of the Euclidean geometry and are later related to the Cartesian X and Y axis.

In his account, Giedion makes a leap from the representation of movement to the capture of movement. Through the first works of Étienne-Jules Marey, in the nineteenth century, we observe a fascination with the graphical representation of movement in a Cartesian plane. Among other devices, the French physiologist invented the spymograph and the myograph to record movement in graphical form. Later, Marey used photography to register the trajectories and transformations of movement that the naked eye could not perceive. His chronophotographs, as he called them (Marey 1893),

traced the movement at the rate of 12 frames per second in the same image. In complement to the work of Eadweard Muybridge, who depicted phases of movement in separated frames, Marey was interested in showing these states in a single frame. Besides his chronophotographs, he also experimented with capturing the movement of an object from different angles (by using three cameras: front, left, top) and he even crafted three dimensional sculptures of the successive positions of sea gull in movement.

From the first graphical representation of movement to the capture of movement, we observe a passage from abstract geometrical figures to images themselves. It was in the late work of Marey and, most prominently, in the works of Frank Gilbreth that the passage comes back to abstract lines. Gilbreth invented the cyclograph around 1912 with the intention to record the movement of workers at their posts. The resulting image was also called light curves because they were mainly white lines over black background. Later, Gilbreth also created a physical 3D model of those lines, but this time using wires. Contrary to Marey, whose interest was specially on scientific experimentation and the production of graphical forms, Gilbreth was interested in assisting workers to improve their efficiency. His graphs can also be considered mechanizations of the human motion and its abstraction could then be implemented as a model for a machine.

At that time, yet another insight on geometric lines and overlapping images came from the artistic domain. An influential initiator was Marcel Duchamp. In 1912 he presented his famous 'Nu descendant un escalier', where the representation recalls the chronophotograph technique. Abstract artists such as Kandinsky, Klee and Miró can also be considered as explorers of the language of motion. The geometrical lines and figures, together with colors and textures, adopted a new symbolism when they were painted on canvas. For artists, the detachment of movement and space from the subject was regarded as qualities for abstraction, as a symbol of liberation, as a rupture with material supports, and as the interpretation of multiple and higher states of consciousness (Henderson 1984).

It is not coincidental that artists also became aware of contemporary advances in mathematics and physics, particularly Einstein's famous theory of relativity and idea of space-time, which was based in Riemannian geometry formulated around 1857. From this perspective, 4D entered the vocabulary of artists such as Theo van Doesburg, El Lissitzky, Matta Echaurren and Oscar Domínguez. For some of them, the fourth dimension was related to time, while for other it was space, inspired by non-Euclidean



geometry such as Riemannian manifolds, hypercubes and polyhedra. According to Henderson, the exploration of 4D as a fourth spatial dimension in art lost impetus after the decade of 1940 (with the exception of M.C. Escher), mainly because the new generation of artists, born around 1905, did not experience the enthusiasm of Einstein and new physics.

### **Representation of Movement with Computing Technologies**

We can distinguish two major entry points to the representation of movement and space with computing technologies. First, media is designed with software, which implies that media designers must learn how to use computers and software or even, at to some point, scripts and plugins to extend the basic options. Second, if media is designed with software, what about the design of software to design media? Why does a software have this or that function instead of another? Why should it be used in a specific way? Indeed, media, software and technologies in general, represent the vision of a creator that identified and developed a way of seeing the world.

In the evolution of digital computers there has been a major change in their social and cultural role. With the advancements in human-computer interaction mainly led at Xerox PARC in the 1960s, it is possible to situate at that time various inventions still in use today: the mouse, the pointer, hypertext, videoconferencing and graphical user interfaces and metaphors. It is interesting to recall the fast pace at which computers evolved afterwards. The following decade, during the 1970s, two of the most influential programming languages were developed: first, Pascal, designed by Niklaus Wirth between the universities of Stanford and Zurich, influential in procedural programming; second, Smalltalk, at Xerox PARC, influential in object-oriented programming. These languages, together with the advancements in hardware and operating systems, allowed computer designers to create another kind of software: software to design media. For instance, one of the most influential software in digital imaging has been Photoshop, developed the next decade, in 1987, mainly with Pascal for the Apple Macintosh by Thomas and John Knoll.

In the 1990s the computer was already seen as a media machine and a variety of media software appeared: Aldus Pagemaker (1985), Adobe Illustrator (1987), Director 1.0 (1988), 3D Studio (1990), Pro Tools 1.0 (1991), After Effects (1993), Maya 1.0 (1998), etc. The manipulation of images and the representation of computing functions

demanded the invention of user interfaces dedicated to work with the representation of movement. A software application like Director, for example, relied on a theater metaphor: actors performing, coming in and out of the stage. Adobe Photoshop, starting from its third version, introduced layers to work with digital images, which can be related to early cell animation techniques.

It is not my intention to analyze in this article the software to design media, a study that needs to be conducted in its own publication. What it is interesting to note is that software applications and the resulting productions created with them entail a complex relationship. On the one hand, they are inspired by previous analog media. They remediate (Bolter & Grusin 2000). They simulate the Cartesian plane, handle algebraic and trigonometric functions, allow the drawing of Euclidean figures, permit the manipulation of images with overlapping, applying filters and effects, composing with layers. On the other hand, they also introduce and explore new ways of interaction; they remix techniques from other media and combine data file formats. In recent years, new kinds of projects have emerged, taking advantage of developments in image processing, computer graphics, information visualization, and media art. Through these projects, it seems the exchange of properties and processes among domains has been a motor for creativity in the quest of alternative ways to see and interact with media.

The domain of motion media has witnessed an expansion of techniques and technologies that were previously used mainly in other contexts: video segmentation (as in photography), video traces (as in slit-scan photography), video annotation (as in text), video summarization (or video abstraction, as in summaries of documents), video cubism and video cubes (as in data visualization), and media visualization (including techniques such as montage, slice, and image plots) (as in scientific imagery).

Moreover, the use of 3D techniques and technologies has also been influential. Today the word *3D* easily applies as prefix for at least the following fields: views, data representation, data description, spatial interaction, modeling, visualization, user interface, model retrieval, capturing, printing, volume rendering. The contribution of 3D-based productions is related to the intention to achieve or facilitate multivariate analysis, immersion, interactivity, representation of larger volumes of information, visual analytics, visual interfaces (commonly for virtual reality, augmented reality, and games), representation of hyperspace, depiction of mathematical models.

As it was the case with abstract artists from the twentieth century, we see in the contemporary digital art creative ways to use digital computing technologies. In fact, art and technology have a long relationship that covers digital art, cybernetic art, electronic art, hypertext literature, virtual art and media art. In comparison to modernist artists, designers, architects and filmmakers who invented new forms appropriate for industrial society, digital artists look for new forms appropriate for the information society. Although today it is difficult to approach an answer to this question, this is precisely the objective with the info-aesthetics paradigm (Manovich & Reyes, 2014). Info-aesthetics studies how the use of computers and the explosion of information change the very concept of form. For example, contemporary new forms are often variable, emergent, distributed and not directly observable.

To mention some examples that have explored alternative ways of representing motion and space, ‘The Invisible Shape of Things Past’ by Art+Com (1997) and ‘Field-Works’ by Masaki Fujihata (2000) consider an image sequence as an array of individual objects (video frames) that are organized along the Z-axis (depth) according to the position of the camera that recorded them. Another case is the ‘Liquid Time Series’ by Camille Utterback (2000-2002), which combines aesthetics of video traces and the physical movement of participants.

The same fascination with the trace of movement can be seen in ‘Sculptures (Time Crystals)’ (1997) by Tamás Waliczky & Anna Szepesi, which recalls the motion sculptures by Marey.

Other projects make available the software and programming code used to produce a piece. In such cases, the artwork is also the software and, perhaps more important, the different versions and operations available to perform on some type of media. Consider the interactive documentary ‘CLOUDS’ by James George and Jonathan Minard, which was created with the RGBD Toolkit (where D stands for depth). While the film was crowd-funded, the software can be downloaded for free from the creators website. An interesting perspective of this project is that it combines the possibilities of a Kinect sensor camera to capture movement not anymore from one perspective of the camera, but from the physical 3D ambient.

## **Motion Structures**

‘Motion structures’ is an approach to explore and interact with motion media, such as film, video and animations, in a different way. Our approach is based on the idea of representing spatial and temporal transformations of an animated sequence. We are interested in representing the shape of spatial and temporal transformations that occur within the visual space of the frame along the duration of the sequence. The final outcome thus traces those transformations in the form of a digital object.

We initiated our approach in 2011, conducting several experiments out of different types of animated sequences. The resulting digital object is represented as a digital 3D model generated from the patterns of time and shape. The mode of interaction with the 3D object allows for different ways of digital exploration: orbiting around, zooming in and out and even exploring the inside structure of the model.

Our process puts special attention on shapes above other visual features. From a technical point of view, to create a motion structure we use a script we wrote for ImageJ, a software application developed at the National Institute of Mental Health, Maryland, mainly used for scientific imagery practices. Basically, the operations decompose an animated video sequence into a series of separated image files, which are then manipulated as a stack of images. Then, several image processing techniques occur under the hood: converting images to 8-bit format, subtracting background and converting the stack as 3D shape in the 3D Viewer window. From the 3D Viewer it is possible to save the result as a static image, as 360-degree rotation movie and to export it as a mesh surface.

The obtained 3D shape encodes the changes of the objects in a frame: the different positions, the movement traces and spatial and temporal relations. The way in which we can interact with an object is not limited to ImageJ. An exported 3D mesh can be manipulated in other 3D software applications such as Maya, Sculptris, or MeshLab. Furthermore, it is also possible to export a motion structure for the web or to 3D print it, however both techniques require destructive 3D model processing, i.e. reducing geometry by simplification, decimation or resampling. For technical records, a motion structure exported from ImageJ has an average of 500,000 vertices and more than 1 million faces, which is a very large amount compared to an optimized 2000-face model for the web, to be loaded with the library three.js.

### **Examples of explorations**

Our first steps into motion structures initiated in late 2011. At that time we were interested in representing the shape of CGI visual effects sequences, starting with the Paris fold-over sequence from the film 'Inception' (Nolan 2010) (figure 1).

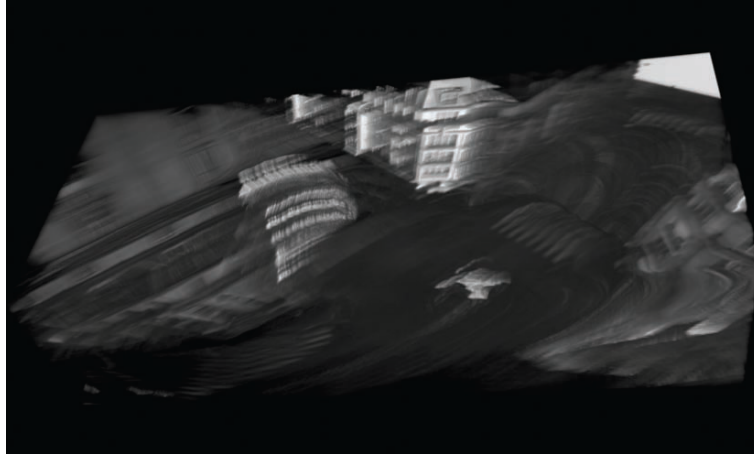


Figure 1: Motion structure from the Paris fold-over sequence in the film 'Inception' by Nolan.

In November 2012, we produced a second motion structure: it came from the title sequence of the TV series Game of Thrones. We took a 5-second shot of a traveling pan of the fictional city of Qarth. The image sequence of the fragment has 143 images and they were staked and converted to a 3D model (figure 2). For this project, we discovered an intrinsic invitation to go deeper in the interaction with a motion structure and to 3D print it as a physical piece (figure 3). The whole process was mainly aimed at experimenting with input/output, import/export, interchange/ exchange of visual features and formats; from digital to physical environments. The first thing we realized was that the amount of faces and vertices must be reduced to cope with the specifications of the 3D printer. At every reduction of geometry the meaning suggested by visual features changed: becoming smoother and eliminating details. The final printed physical object can be seen as a map of traces. We selected white plastic as printing material in order to convey the aesthetics of rapid prototyping.

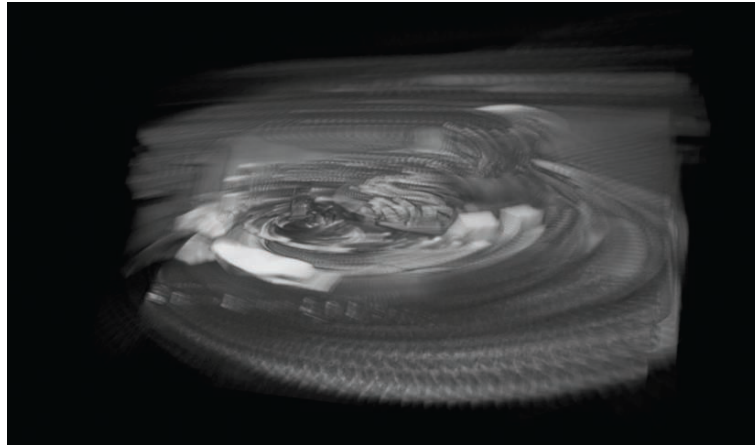


Figure 2: Motion structure from the title sequence of the TV series Game of Thrones.

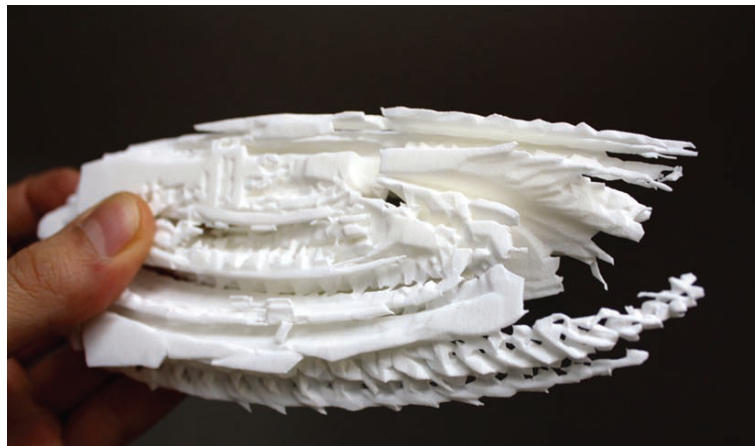


Figure 3: 3D printed motion structure from the title sequence of the TV series Game of Thrones.

At the occasion of the re-new 2013 digital arts forum (Reyes, 2013a), our selected image sequences came from seminal video artworks by Charles Csurí, Peter Weibel and Bill Viola. The importance of taking into account video as input media was its inherent characteristics in opposition to cinema. The introduction of video and animation technologies for recording, processing, and playing back moving pictures opened a wide range of possibilities for artists to explore and experiment with the aesthetics of space and time. Contrary to cinema, video was more accessible, malleable and portable for artists. It was also easier and faster to watch and project the recorded movie. Finally, the look and size of technological image was based on lines, reproduced at a different pace than film.

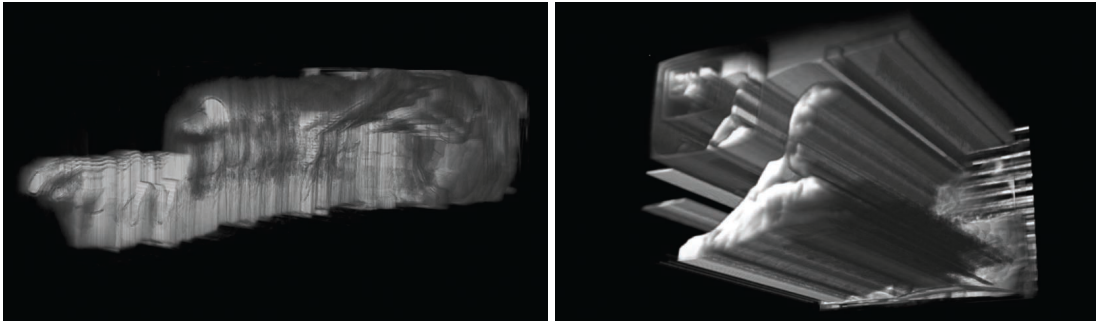


Figure 4:&5 Motion structure generated from Charles Csuri's "Hummingbird" (1967). 02:10 minutes, 1295 frames. This is a forward angle perspective captured from ImageJ 3D Viewer (Csuri 1967). Motion structure generated from Peter Weibel's "Endless Sandwich" (1969). 00:38 seconds, 378 frames. This is a forward angle perspective captured from ImageJ 3D Viewer (Weibel 1969).



Figure 6: Motion structure generated from Peter Weibel's "Endless Sandwich" (1969). 00:38 seconds, 378 frames. The object was exported as mesh surface in OBJ format and then opened in MeshLab. This is a perspective inside the object.

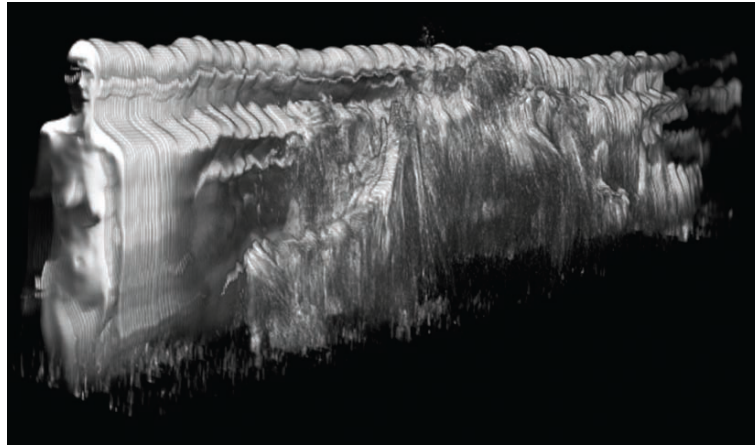


Figure 7: Motion structure of Bill Viola's "Acceptance" (2008). 02:03 minutes, equivalent to 1231 frames. This is a reverse angle perspective captured from ImageJ 3D Viewer, which means the first figure to the left is the last frame shown in the original video (Viola 2008).

### **Discussion**

The representation of these seminal video artworks as motion structures allows one to see patterns of spatial and temporal transformations. The main rhetorical turn comes from a rupture of the traditional way of interacting with motion media (i.e. one frame after another in the same visual space). The original contemplative character of these artworks is then represented as an interactive single object that depicts a rhythm that goes from simplicity towards complexity. At the beginning of the animated sequence we observe fewer elements that evolve in time, increase in number, and occupy more space of the frame surface. This is also perceived in the form of scaling shapes that change in scale along the Z axis.

Some reflections from the aesthetical front involve the fundamental question: why transform a video into an object? Recent research on visual epistemology recalls the difficulties of exploring new ways of seeing things. Following the idea of what has been called 'aesthetic provocations' (Drucker & Nowwiskie 2004), we take into account the approach interested on the aesthetic experience over functionality. That is, to put it simply, to focus on form over function. Aesthetic provocations are also a mechanism to 'augment our understanding of the encoded material' through the discovery of hidden patterns; to take a look at the way the work was produced. This would require the eye to give importance to abstractness because sometimes the aesthetic production engages with non-rational systems of thought.



In our case, the video is not anymore a motion picture but an object. Aesthetics of contemplation changes to aesthetics of exploration, holding, weighting, orbiting, destructing, or decorating. It seems the fascination and invitation to 3D print a motion structure is related with the current turn of a 'culture of craft', that prefers physical presence to electronic, touch over sight, poor media over rich media (Burdick et al 2012). As the authors put it: Is there a revolt against the screen culture? Or is a motion structure an 'iconoclastic delight' (Groys 2008), irreverent enough to destruct and decompose master pieces of video art or cinema?

Video art has been in itself a rhetorical movement against traditional representation of moving images. Artists working with video explored the plasticity of the video image. The aesthetics of video art has also influenced other media such as film, multimedia and websites. We observe this influence in special visual effects, in hybrid media (media made out of different media) and media art installations. The study of transformations of space and time within the boundaries of a frame is also an endeavor to pay attention to the plastic properties and invisible (or unnoticeable, that the naked human eye cannot perceive) elements of visual media (spatial-temporal patterns, visual features, software operations). Motion structures of video artworks are a second-degree; an aesthetization of the shape of time and space.

Although motion structures may seem non-figurative, they may foster readings and meaning effects of: roundness/harshness, flat/jagged, union/dispersion, small/tall, stretched/squashed. For an audience, the only reference to a figurative reading is through the original model.

Motion structures thus make evident the shape of movement. Instead of analyzing camera movements or character performances, we trace the transformations within the image itself, i.e. how the image changes over the time in the same visual region. This region is the rectangular space contained by the frame shot but it changes to a volumetric box when images are staked one on top of the other. In a motion structure it is easy to notice the rhythm of shapes: rhythm of position, orientation and dimension. The most noticeable plastic signs in a motion structure are shapes. Colors are lost when we change the format to black and white, while textures of the original image remain visible but the transformation of shapes becomes a texture in itself as well. A motion structure permits connecting two different fields: film analysis and 3D fabrication. It is interesting to note that new meanings may emerge when visual features connect in different ways. For us,

this passage raises some questions: can we analyze movement from a static object (as would be the case of sculpture)? Are there any extended, inherited or lost visual properties from one environment to the other? What does it mean to 3D print a motion structure?

Motion structures have also fostered some reflections about the relationship of a medium to its support. The possibilities to interact with a medium are determined by the software containing it. So, our macro script could be seen not only a small piece of software that allows converting an image sequence into a 3D object, but more important the operations and processes behind this process. These operations can be remixed, substituted, replaced and reorganized. As Lev Manovich says: 'Everardo adds his own unique take on how moving images can be converted into new visual representations; and since he made available his software tool, everybody can apply to other films, videos, TV shows, recordings of dance and other performances, and all other genres of moving images' (Manovich 2013). Our script is freely available to download and remix (Reyes 2013b).

We consider that motion structures are also a kind of abstract and disrupting models (Reyes 2012). Our initiative toward film may be considered as a kind of iconoclastic, in terms of Boris Groys (Groys 2008), but it is also a kind of transcoding. The final outcome may not resemble the high-resolution and neat image of film, but it does preserve fundamental traces and similarity through plastic signs. It also shares some principles with what has been called a 'sculpturalization of images' or video sculptures (Jaschko 2013), which are objects produced out of existent moving pictures, but which also have artistic values (rhetorical and aesthetical) on their own, mainly because they alter the viewers' expectations of traditional time and space depiction.

The current constraints of the exploration of motion structures in web-based environments and as printed objects can be seen as a similar path to the evolution of the representation of movement. As we saw, pioneers such as Étienne-Jules Marey and Eadweard Muybridge first represented movement with pictures and images themselves, but later Frank Gilbreth abstracted the traces of movement and created diagrams made out of lines. At that moment, artists got inspiration from both types of representation with the intention to explore a vocabulary of symbols, myths, and psychic processes. Perhaps, the same process can be applied to 3D models and shapes. By lowering the resolution or applying image processing techniques like summarization, the shape of

movement can be abstracted from the object. In this case, the abstraction could give place to detached forms and shapes of movement that can be used in different contexts, as it happens with contemporary parametric and algorithmic architecture (Terzidis 2006).

Experimental projects on the representation of movement and motion media contribute to the design of data visualization in two manners. First, through the abstraction of shapes, traces and patterns, it permits discovering diagrammatical representations, spatial distributions of elements, and combinations of shapes. Second, through the inclusion of images and the design of exploratory and immersive experiences, it provides insights for investigating animated behaviors, combinations of colors, mix of media, and graphical indicators to improve the comprehension of patterns in non-figurative productions.

However, from a more experimental point of view, motion structures still and information design in general still has not yet explored the possibilities of non-Euclidean geometry and the representation of a fourth spatial dimension. The decomposition of an image sequence into frames could be reconstituted according to non-Euclidean geometric figures. Let's imagine moving around different sequences following the rotation of a hypercube or a sphere eversion. Of course, such representations need to be rendered in a simulating device for computing visualization, virtual environments and augmented reality. But this is precisely the advantage of interacting and discovering emergent immersive experiences. Even more, can we apply our approach to disrupting of models and video sequences to virtual worlds? Disrupting media and software could foster creative practices, but in a virtual world we can also disrupt reality, the physical world and combine them with current and forgotten inventions and fictions. The task would require to think beyond human perception, to rethink the processes that have been translated into our computing tools, to adopt existing processes from other fields (science, astronomy, neurology, archaeology, etc.). But because one of the intentions behind the design of software and digital media has been to extend our senses, we have to consider the world in large, beyond our senses and experiences, from the transcendental perspective.

## **Conclusion**

In this article, we have introduced 'motion structures' as an approach to explore and interact with motion media in a different way. We studied prominent representations of

movement and we put attention on the aesthetics of spatial and temporal transformations occurring within the visual space of the frame. A motion structure implies decomposing an animated sequence into individual frames in order to perform software operations that will convert the image sequence into a virtual 3D object.

In this article we have shown examples of motion structures generated from seminal video artists, namely Bill Viola, Peter Weibel and Charles Csuri. In the end, we reflect on the aesthetical values of motion structures. Because video art has been in itself a rhetorical movement against traditional representation of moving images, motion structures could be seen as a second-degree aesthetization of the shape of time and space. For the selected artworks, they all are contemplative and occur in a single shot without any cuts. The motion structure captures well the traces of movement and the rhythm of the transformations.

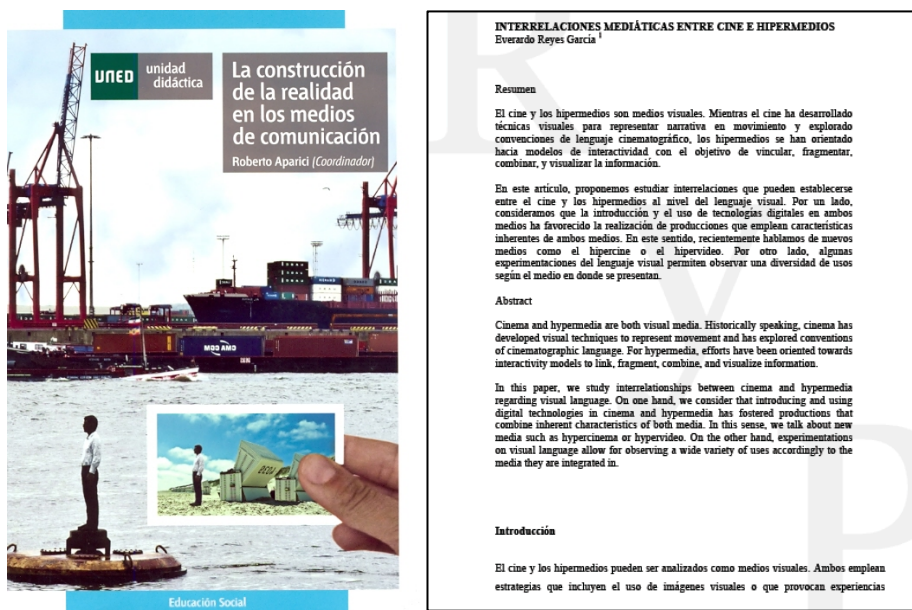
Our understanding of aesthetics is related to the idea of 'aesthetic provocations'. We try to use our approach not only for the sketch of visual artworks and design, but also to contribute to a visual and software epistemology by taking into account plastic properties and software operations in a reflexive manner.

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## 2.3 Interrelations médiatiques entre ciné et hypermédias



**Figure 7.** Couverture de l'ouvrage *La construcción de la realidad en los medios audiovisuales*, édité par Roberto Aparici. Madrid: UNED, 2010. ISBN: 978-84-362-6142-4 et du chapitre « Interrelaciones mediáticas entre cine e hipermedios », pp. 211-232

### 2.3.1 Résumé en français du chapitre

Le cinéma et les hypermédias sont des médias visuels. Tandis que le cinéma a développé des techniques visuelles pour représenter une narrative en mouvement, toute en exploitant les conventions du langage cinématographique, les hypermédias se sont penchés vers des modèles d'interactivité dans le but de lier, de fragmenter, de combiner et de visualiser l'information. Dans ce chapitre nous étudions les interrelations qui peuvent s'élucider entre cinéma et hypermédia au niveau visuel. D'un côté, nous considérons que la pénétration et l'utilisation des technologies numériques a bénéficié la réalisation de productions qui emploient les caractéristiques inhérentes aux deux médias. Sur cette ligne, nous parlons de nouveaux médias comme l'« hypercinéma » ou l'« hypervidéo ». D'un autre côté, quelques expérimentations du langage visuel permettent d'observer une diversité d'utilisations, selon le média dans lequel ces expérimentations se manifestent.

### 2.3.2 Texte intégral du chapitre, pp. 211-232

#### Introducción

El cine y los hipermedios pueden ser analizados como medios visuales. Ambos emplean estrategias que incluyen el uso de imágenes visuales o que provocan experiencias visuales. Desde esta perspectiva, es posible indicar que existen otros medios que podrían agrupar una categoría de medios visuales. Pensemos en medios clásicos como la fotografía, la danza, el teatro, las instalaciones, la televisión, los productos impresos, entre otros. Las aportaciones que estos medios han hecho al cine ha sido ya observada desde varios puntos de vista. De forma general, podemos mencionar que el cine consiste en una secuencia de fotografías; que los personajes de una película desempeñan roles similares a la actuación en una obra de teatro; que las instalaciones aportan conceptos de espacio y escenografía; que las realizaciones cinematográficas son distribuidas por televisión; o que los productos impresos permiten al cine salir de la pantalla de proyección.

En años recientes, hemos presenciado el surgimiento y desarrollo de medios basados en tecnologías digitales. Siguiendo una categoría visual, podemos incluir medios como el DVD, los videojuegos, la realidad virtual, los sistemas operativos, o el World Wide Web. En estos casos, las relaciones con el cine han sido consistentes con modelos de negocios o como fuente de inspiración para abordar temáticas sociales contemporáneas.

Pero a nivel visual, consideramos pertinente abordar las relaciones que se establecen cuando el cine adopta elementos propios de otro medio y, en sentido opuesto, la influencia que las imágenes en movimiento tienen en medios interactivos para modificar su lenguaje y convenciones visuales.

En este artículo, proponemos estudiar interrelaciones mediáticas entre cine e hipermedios. Mientras el cine ha desarrollado técnicas visuales para representar narrativa en movimiento y explorado convenciones de lenguaje cinematográfico, los hipermedios se han orientado hacia modelos de interactividad con el objetivo de vincular, fragmentar, combinar, y visualizar la información. El concepto de interrelación será empleado para observar influencias de un medio a otro y, sobretodo, aquellas relaciones que están íntimamente ligadas para generar nuevos medios o nuevos modelos de interactividad. La vía de acceso a estas interrelaciones será la comunicación visual. Cuando hablamos aquí

de lenguaje visual haremos referencia a convenciones o estrategias que han sido exploradas por un medio, desde su propia perspectiva, con sus mecanismos y objetivos.

Nos queda claro que esta tarea requiere una amplia revisión de producciones cinematográficas y realizaciones hipermediáticas, en diferentes épocas y corrientes. Sin embargo, hemos favorecido la selección de obras prominentes, con propuestas visuales audaces, es decir, que ponen acento especial en la exploración de formas y composición visual. En consecuencia, hemos dejado de lado producciones fílmicas con estructuras narrativas complejas y no lineales, que aportan elementos significativos a la forma del relato sobre lo visual.

Este artículo hemos estructurado, primero, la revisión a algunas características y transformaciones que el cine ha aportado como medio visual. Después, repasamos conceptos básicos de los hipermedios. Finalmente, analizamos algunas interrelaciones mediáticas mediante ejemplos concretos.

### **Estrategias visuales del cine**

Hemos enunciado que el cine ha desarrollado técnicas visuales para representar narrativa en movimiento y explorado convenciones de lenguaje cinematográfico. En esta sección, nos acercamos a esas técnicas visuales y las relacionamos con dos tipos de uso propios al cine: la exploración de la forma a través de la imagen y la representación de movimiento.

Al hablar de técnicas visuales nos ubicamos en el plano de la “denotación cinematográfica”, que Pier Paolo Pasolini opone a la “connotación cinematográfica”. Esta última está relacionada con la codificación de la comunicación según determinadas reglas de narración. Por su lado, la primera está asociada a la codificación de la reproductibilidad de la realidad por medio de aparatos cinematográficos.

En este sentido, al ser proyectado sobre superficies planas, se puede decir que el cine hereda los componentes de una comunicación visual más grande. Para los medios audiovisuales, son recurrentes las técnicas basadas en planos, ángulos y movimientos. En un intento aplicado al cine, Umberto Eco extiende los cinemas de Pasolini y establece tres componentes: signos icónicos (figuras visuales como ángulos, relaciones de clarooscuro, curvas, relaciones de figura-fondo), enunciados icónicos (combinación de varios signos icónicos en un plano) y fotogramas (implican movimiento, es decir, la generación de planos se da por combinación diacrónica) (Eco, 1999: 243).



En un análisis más reciente, Warren Buckland establece que la estructura del lenguaje cinematográfico está dada por la puesta en escena, la puesta en plano y la ediciónmontaje-sonido (Buckland, 2008). La puesta en plano, específicamente, contiene elementos como la visualidad que ofrece la posición de la cámara, su movimiento, el tamaño del plano y su duración. Dos técnicas son recurrentes en el uso del plano: el plano secuencia y la profundidad del plano.

Las estrategias visuales del cine estarán soportadas entonces por las investigaciones de la comunicación visual en general. Para nuestro estudio, será interesante adoptar una postura enfocada a los signos visuales que se delimite de la tradición lingüística. Aunque las posibilidades de un método basado en la lengua son adecuadas a determinados niveles, el enfoque que sugiere la semiótica visual intentar ir más allá de codificaciones basadas en dos elementos de articulación. Se habla, por ejemplo, de tres elementos: signos o unidades de reconocimiento; figuras o condiciones de percepción en signos gráficos; y, semas o enunciados icónicos (Prieto, citado por Eco, 1999: 224).

Otra clasificación que resulta indispensable es la que realiza Charles Sanders Peirce, quien concibe a los signos a partir de imágenes y de sus combinaciones. Para Peirce, un signo tiene tres referencias: “*first, it is a sign to some thought which interprets it; second, it is a sign for some object to which in that thought it is equivalent; third, it is a sign, in some respect or quality, which brings it into connection with its object*” (Peirce, 1934: 169). Como se nota, la semiótica de Peirce cobra valor en una relación dinámica que él llama semiósis, una cooperación de tres sujetos: el signo, su objeto y su interpretante.

Veremos que en el cine, las imágenes mostradas sobre la superficie de proyección pueden representar icónicamente algún objeto de la realidad física y material, sin embargo también pueden representar convenciones sociales de forma simbólica... pero además pueden no representar nada más que ellas mismas. Para concentrarnos en la exploración de formas a través de la imagen, ubicamos dos terrenos propicios para identificar ejemplos prominentes: el cine experimental y el cine digital.

Debemos notar que este análisis exige considerar la propiedad del cine como medio para representar narratividad en movimiento. En este contexto, nos apoyamos en las reflexiones de Gilles Deleuze sobre dos conceptos clave: imagen-movimiento e imagen-tiempo.

Deleuze habla de la imagen-movimiento como una materia no lingüística que comprende rasgos de modulación de diversos tipos, ya sean sensoriales (visuales y sonoros), kinésicos, afectivos, rítmicos, tonales, e incluso verbales (orales y escritos). De esta manera, la imagen-movimiento permite distinguir dos caras: una respecto de los objetos que varían su posición relativa en el espacio; y otra que se refiere a un todo que expresa un cambio absoluto. Este “todo” se da en el tiempo (Deleuze, 1985: 50).

Pensemos que la primera cara se manifiesta en el plano, mientras que la segunda en el montaje. En el plano, es posible la denotación de objetos y en el montaje se trata del tiempo. Para Deleuze, el montaje ofrece la imagen del tiempo, y este es el acto principal del cine.

Una valiosa contribución de Deleuze sobre el tiempo en el cine es que su representación es esencialmente aberrante. Es decir, el tiempo, tal como es observado en las producciones cinematográficas, recurre a técnicas tan variadas como la elipsis, las aceleraciones, los alentamientos, las inversiones, los cambios de escala y proporción. De cierta manera, precisa Deleuze, ya no es el tiempo el que depende del movimiento, sino a la inversa. Y esta inversión parece ser la norma en el cine.

Mediante estas reflexiones, resalta el hecho de que el cine no es una lengua. Más bien, se trata de una materia perceptible e inteligible que construye sus propios objetos cada vez que es actualizada, o sea, cada vez que se realiza una nueva producción fílmica, siendo los objetos que son puestos en plano y en escena, las unidades de significación.

Esta última premisa nos aclara pistas sobre el cine como medio visual. Los realizadores pueden echar mano de infinitas formas visuales. Mediante la combinación de objetos en el espacio de un plano y en un tiempo total como el montaje se generan nuevos lenguajes. Entendemos entonces que la narrativa, como infiere Deleuze, no está dada a priori, sino que radica en las imágenes mismas. De hecho, podemos añadir, dichas imágenes van más allá de la pantalla y de la duración de la proyección, cuando se provoca en el espectador una semiósis ilimitada: un objeto reenvía a otro objeto y éste a otro, y así incesantemente. El mismo proceso puede suceder en los realizadores, quienes encuentran inspiración en formas que no representan forzosamente aspectos de la realidad física y real.

Ahora, ¿qué sucede cuando el cine, objetos de movimiento y objetos de tiempo, se pone en contacto con las tecnologías digitales? Una clara influencia se puede observar en el carácter material de los medios contemporáneos. Comúnmente, se entiende que existe

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un proceso que va de lo analógico hacia lo digital, en donde la diferencia fundamental es que la producción, el almacenamiento, y la distribución está mediada por la computadora. Esto conlleva el hecho de que la información que contiene un medio es traducida al código binario de las máquinas informáticas.

Según el teórico de nuevos medios, Lev Manovich, algunos efectos de la computación en el cine son (Manovich, 2001: 287):

- 1 Uso de técnicas computacionales en la realización cinematográfica tradicional: animación digital 3D, matte painting, sets virtuales, actores virtuales.
- 2 Nuevas formas de cine basadas en computadora: gráficas computacionales en movimiento, net cinema, interfaces hipermedia, cine interactivo.
- 3 Apoyo en la post-producción por parte de los realizadores: uso de formatos de bajo costo como el DV.
- 4 Reacciones de los realizadores a las convenciones de los nuevos medios: convenciones de la pantalla de computadora, convenciones de narrativas de videojuegos.

Manovich propone que el cine digital es una combinación de imágenes filmadas (liveaction), pintura, procesamiento de imágenes, compositing, animación digital 2D y animación 3D por computadora (Manovich, 2000:180). Esta combinación introduce una nueva estética que es característica del cine digital.

Como veremos en secciones subsecuentes, es cierto que las posibilidades de las tecnologías digitales brindan nuevas técnicas para generar formas visuales basadas en movimiento y tiempo. Empero, habremos de incluir en este apartado que otro efecto de lo digital se percibe en las superficies de proyección.

Las salas teatrales o los aparatos de TV ya no son los únicos soportes de proyección cinematográfica. Actualmente, son conocidos los dispositivos móviles con pantallas integradas; los video walls; las video gafas; los ambientes inmersitos tipo CAVE, con proyecciones múltiples en paredes, piso y plafón, simultáneamente.

Esta variedad de soportes puede complementar, y en ocasiones recrea, una arqueología de medios visuales. Si nos enfocamos a aquellos medios que han promovido la inmersión del espectador, debemos citar: la linterna mágica de Athanasius Kirsher en 1671; el eidophusikon de P.J. de Louthembourg en 1786; el ciclorama de Robert Baker en

1787; la fantasmagoria de Etienne Robertson en 1797; el diorama de Louis Daguerre en 1822; la estereoscopia de Charles Wheatstone en 1840; el myriorama de Moses Gompertz en 1855; el cineorama de Raoul Grimoin-Sanson en 1902, y, más recientemente, las pantalla IMAX de Graeme Ferguson en 1967 (Reyes, 2009).

Sin tener la intención de profundizar en el debate de que estos medios clásicos pueden ser considerados como precursores del cine, lo que nos interesa resaltar son tres aspectos: las técnicas visuales a las que recurrían los autores; el aparente carácter efímero de dichos medios; y, la relación que se motiva al nivel del movimiento y del tiempo. Por ejemplo, la proyección en superficies blandas, como el humo o telas, de personajes fantásticos de la fantasmagoria, puede observarse en conciertos de rock masivos, en programas de TV grabados en estudio o en obras de Media Art.

Sobre la relación con el tiempo y movimiento, los soportes de proyección, en general, se han convertido en un mecanismo desafiante. Cuando un espectador tiene control sobre el movimiento y tiempo de una producción cinematográfica, gracias a los comandos pause y stop de los reproductores DVD, TiVo, VLC, Quicktime o VHS, la imagen no sólo es interrumpida, sino también sobre-observada.

Para el teórico ruso Boris Groys, existen dos modos fundamentales para controlar el tiempo que pasamos observando una imagen. Por un lado, la inmovilización de la imagen en el museo y, por otro, la inmovilización del espectador en un sala de proyección. Sin embargo, ambas inmovilizaciones se vuelven difusas cuando las imágenes se transfieren a una multiplicidad de espacios de la vida cotidiana. El cine se vuelve invisible, o como lo dice Groys, se ha vuelto iconoclasta contra sí mismo (Groys, 2008: 15).

Este breve recorrido que hemos hecho sobre estrategias visuales del cine, debe ser completado con otras características mediáticas como la fragmentación, la combinación re-composición, y la hipervinculación. La importancia de esta extensión será distinguir algunas influencias contemporáneas provenientes de otros medios.

### **Estrategias visuales de los hipermedios**

Los hipermedios son aquellos medios que justamente permiten realizar vinculaciones entre fragmentos de medios. Permiten también componer y recomponer cuerpos de información a partir de fuentes repartidas por cualquier parte del mundo.

La primera definición de hipertexto fue acuñada por Theodor Holm Nelson en 1965: “Déjenme introducir la palabra hipertexto para significar un cuerpo de material escrito o

pictórico, interconectado de manera tan compleja que no sería conveniente presentarlo o representarlo en papel. Este cuerpo contendría sumarios o mapas de su contenido y sus interrelaciones; podría también contener anotaciones, adiciones o pies de página de académicos que lo hayan examinado (...) Un sistema tal podría crecer indefinidamente (...) pero la estructura interna de sus archivos debería estar construida para soportar dicho crecimiento, cambio y ordenamientos complejos de información”. (Nelson, 65: 96). En ese mismo ensayo, Nelson también introduce el término hipermedia, poniendo énfasis en la no-linearidad, en la posibilidad de búsqueda de contenidos, y en la visualización de múltiples secuencias de video y audio.

Actualmente, los vocablos hipertexto o hipermedio, e incluso hiperdocumento, se usan de forma indistinta. Este hecho manifiesta que lo interesante de un hipermedio no es su contenido, sino el hiperespacio que se crea y la estructura del mismo. Es interesante añadir en este punto que los hipermedios son un tipo de medio que no surge gracias al uso de tecnologías digitales, como podría parecer a un primer vistazo. Recordemos que la primera noción de un sistema hipertextual fue propuesta por Vannevar Bush en 1945 (Bush, 1945). El sistema fue conocido como memex y aunque sólo quedó en prototipo, sirvió como fuente de inspiración para trabajos como Xanadu de Ted Nelson (Nelson, 1999) y el mismo World Wide Web de Tim Berners-Lee (Berners-Lee, 1999).

De hecho, consideramos que la noción de hipermedio puede ser observada desde mucho antes. Pensemos en el uso de índices como forma de acceder de forma no lineal un manuscrito; o las anotaciones e ilustraciones en los márgenes que hacían los escribanos en libros medievales. Ya en otro lado hemos propuesto que los hipermedios no son un tipo de medio porque permiten la fragmentación, combinación, vinculación o visualización de la información; son un medio porque pueden crear nuevos medios y porque transforman el proceso comunicativo (Reyes, 2009).

Con el objetivo de enfocarnos en el lenguaje visual de los hipermedios, nos apoyaremos en cuatro de sus características esenciales: fragmentación de cuerpos de información; vinculación entre fragmentos y documentos; combinación y recomposición de fragmentos en cuerpos más grandes o más pequeños; y, visualización de la información para representar relaciones o representar la forma del documento.

Estas características son necesarias para identificar que un documento hipermedia puede ser todo documento con una intención comunicativa bien definida y con

propiedades hipertextuales para explorar su contenido; este documento deberá haber sido terminado hasta cierto punto, pero esto no impide que su contenido siga creciendo. De la misma manera, una herramienta que sirve para crear documentos hipermedia puede emplear las mismas capacidades hipermedia para su escritura que para su lectura. Notemos que un software como Microsoft Word incluye posibilidades hipermedia enfocadas a “virtualizar”, o potencializar, medios basados en la escritura: hipervínculos a sitios Web u otros documentos, creación de índices automáticos, textos dinámicos como número de páginas, etc. Por su parte, una herramienta como Adobe Flash lo hace para medios audiovisuales e interactivos: la Library consiste en una biblioteca de los recursos que se pueden usar y re-usar en un proyecto, los sockets de conexión con protocolos Web pueden analizar documentos almacenados en servidores deslocalizados, etc.

El uso de los hipermedios que quizá ha sido más explotado y estudiado es aquel con fines informativos y documentales. En este sentido, el Web ha sido visto como una biblioteca universal; así como las enciclopedias multimedia en CD-ROM o los diccionarios en línea. Es evidente que estos usos han ganado popularidad gracias a las tecnologías digitales. Los discursos asociados para su promoción incluyen rapidez de acceso, ubicuidad, disponibilidad, libertad de uso.

Pero cuando se habla de usos que no son forzosamente documentales, como las obras net art o videos para ser exhibidos por el Web, se trata de un campo ambivalente. Los usuarios pueden contemplar las producciones pero no pueden guardarlas en sus discos duros (por ejemplo, YouTube.com) o pueden interactuar con ellas, pero no pueden decomponerlas o recomponerlas en otros contextos (por ejemplo, net art que se reproduce con Flash Player).

En este caso, la creación de contenidos requiere, en numerosas ocasiones, competencias propias de las ciencias computacionales. Aún cuando las herramientas disponibles actualmente están orientadas a facilitar algunos procesos complicados, los autores pueden optar por trabajar con un equipo multidisciplinario y delegar tareas; o, adquirir y practicar conocimientos básicos para la realización de obras.

Si nos orientamos a un contexto Web, observamos que el texto, como medio, se encuentra en tres niveles principales (Jeanneret, 1999):

1 Texto en pantalla: todo texto que el usuario puede ver en la pantalla o en la superficie de proyección. Aquí, Jeanneret entiende “texto” en su sentido amplio: puede

ser un documento formado verdaderamente de texto (trazos de la escritura verbal, matemática, etc.) o cualquier otro medio (video, audio, o interactividad).

2 Arquitexto: el texto que determina la forma en que el texto en pantalla es visualizado. Para el Web, hablamos, sobretodo, del código HTML (HyperText Markup Language); para Adobe Flash, el lenguaje ActionScript.

3 Texto binario: el conjunto de códigos que la computadora procesa, sabiendo que son datos binarios, 0 ó 1.

Para analizar el lenguaje visual de los hipermedios, habrá que enfocarse en la primera capa. Las investigaciones sobre hipermedios identifican como “dominios” o “modelos” a las formas innovadoras para representar, navegar, o interactuar con la información. Los “dominios hipermedia” son considerados como una línea complementaria a la investigación centrada en “sistemas” que define abstracciones de servicios, arquitectura de sistemas, y funcionalidades.

Un repaso histórico de sistemas hipermedia, nos muestra que los dominios han tratado de solucionar problemas comunes como la sobrecarga cognitiva o la desorientación de los usuarios en un sistema dado. Algunos ejemplos clásicos son: el modelo referencial, que es tal vez el más popular en ambientes basados en el Web gracias a la definición de ligas entre recursos (Landow, 2006); el modelo espacial, que sustenta el hecho de que las relaciones entre ligas se puede dar por su ubicación en el espacio, mediante símbolos: los nodos pueden ser representados con figuras geométricas y las ligas mediante la proximidad entre ellas (Marshall & Shipman, 1995); el modelo argumentativo, que es una especie de modelo espacial pero que asigna tipos de nodos y tipos de ligas. Cada tipo tiene un nombre y propiedades particulares para representar relaciones (por ejemplo, este nodo rechaza este nodo) (Conklin & Begeman, 1987); el modelo taxonómico, que visualiza la información en forma de arborescencia, con jerarquías entre nodos (Parunak, 1991); el modelo secuencial, que añade componentes basados en tiempo a la interactividad (Rutledge, et al, 2001). En la figura 1, reagrupamos de forma gráfica estos modelos hipermedia.

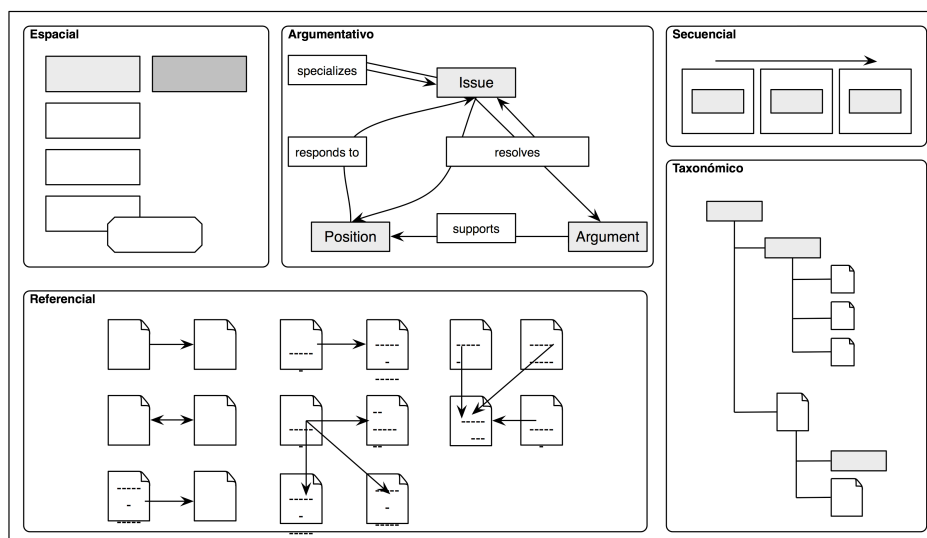


Figura 1. Algunos modelos hipertexto clásicos.

Si siguiendo en la línea del Web, es posible identificar otros modelos recientes que han surgido con la ola 2.0. Entre ellos, podemos mencionar las tag clouds, que representan categorías de importancia de acuerdo al tamaño de la letra; o los MSpaces, que son pequeñas ventanas que se despliegan horizontalmente cada vez que el usuario selecciona un elemento de la lista.

Pero, estos modelos ¿pueden ser considerados como representaciones semánticas? Es decir, ¿representan adecuadamente sus funciones de interactividad con la información y pueden ser empleadas en otros contextos o medios? Un punto de partida es admitir que el Web, y los hipermedios, son medios visuales que están compuestos fundamentalmente por signos, en su mayor parte símbolos digitales. El Web, es una máquina cultural en el sentido en que los signos con los interactuamos representan objetos culturales. Este proceso se da cuando un video es visto como una película, cuando un sonido es identificado como una canción, cuando una imagen representa una fotografía, o cuando un texto nos indica que se trata del nombre una persona que conocemos.

El Web es también un espacio complejo con sus propias convenciones gráficas. Reconocemos imágenes que indican la posición del cursor, y sus estados; iconografía asociada a procesos computacionales: copiar, pegar, seleccionar, importar, exportar, etc. Incluso, la interactividad en el Web puede seguir una estructura narrativa. El logro de una determinada tarea realizada por un usuario va de un punto A a un punto B, en donde el diseño de la interactividad y el uso de los elementos hipertexto juegan roles semejantes



al modelo actancial de Algirdas Greimas: algunas veces impiden que el usuario desempeñe la acción; mientras que, en otras, son aliados.

A la cuestión de si los modelos hipermedia pueden ser usados en otros contextos o medios, obtenemos algunas pistas interesantes a partir de la noción de tiempo y de la noción de medio. Por un parte, observamos un carácter temporal que se percibe mediante la inmediatez de la transferencia de información. Por otra parte, la impresión de inmediatez que provoca la infraestructura tecnológica necesaria de los hipermedios basados en el Web puede ser comparada a la imagen-tiempo directa de Deleuze. En el Web, el tiempo se presenta alterado al que existe en el mundo físico. Se trata de una serie de recursos y documentos almacenados en servidores que le confieren un carácter atemporal. En efecto, al tratarse de un medio informático y visual, se deben tomar en cuenta las versiones de cada documento y algunos rasgos que permiten identificar la “era Web” a la que pertenece. Lo interesante aquí es notar que estos documentos y recursos pueden ser accedidos en cualquier momento, sin importar el año de su creación.

Respecto de la noción de medio, habíamos adelantado que los hipermedios no son un medio debido a que permiten vincular, fragmentar, combinar, o visualizar información. Decíamos que son un medio porque permiten transformar el proceso comunicativo y porque permiten la creación de otro tipo de medios. Los nuevos medios que emergen parten del hecho de que los medios ya no son entidades dadas, temporales, sino más bien atemporales; los medios se vuelven un conjunto de procesos, contenedores de acciones más que de sustancias distinguibles.

### **Interrelaciones mediáticas**

En esta parte, pretendemos ilustrar algunas interrelaciones mediáticas entre producciones cinematográficas y realizaciones hipermedia. Como señalábamos anteriormente, el cine experimental y el cine digital aportan material interesante para realizar asociaciones con realizaciones hipermedia. Y para estas últimas, nos centraremos principalmente en aquellas distribuidas en ambientes Web.

Un primer caso puede ser visto en los efectos visuales. Mientras software contemporáneo, especializado en edición de video, permite incluir fácilmente efectos visuales en transiciones, cortinillas, o mediante el uso de capas de video, estas estrategias habían sido ya exploradas por Dziga Vertov en “Man with a movie camera” (1929).

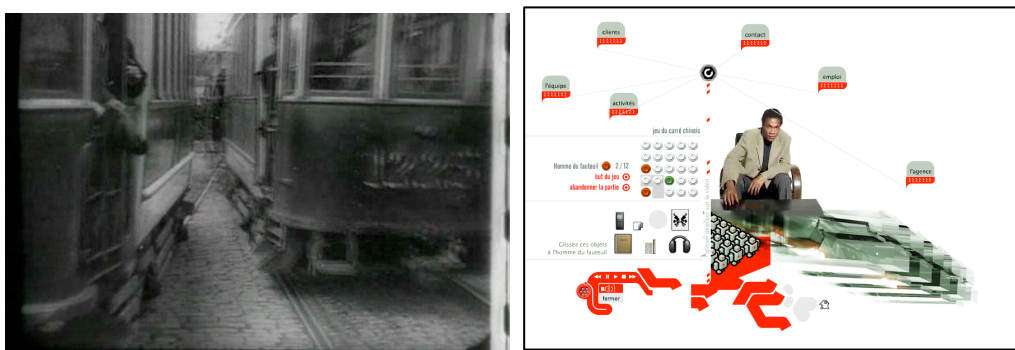


Figura 2 y 3. Fotograma de Man with a movie cámara. Sitio Web de leschinois.com

Las experimentaciones visuales de Vertov pretendían representar tiempo y espacio de forma que sólo un medio cinético fuera capaz de realizar. Mediante la “sobreimposición” de planos o escenas, el espectador tenía frente a él composiciones que rara vez habían sido vistas hasta ese momento. La principal consecuencia para un análisis de formas identificables, o con una relación icónica con su objeto, se ve en el hecho que las formas ahora contienen transparencias, variaciones de claroscuro en ciertas partes del plano, y, por supuesto, formas que no tienen ninguna relación con algún objeto del mundo físico... se trata más bien del resultado de varias imágenes “sobreimpuestas”.

Pero la estrategia de añadir imágenes con transparencia y múltiples capas de video en sitios Web, comienza a también a explorarse, aunque aún no podemos hablar de una clara tendencia como en el cine. Consideremos sitios de agencias para el diseño de imagen corporativa o campañas publicitarias, como tokyoplastic.com o leschinois.com

En este sitio, la interfaz de navegación es simple y está dada desde el inicio. Un hombre está sentado frente al usuario y, al mismo tiempo, otra simbología remite a funciones propias de un menú de exploración. Cada vez que un botón del menú es presionado, el hombre cambia su comportamiento: se levanta, se voltea, se para, camina. Los cambios de acciones están denotados justamente con transiciones propias de efectos de video, pero todos los elementos del menú son persistentes, quedan visibles en un capa superior que cubre al mismo hombre.

Otra estrategia visual explorada en el cine experimental han sido las proyecciones simultáneas. A esta técnica, Abel Gance le dio el nombre de “polyvision”, en su film “Napoléon” (1927), que contenía en ciertas partes del montaje tres proyecciones al mismo tiempo. Quizá el realizador que ha llevado esta estrategia al extremo haya sido Zbig Rybczynski, quien en su producción “New book” (1975) confronta al espectador

con nueve cuadros simultáneos, con acciones diferentes en cada uno de ellos, durante los 25 minutos de duración.

Consideramos que la complejidad visual que causa la proyección de secuencias simultáneas, está asociada a un intento por capturar ese tiempo que Deleuze llama “total”; el tiempo que se extiende más allá del montaje y que pretende responder a la pregunta ¿qué pasa con las demás acciones que suceden cuando el plano ya no la encuadra? Rybczynski responde con una historia sencilla y con hechos que asemejan a la vida cotidiana: en algunos cuadros casi no hay acción, en otros hay mucha, y en otros suceden situaciones chuscas o consecuencias de otros hechos precedentes.

En el Web, la capacidad que tienen los sitios para presentar diversas pantallas sobre diferentes hechos se ha popularizado con aplicaciones tipo iGoogle (google.com/ig) o NetVibes.com

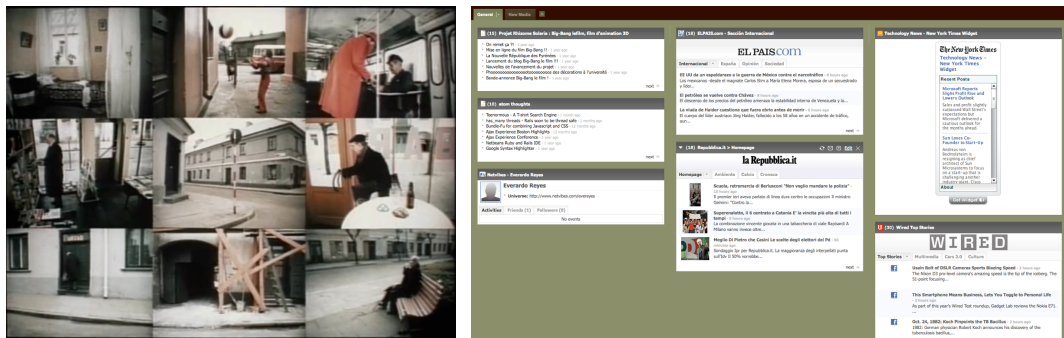


Figura 4 y 5. Fotograma de New book . Sitio Web de NetVibes.com

NetVibes.com propone a los usuarios un espacio personalizable a partir de diferentes flujos de información, la mayor parte de ellos como RSS (Really Simple Syndication) o como meras aplicaciones JavaScript. De esta manera, el usuario puede disponer en un solo vistazo de las noticias de La Repubblica.it, de ElPais.es, de LeMonde.fr, o de aplicaciones tipo efemérides, calendarios, chiste del día, etc.

En 1926, Marcel Duchamp presentaba una producción llamada “Anémic cinéma”. Dicha obra estaba compuesta de formas espirales que giraban de derecha a izquierda. A lo largo de los seis minutos de proyección, los espirales alternaban con texto, escrito también de forma espiral y con el mismo movimiento. El espectador leía entonces frases como: “L’enfant qui tête est un souffleur de chair chaude et n’aime pas le chou-fleur de serre chaude” (el niño que mama es un aspirador de carne caliente y no le gusta el coliflor de puntas calientes, nuestra traducción).

Esta puesta en escena podemos asociarla a una lectura espacial. Autores como Duchamp, u de obras más recientes como “Herzog and the monsters” (Lesley Barnes, Inglaterra, 2006), proponen una lectura determinada por la codificación textual, pero también por su localización el espacio y su movimiento.

Para los hipermedios, hemos hablado del modelo espacial, que puede ser extendido en la ola del Web 2.0 con sitios que basan su navegación en la visualización de datos. Una aplicación como “Facebook visualizer” ([vansande.org/Factbook/visualizer](http://vansande.org/Factbook/visualizer)) o un sitio como LivePlasma.com, incluyen una estrategia visual similar: cada nodo de interés está representado por una esfera de color, su tamaño y cercanía al centro corresponde al nivel de importancia en una escala de pertinencia. De manera complementaria, otros nodos se pueden distinguir con diferentes colores y tamaños. ¿Cómo se lee un mapa de este tipo? Creemos que sólo es posible a través de una identificación de signos reconocibles (texto o imágenes familiares) y convenciones de los hipermedios (líneas que representan ligas, texto que representa un hipervínculo, botones, etc.)

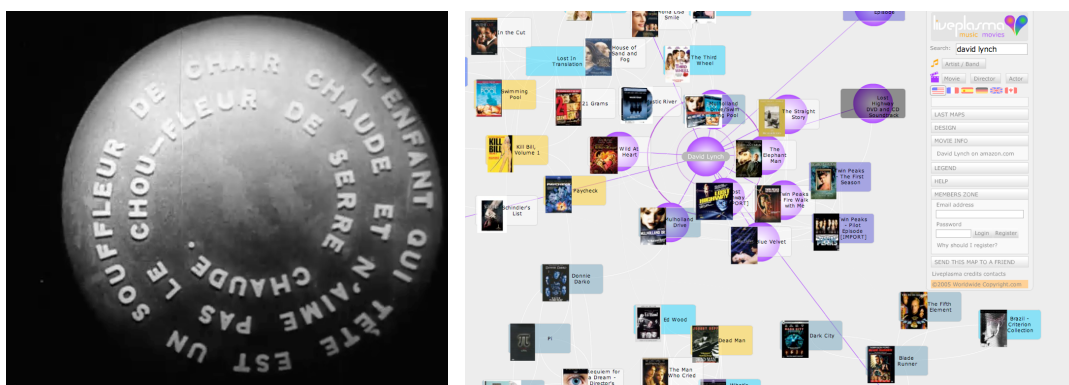


Figura 6 y 7. Fotograma de Anémic cinéma . Sitio Web de LivePlasma.com

Otro ejemplo que consideramos pertinente son las exploraciones secuenciales de contenidos en sitios Web. Actualmente, herramientas en línea para almacenar, organizar, compartir, y distribuir fotografías como Flickr.com incluyen una función predeterminada para visualizar el contenido como una presentación multimedia temporal. Cada imagen está presente durante tres segundos y cambia a otra en una transición tipo crossfade. Esta forma de contar historias basadas en imágenes estáticas fue explorada por producciones cinematográficas antes que los multimedios. Recordemos la obra *La Jetée* de Chris Marker, realizada en 1962.

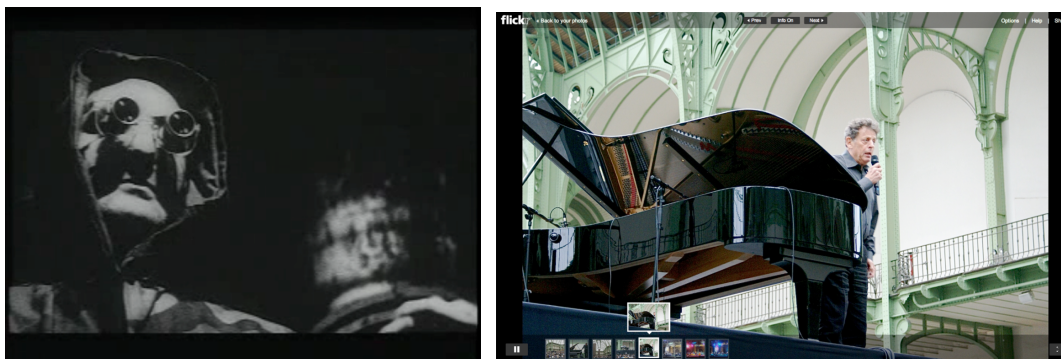


Figura 8 y 9. Fotograma de La Jetée . Presentación secuencial del sitio Web Flickr.com

Esta breve ilustración de obras queda incompleta si no observamos cómo algunas estrategias inherentes a los hipermedios han sido utilizadas en el cine. En este terreno, hablamos de obras llamadas cine interactivo, hipercine o cine digital.

Un ejemplo audaz lo encontramos en “E1000” (Regottaz & Horellou, 2008). La clara intención de los realizadores de este film es transportar el fenómeno de la participación colectiva y masiva que se da en sitios Web (blogs, foros de discusión) al cine. Como el mismo slogan lo señala “el primer film en donde se recomienda encender sus teléfonos móviles”, la llamada al público para interactuar con la estructura de la película es mediante un dispositivo celular. Durante la proyección, la historia se desarrolla de forma tradicional. Cuando la trama va llegando a su clímax, aparece en la pantalla del teatro un texto que invita al público a marcar un número. Así, la forma en la que se da el desenlace para el personaje principal está directamente ligada con la cantidad de llamadas que los espectadores realizaron. El montaje se hace en tiempo real. Técnicamente, la cantidad de llamadas es recibida por un servidor que, a su vez, envía los fragmentos de video correspondientes. Existen hasta cuatro finales posibles para el film. Aunque los autores los conocen, sólo pueden ser decididos por los propios espectadores.

Otro intento por explorar características de los hipermedios en el cine es el proyecto TR•33 (Reyes, 2008). La idea surge de motivar en una comunidad académica la realización de lo que llamamos “cine colectivo”. Se trata de poner a la disposición del público dispositivos portátiles capaces de grabar video (seis Blackberries) en un ambiente metafórico del mundo natural. Para esto, una instalación de 6 l. \* 3 h. \* 2.4 w. metros fue elaborada para proyectar un árbol fractal y colgar los Blackberries en estuches semejantes a hojas de árbol. Cuando los usuarios-espectadores se acercaban a la instalación y comprendían las posibilidades, grababan fragmentos espontáneos. Fue interesante descubrir que la interactividad estuvo influenciada por el horario y la cantidad de gente

alrededor. Mientras los videos en horas diurnas reflejaban tomas del entorno, las nocturnas fueron más íntimas, con mensajes personales alusivos al medio ambiente.

La instalación fue colocada en el Tecnológico de Monterrey Campus Toluca, del 22 al 25 de octubre 2008. La etapa de grabación se efectuó durante el primer día. En el tercero, la instalación sirvió como proyección de los videos grabados, ambientados con música creada especialmente para la ocasión en donde cada Blackberry contenía los tonos de un instrumento musical diferente. Como resultado, se recopilaron 95 clips de video que fueron guardados en un servidor y montándose de forma aleatoria con Adobe Flash sobre toda la superficie de proyección.

## **Conclusión**

En este artículo, hemos estudiado estrategias visuales del cine y de los hipermedios con el objetivo de identificar interrelaciones mediáticas. Las interrelaciones que hemos ejemplificado han estado relacionadas a aspectos visuales de ambos medios y su forma de representar el tiempo, el espacio y movimiento. Hemos observado que, mientras el cine ha desarrollado técnicas visuales para representar narrativa en movimiento y explorado convenciones de lenguaje cinematográfico, los hipermedios se han orientado hacia modelos de interactividad con el objetivo de vincular, fragmentar, combinar, y visualizar la información.

Ambos medios, cine e hipermedios, son visuales. Las formas de las que disponen los usuarios para interactuar con la información, así como las formas en las que el cine ha intentando representar su relación con el tiempo y movimiento, son terrenos propicios para explorar nuevas formas visuales.

A través de nuestros ejemplos, hemos favorecido aquellas producciones y realizaciones que han introducido estrategias audaces. Como se ha podido notar, es difícil saber si autores de un medio son también autores en otro... o si han estado expuestos a diferentes medios. Nos conformaremos, por el momento, en indicar que las estrategias visuales vuelven difusas las barreras del tiempo y del espacio.

Nos queda una pregunta, ¿es posible, en el mundo contemporáneo, buscar nuevas formas visuales?, ¿en dónde? Quizá sea necesario releer una historia visual de los medios; o quizá podamos encontrar pistas adoptando una óptica multidisciplinaria, como en la física, la geografía, o la biotecnología; o quizá sea otorgando libertad creativa a procesos automáticos de la computadora, como el loop o el random.

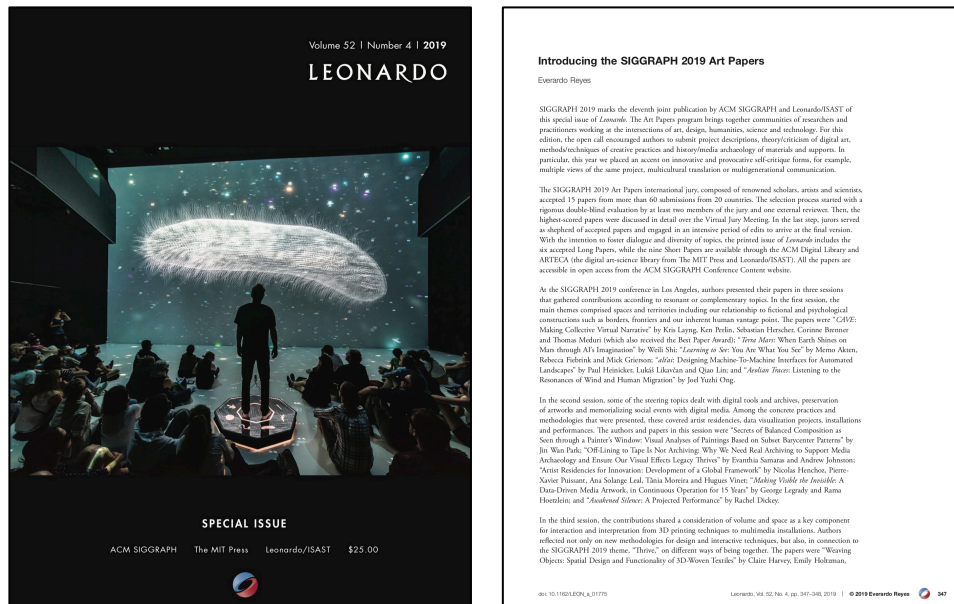
En todo caso, consideramos que la mejor postura para iniciar la búsqueda es admitiendo que los medios no son extraños unos con otros. Mientras una estrategia puede tener un uso o representar una funcionalidad para un medio; en otro puede tener un sentido distinto. Existe una variedad de usos y los medios no son, a final de cuentas, más que representaciones o virtualizaciones de nosotros mismos.

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## 2.5 Présentations des articles scientifiques-artistiques de SIGGRAPH 2019



**Figure 8.** Couverture de la revue *Leonardo*. Ce numéro spécial inclut les *Long Art Papers* de SIGGRAPH 2019, édité par Everardo Reyes. Cambridge, MA : MIT Press, 2019.

ISSN: 1071-4391, pp. 347-348.



**Figure 9.** Couverture de la nouvelle revue *SIGGRAPH Short Papers Proceedings*. Vol. 1, No. 1. Juillet 2019. Cette publication a été initiée par E. Reyes et inclut les *Short Art Papers*. New York : ACM Press, 2019. ISSN: 978-1-4503



### **2.5.1 Résumé en français de la présentation**

SIGGRAPH 2019 marque l'onzième publication en partenariat entre ACM SIGGRAPH et Leonardo/ISAST des numéros spéciaux de Leonardo. Le programme Art Papers réunit des communautés de chercheurs et techniciens travaillant au croisement de l'art, du design, les humanités, la science et la technologie. Pour la présente édition, l'appel à contribution encourageait des les auteurs à envoyer des descriptions, théories et critiques de l'art numérique, méthodes et techniques de processus créatifs, et histoire et archéologie des médias et des supports. En particulier, cette année nous avons mis l'accent sur les formes innovantes, provocatrices et réflexives, par exemple les auteurs pouvaient explorer plusieurs vues d'un même projet, des traductions multiculturelles ou des cadres de communication multi-générationnelle.

### **2.5.2 Texte intégral de l'article, pp. 347-348**

SIGGRAPH 2019 marks the eleventh joint publication by ACM SIGGRAPH and Leonardo/ISAST of this special issue of Leonardo. The Art Papers program brings together communities of researchers and practitioners working at the intersections of art, design, humanities, science and technology. For this edition, the open call encouraged authors to submit project descriptions, theory/criticism of digital art, methods/techniques of creative practices and history/media archaeology of materials and supports. In particular, this year we placed an accent on innovative and provocative self-critique forms, for example, multiple views of the same project, multicultural translation or multigenerational communication.

The SIGGRAPH 2019 Art Papers international jury, composed of renowned scholars, artists and scientists, accepted 15 papers from more than 60 submissions from 20 countries. The selection process started with a rigorous double-blind evaluation by at least two members of the jury and one external reviewer. Then, the highest-scored papers were discussed in detail over the Virtual Jury Meeting. In the last step, jurors served as shepherd of accepted papers and engaged in an intensive period of edits to arrive at the final version. With the intention to foster dialogue and diversity of topics, the printed issue of Leonardo includes the six accepted Long Papers, while the nine Short Papers are available through the ACM Digital Library and ARTECA (the digital art-science library from The MIT Press and Leonardo/ISAST). All the papers are accessible in open access from the ACM SIGGRAPH Conference Content website.

At the SIGGRAPH 2019 conference in Los Angeles, authors presented their papers in three sessions that gathered contributions according to resonant or complementary topics. In the first session, the main themes comprised spaces and territories including our relationship to fictional and psychological constructions such as borders, frontiers and our inherent human vantage point. The papers were “*CAVE: Making Collective Virtual Narrative*” by Kris Layng, Ken Perlin, Sebastian Herscher, Corinne Brenner and Thomas Meduri (which also received the Best Paper Award); “*Terra Mars: When Earth Shines on Mars through AI’s Imagination*” by Weili Shi; “*Learning to See: You Are What You See*” by Memo Akten, Rebecca Fiebrink and Mick Grierson; “*alt’ai: Designing Machine-To-Machine Interfaces for Automated Landscapes*” by Paul Heinicker, Lukáš Likavčan and Qiao Lin; and “*Aeolian Traces: Listening to the Resonances of Wind and Human Migration*” by Joel Yuzhi Ong.

In the second session, some of the steering topics dealt with digital tools and archives, preservation of artworks and memorializing social events with digital media. Among the concrete practices and methodologies that were presented, these covered artist residencies, data visualization projects, installations and performances. The authors and papers in this session were “*Secrets of Balanced Composition as Seen through a Painter’s Window: Visual Analyses of Paintings Based on Subset Barycenter Patterns*” by Jin Wan Park; “*Off-Lining to Tape Is Not Archiving: Why We Need Real Archiving to Support Media Archaeology and Ensure Our Visual Effects Legacy Thrives*” by Evanthia Samaras and Andrew Johnston; “*Artist Residencies for Innovation: Development of a Global Framework*” by Nicolas Henchoz, Pierre-Xavier Puissant, Ana Solange Leal, Tânia Moreira and Hugues Vinet; “*Making Visible the Invisible: A Data-Driven Media Artwork, in Continuous Operation for 15 Years*” by George Legrady and Rama Hoetzlein; and “*Awakened Silence: A Projected Performance*” by Rachel Dickey.

In the third session, the contributions shared a consideration of volume and space as a key component for interaction and interpretation from 3D printing techniques to multimedia installations. Authors reflected not only on new methodologies for design and interactive techniques, but also, in connection to the SIGGRAPH 2019 theme, “Thrive,” on different ways of being together. The papers were “*Weaving Objects: Spatial Design and Functionality of 3D-Woven Textiles*” by Claire Harvey, Emily Holtzman, Joy Ko, Brooks Hagan, Rundong Wu, Steve Marschner and David Kessler; “*The Trained Particles Circus: Dealing with Attractors, Automaton, Ghosts and Their Shadows*” by Patxi Araujo; “*Knowing Together: An Experiment in Collaborative Photogrammetry*” by Rosalie Yu and Charles

Berret; “*Air Hugs: A Large-Scale Interactive Installation*” by Rachel Dickey; and “*No in Disguise: Algorithmically Targeted Conversations About Sexual Consent in a Multimedia Art Installation*” by Simon Boas.

The journey to achieve the present issue started two years ago and I am honored to have served with so many talented colleagues. I am deeply thankful to the jury members—Andrés Burbano, Daniel Cardoso Llach, Haru Hyunkyung Ji, Tobias Klein, Paul Magee, Conor McGarrigle, Hye Yeon Nam, Gabriela Aceves Sepúlveda, Jack Stenner, and Victoria Szabo—for their commitment in a very professional manner to the tight schedule of reviewing and shepherding processes. I would also like to express my gratitude to the 28 external reviewers who gave us invaluable insight through their paper reviews. None of this could have been possible without the confidence that Mikki Rose instilled in me to lead the SIGGRAPH 2019 Art Papers program. I want to extend my appreciation to last year’s Art Papers chair, Angus Forbes, and to next year’s Art Papers chair, Andrés Burbano, who provided rich advice and support. Thank you also to all my colleagues on the SIGGRAPH 2019 conference committee for their inspiration and good fellowship in which we celebrated the planning meetings for the conference, the SmithBucklin conference administration team, the Leonardo editors and the ACM SIGGRAPH team. Thank you to all the contributors and submitters for their interest in sharing their work with SIGGRAPH and Leonardo/ISAST.

## **Partie 03. Vers une approche sémiotique des objets hypermédia**

Dans cette partie, l'articulation « informatique-sémiotique » est mise en avant comme une variante de la relation « information-communication ». Bien que dans plusieurs parties de ce dossier HDR j'utilise des méthodes et des systèmes de notations forgées en sciences informatiques, leur étude en tant que chercheur en SIC est fondamentalement celui de traductions des systèmes des signes. Le passage des significations d'un stade profond (comme le stade algorithmique) vers sa forme manifestée à l'écran, est pour moi une série des « mises en interface » ou une « énonciation computationnelle ».

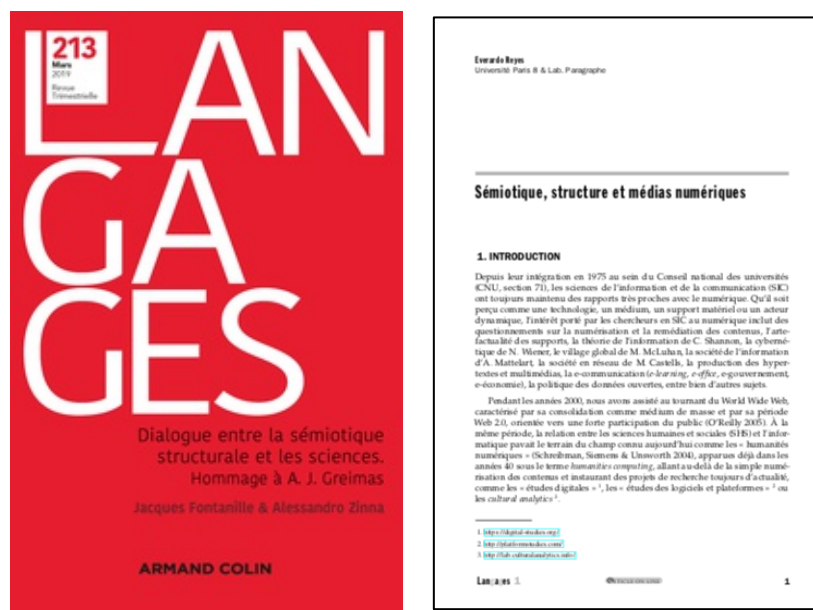
Les textes ici fédérés ont parus au sein des communautés de chercheurs en sémiotique et sciences humaines. Le premier fait partie de la prestigieuse revue *Langages*, fondée en 1966 par Roland Barthes, Algirdas Greimas, Jean Dubois, Bernard Pottier, Bernard Quemada et Nicolas Ruwet. Dans ces lignes, j'identifie quelques pistes pour rapprocher davantage les SIC et la tradition structuraliste de la sémiotique.

Le deuxième texte est en cours de production par la maison d'édition De Gruyter, qui publie *Semiotica*, le célèbre journal de l'International Association for Semiotic Studies, fondée en 1969 et dirigé longtemps par Thomas Sebeok. Dans cet article, le seul de la compilation à avoir un co-auteur (Göran Sonesson, président de l'Association Internationale de Sémiotique Visuelle depuis 2015), nous présentons et discutons les méthodes numériques appliquées aux images figuratives et non-figuratives.

Quant au troisième texte, il est présent dans le numéro 41 de la revue *MEI : Médiation et information*. Cette revue, initiée en 1993 par Bernard Darras (à l'époque Maître de conférences en SIC à Paris I) et Marie Thonon (alors Maître de conférence en SIC à l'Université Paris 8), accueille plusieurs disciplines autour de la culture et la communication, dont la sémiotique fait partie importante du programme. Dans le texte se focalise sur les relations entre design et communication à partir d'une approche sémiotique. Le rôle du design permet d'encadrer le processus communicationnel en

prenant en compte les acteurs humains, techniques et culturels associés à la conception et production d'objets hypermédia.

### 3.1 Sémiotique, structure et médias numériques



**Figure 10.** Couverture de la revue *Langages*. « *Le dialogue entre la sémiotique structurale et les sciences : hommage à Algirdas Greimas* », sous la direction de J. FONTANILLE et A. ZINNA. Paris, Armand Colin, 2019, ISSN : 1958-9549, et de l'article « Sémiotique, structure et médias numériques », pp. 119 - 135

#### 3.1.1 Texte intégral de l'article, pp. 119-135

##### Résumé

Cet article propose une démarche de coopération entre la sémiotique et les sciences de l'information et de la communication appliquées au numérique. L'optique que nous adoptons est celle de la production des objets numériques. Dans un premier temps, la complexité associée à l'artefactualité des représentations à l'écran est analysée sous le prisme du parcours génératif de l'expression. Ensuite, nous discutons quelques pratiques info-communicationnelles émergentes. Nos propos sont illustrés à travers une interprétation et mis en interface du *Dictionnaire* de Greimas et Courtés.

##### Introduction

Depuis leur intégration en 1975 au sein du Conseil national des universités (CNU section 71), les sciences de l'information et de la communication (SIC) ont toujours maintenu des rapports très proches avec le numérique. Qu'il soit perçu comme une technologie, un médium, un support matériel ou un acteur dynamique, l'intérêt porté les chercheurs en SIC au numérique inclut des questionnements sur la numérisation et la

remédiation des contenus, l'artefactualité des supports, la théorie de l'information de Claude Shannon, la cybernétique de Norbert Wiener, le village global de Marshall McLuhan, la société de l'information d'Armand Mattelart, la société en réseau de Manuel Castells, la production des hypertextes et multimédias, la e-communication (« *e-learning* », « *e-office* », e-gouvernement, e-économie), la politique des données ouvertes, entre bien d'autres sujets.

Pendant les années 2000 nous avons assisté au tournant du World Wide Web, caractérisé par sa consolidation comme médium de masse et par sa période Web 2.0, orienté vers une forte participation du public (O'Reilly 2005). À la même période, la relation entre les sciences humaines et sociales (SHS) et l'informatique pavait le terrain du champ connu aujourd'hui comme les « humanités numériques » (Schreibman et al. 2004), apparues déjà dans les années 40 sous le terme « *humanities computing* », allant au-delà de la simple numérisation des contenus et instaurant des projets de recherche toujours d'actualité comme les « études digitales »<sup>25</sup>, les « études des logiciels et plateformes »<sup>26</sup> ou les « *cultural analytics* »<sup>27</sup>.

Pour plusieurs chercheurs et équipes en SIC, le tournant du Web a été une invitation à penser différemment les outils numériques. Sans laisser de côté les démarches analytiques, descriptives et critiques propres aux SHS, le Web a aidé à surmonter plusieurs barrières techniques imposées aux chercheurs s'intéressant de près aux systèmes d'information : les ouvrir pour explorer les composants, proposer des nouvelles versions, faire de l'archéologie des opérations ou encore détourner les fonctions primaires. Bien que ce mode de travail semble plus pragmatique, synthétique et fonctionnel, leur objectif n'a jamais été de devenir ingénieur de systèmes ou développeur informatique professionnel. Le chercheur en SIC propose plutôt des modèles, des prototypes, et ne s'interdit pas d'agir par expérimentation, spéculation ou improvisation.

Ainsi, une nouvelle génération de productions numériques a commencé à voir le jour. À part la souplesse des langages informatiques orientés Web<sup>28</sup>, les nouvelles réalisations ont l'avantage d'être accessibles depuis un navigateur conventionnel, de permettre l'accès au code source et aux corpus des données, sans compter qu'une véritable communauté

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<sup>25</sup> <https://digital-studies.org/>

<sup>26</sup> <http://platformstudies.com/>

<sup>27</sup> <http://lab.culturalanalytics.info/>

<sup>28</sup> Souplesse relative par rapport aux compilateurs et des langages plus proches de la machine, nécessaires au développement des applications logiciels ou systèmes d'exploitation.

d'artisans du Web partage des tutoriels et de la documentation en ligne. Dans ce contexte, certains chercheurs en SIC ont commencé à prendre en compte la théorisation des outils et les méthodes numériques, la dimension communicationnelle de l'utilisateur, les dispositifs techniques comme agents de médiation et l'espace physique où se déroulent les manipulations.

Dans cet article nous considérons les productions numériques comme des objets-médias, c'est-à-dire qu'elles participent à un réseau d'acteurs de communication, façonnent des messages et s'appuient sur des règles de signification. Dans un premier temps, notre contribution portera sur les aspects structurants des objets-médias : à l'aide des principes de la sémiotique structurale d'Algirdas Greimas et ses disciples nous proposons un modèle adapté à l'expression des réalisations numériques. Ensuite, nous démontrons l'utilité d'une telle structure à travers une interprétation et une mise en interface du célèbre « Sémiotique : dictionnaire raisonné de la théorie du langage » (Greimas et Courtés 1993). La dernière partie de cet article est dédiée à la discussion des diverses pratiques en information-communication pouvant tirer profit de notre modèle.

### **Structure et médias numériques**

Les productions et réalisations médiatiques auxquelles nous faisons référence partagent au moins deux caractéristiques communes au niveau de leur surface. Premièrement, ce sont des manifestations existant sur les écrans des dispositifs électroniques. Deuxièmement, leur structure matérielle est régie par des normes et standards informatiques. Au niveau de leur contenu, ces réalisations fonctionnent comme des conteneurs des structures narratives grâce à la représentation de plusieurs sémiotiques-objets (textes écrits, images visuelles, etc.) où des instances d'énonciation sont mobilisées.

Du point de vue de la conception et de la création, il est souvent convenable d'identifier les possibilités et les limites techniques avant de procéder aux étapes du développement et d'intervention des composants informatiques. De plus, le fait d'avoir une vue générale des relations des composants facilite la définition d'objectifs et du fonctionnement du système. À ce stade, malgré les efforts des chercheurs en SIC pour expliquer l'importance et les méthodes du « bricolage » informatique, il nous semble que les modèles de description des médias numériques n'ont pas encore été suffisamment explorés.



Nous soutenons que les principes de la sémiotique structurale offrent un modèle cohérent pour identifier les relations entre les médias comme objets numériques et comme représentation à l'écran. Observons quelques concepts de base. Pour Greimas, la notion de *structure* a toujours été intimement liée à celle de signification. Dans *Sémantique structurale* il indique, par exemple, que « la structure est le mode d'existence de la signification » (1986 : 28). Plus tard, dans le *Dictionnaire*, la structure est définie comme une entité de relations ayant une organisation interne propre et pouvant se décomposer en parties (1993 : 359). Bien qu'à des fins opératoires il est possible de distinguer plusieurs types de structures (narratives, actantielles, aspectuelles, modales, entre autres), le modèle d'articulation de la signification comprend toujours des structures profondes et des structures superficielles. Le modèle canonique a été schématisé dans un parcours génératif qui relie les structures sémio-narratives et les structures discursives, qui va du plus simple au plus complexe, du plus abstrait au plus concret. À leur tour, chacune de ces structures contient une composante syntaxique et une autre sémantique.

Pour revenir à notre propos, nous pouvons commencer par situer les productions médiatiques au stade de leur affichage (à l'écran, projetées *via* un vidéoprojecteur, ou même imprimées au format 2D ou 3D). À ce moment, les réalisations sont perceptibles visuellement et se cantonnent au support matériel d'affichage. Devant une telle réalisation, l'utilisateur peut interagir et manipuler l'objet avec une souris, un clavier, ou d'autres périphériques d'interaction homme-machine. Par contre, si l'utilisateur souhaite comprendre comment le système est fait et « voir » ses composants il sera alors nécessaire de regarder un niveau plus profond, où réside le code source informatique de la production médiatique.

De fait, une hiérarchie des différents niveaux d'expériences sémiotiques a été proposée par Jacques Fontanille, disciple et collaborateur de Greimas. Dans *Pratiques sémiotiques*, Fontanille intègre les différents types d'expériences avec les instances formelles et les interfaces nécessaires pour passer d'un niveau à un autre (2008 : 34). Adapté aux productions numériques génériques, ce schéma peut être perçu comme un parcours génératif de l'expression dont les quatre premiers niveaux peuvent être visualisés dans le tableau 01.

Tableau 01. Parcours de l'expression adapté aux productions numériques à l'écran

Niveau de pertinence	Interface	Expression	Expérience
Signes	Source des formants	- Diffusion d'électrons - Code binaire	Figuration
	Formants récurrents	- Structures des données - Algorithmes	
Textes	Isotopies figuratives	- Langages de programmation - Paradigmes de programmation - Éléments de l'interface graphique	Interprétation
	Dispositif d'énonciation	- Code informatique - Formats des fichiers - Interface graphique - Logiciels	
Objets	Support formel d'inscription	- Grille de pixels-écran	Corporité
	Praxis morphologique	- Technologies d'affichages	
Scènes pratiques	Scène prédictives	- Manipulation, retouche, design, expérimentation, etc. - Logiques d'interface	Pratiques
	Processus de négociation	- Différentes pratiques artistiques, éducatives, scientifiques, etc.	

Cette organisation des niveaux nous permet de penser les réalisations numériques comme des « images-interfaces » (Reyes 2017). D'un côté, leurs qualités visuelles proviennent du fait qu'elles existent essentiellement comme des pixels-écran, indépendamment du fait que l'objet simulé soit un texte écrit, une photographie, une vidéo, ou les éléments de l'interface graphique du logiciel (boutons, pointeur, fenêtres, etc.). D'un autre côté, tout l'espace affiché est une région potentiellement interactive et paramétrable, c'est-à-dire que les textes et les images peuvent acquérir des propriétés dynamiques propres à l'interface et à des programmes procéduraux. Ainsi, nous remarquons que face à la conception et création des productions médiatiques, l'éventail de possibilités est déterminé, au niveau profond, par la manière dont les données de base sont organisées (on parle de structures de données), ensuite par le langage de programmation qui sert d'interface entre les données et l'interface graphique, puis par les formats de fichiers. Au niveau des objets, c'est la configuration matérielle des composants et périphériques qui fonctionnera comme support des niveaux supérieurs comprenant des « logiques d'interface graphique » et des pratiques artistiques, éducatives, ou informationnelles-communicationnelles. Afin d'illustrer l'utilité du modèle, explorons à présent un exemple de production médiatique.

### **Interprétations numériques du Dictionnaire**

À l'occasion du centenaire de la naissance de Greimas et de notre participation au 13<sup>ème</sup> Congrès de l'Association International de Sémiotique<sup>29</sup>, nous avons sélectionné le *Dictionnaire* comme objet d'analyse et d'interventions numériques. En effet, ce texte constitue toujours un point d'entrée et de référence de l'école sémiotique de Paris. Par ailleurs, il a été conçu par Greimas et Courtés comme un véritable outil permettant un accès rapide et non-linéaire à la terminologie de la théorie du langage, augmenté d'un système de renvois comprenant, pour chaque terme, son contexte sémantique, son champ conceptuel et sa brève définition.

Pour nos explorations, le corpus textuel que nous avons pris en compte correspond à celui de la version imprimée du 1993, disponible aussi comme livre numérique (format ePub 2 et Kindle). À partir du texte intégral numérisé du *Dictionnaire*, une fois qu'il a été obtenu et nettoyé (c'est-à-dire en supprimant les erreurs liées surtout à la reconnaissance optique de caractères), il est possible de procéder à des analyses lexicales de base.

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<sup>29</sup> Célébré à Kaunas, Lituanie, du 26 au 30 juin 2017.

Tableau 02. Analyse des textes écrits du *Dictionnaire*

Nombre de signes	1.012.854 (sans espaces)	
Nombre de mots	184.543	
Les 10 mots les plus fréquents	Sémiotique (1.082) Discours (849) Sémantique (505) Exemple (460) Sujet (452)	Terme (452) Linguistique (424) Sens (414) Niveau (373) Langage (336)
Les 5 trinômes de mots les plus fréquents	Point de vue (175) C'est-à-dire (158) Le terme de (134)	En tant que (129) Dans le cadre (107)

Ces calculs simples montrent déjà les premières relations entre les niveaux du parcours de l'expression. Le texte écrit est tout d'abord comptabilisé : la structure à base de chaînes de caractères est transformée en une structure chiffrée. Ce processus de transformation est médié par une interface graphique simple permettant l'entrée du texte et l'appui sur un bouton qui déclenche le programme informatique<sup>30</sup>. Le résultat des calculs est donné immédiatement sur la même page Web, sous forme des tableaux mettant en relation des mots et des quantités. Comme d'autres outils dédiés au traitement informatique des textes, le site fournit des résultats utilisant un algorithme de densité lexicale (LD), qui permet d'estimer le niveau de richesse ou d'expressivité d'un corpus textuel, soit 6,6 pour le *Dictionnaire*<sup>31</sup>.

Mais le rendu sous forme de tableau de données n'est qu'un exemple de possibilité d'affichage. Parmi les formes traditionnelles de représentation de la variation et de la distribution des données nous trouvons les histogrammes et les camemberts. Nous avons décidé d'illustrer ce propos à travers une comptabilisation des signes de chaque terme (autrement dit, l'extension de l'article). Ainsi, les différentes extensions du *Dictionnaire* vont de 76 signes (pour « Intercalation ») jusqu'à 23.373 (pour « Sémiotique »). La figure

<sup>30</sup> Nous avons utilisé l'outil en ligne Text Analyzer, développé par Mladen Adamovic : <https://www.online-utility.org/text/analyzer.jsp>

<sup>31</sup> Ce qui semble assez élevé par rapport à la moyenne des, par exemple, articles chez Wikipédia (5,5) ou des romans de fiction (4,9). Voir : <http://www.analyzemywriting.com/index.html>

01 montre seulement les 55 articles les plus longs<sup>32</sup>. Cet exercice comparatif de base permet de repérer que les mots les plus fréquents ne correspondent pas forcément aux articles les plus longs.

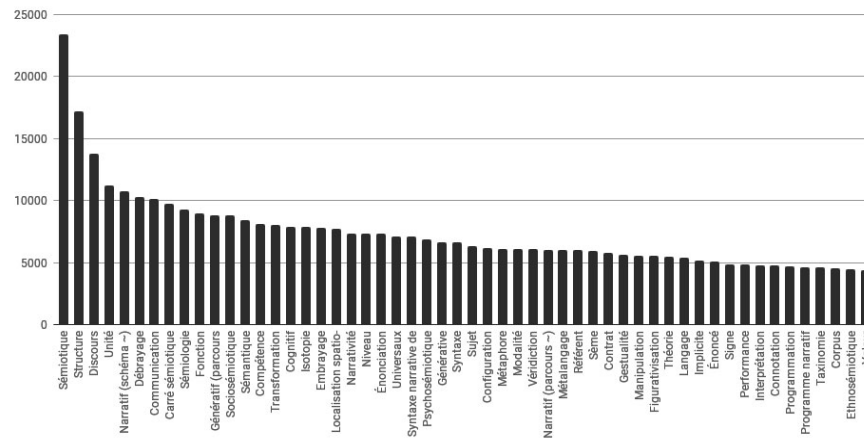


Figure 01. Histogramme des 55 articles les plus longs du *Dictionnaire*

À présent, revenons sur l'idée originale de créer un système de renvois par Greimas et Courtés. Dans le *Dictionnaire*, à la fin de chaque article, une inscription sous forme de triangle réunit les principales « imbrications conceptuelles » du terme. Il s'agit d'un système clos dans le sens où les termes imbriqués sont les mêmes termes définis dans le corpus. Nous avons repéré que ces renvois peuvent aller de 0 à 23 imbrications selon le terme. Une manière qui nous semble adaptée pour représenter ces relations se présente sous forme de diagramme de réseau.

Afin d'afficher et manipuler un diagramme de réseau interactif sur le Web, quelques ajustements sont nécessaires au niveau de données. Nous explicitons nos choix dans le tableau ci-dessous, suivant le parcours génératif de l'expression.

Tableau 02. Parcours génératif adapté à un diagramme de réseau du *Dictionnaire*

Structure de données	Arbres hiérarchiques de nœuds et de liens
Algorithmes de spatialisation	Force atlas, diagramme circulaire, emboîtement circulaire, isométrique, etc.
Langages de programmation	Java et JavaScript
Code informatique	HTML5, CSS, JavaScript et bibliothèques d3.js ou sigma.js

<sup>32</sup> Une version complète et interactive est disponible en ligne : <http://ereyes.net/dict/>

Formats de fichiers	GEXF, JSON, CSV
Logiciels	Gephi, éditeur de code, navigateur Web

Nous avons créé un tableau comprenant les 645 nœuds correspondants à l'ensemble de termes du *Dictionnaire*. Chaque nœud est accompagné de quelques propriétés obtenues du modèle du terme : titre, abréviation du dictionnaire, terme en anglais, nombre de signes. Ensuite, dans un deuxième tableau nous avons spécifié les liens entre les nœuds, par exemple le terme indexé numéro 1 (« Absence ») pointe vers les termes numéros 234 (« Existence sémiotique ») et 470 (« Présence »). Au total, le réseau complet comprend 1.521 relations. La figure 02 montre un fragment de la spatialisation des nœuds et des liens selon l'algorithme « force atlas »<sup>33</sup>.

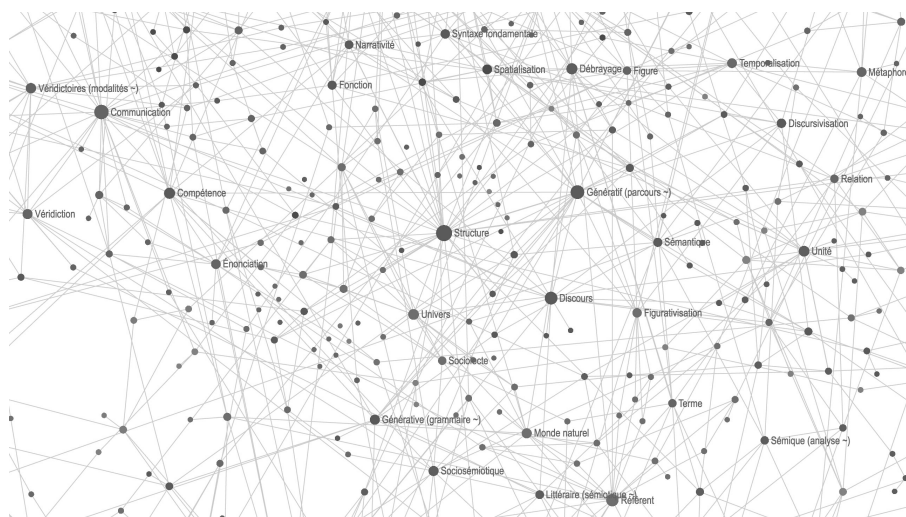


Figure 02. Fragment du diagramme de réseau du *Dictionnaire*<sup>34</sup>

Sous forme de réseau, un logiciel comme Gephi permet d'effectuer des mesures statistiques telles que la distance moyenne entre les nœuds (6,32 dans le cas du *Dictionnaire*), la modularité (48 groupes ou communautés) ou la moyenne de connexions par nœud (2,35). Ces mesures sont représentées sous forme graphique : les couleurs des nœuds sont associées aux groupes, la taille des nœuds à la quantité de leurs liens et la distance moyenne au positionnement des nœuds dans l'espace grâce à l'algorithme force atlas.

<sup>33</sup> Cet algorithme de spatialisation est inclus par défaut dans le logiciel Gephi (<https://gephi.org/>) et sert à positionner les nœuds en fonction des rapprochements les uns avec les autres. Le diagramme obtenu a été ensuite traité avec sigma.js pour sa version sur le Web.

<sup>34</sup> Une version complète et interactive est disponible : <http://ereyes.net/dict/sigmajs/viz/filters.html>

Nous considérons que cette représentation graphique apporte des avantages notamment dans la découverte des relations du *Dictionnaire*. Nous pouvons explorer les familles de termes à partir des nœuds centraux ou identifier les nœuds qui connectent d'autres groupes. De manière réciproque, nous pouvons repérer que les termes les plus « influents » sont « Carré sémiotique » (42 liens), « Sémiotique » (39 liens) et « Structure » (33 liens), ce dernier apparaissant au centre du graphe. En tant qu'image-interface sur le Web, dans sa version actuelle en ligne nous avons implémenté quelques fonctionnalités additionnelles pour faciliter son exploration : zoom, filtres de catégories et nombre de liens, glisser pour repositionner le diagramme, et un moteur de recherche.

### **Pratiques d'information-communication**

Le point de vue de la conception et création de réalisations numériques, examiné au prisme du parcours génératif de l'expression, est celui d'une vision plus organisée des composants matériels et formels. On peut approcher le contexte, les limites et les relations entre la représentation à l'écran, les langages informatiques et les algorithmes disponibles pour le traitement des données. Face aux représentations affichées, que nous nommons « images-interfaces », nous soulevons dans cette partie quelques pratiques qui s'observent du point de vue de l'information-communication.

### **Esthétisation de l'information**

L'esthétisation de l'information regroupe les préoccupations des chercheurs en SIC sur les nouvelles formes que l'information peut acquérir. Le théoricien des médias Lev Manovich a introduit la notion d'« info-esthétique » pour faire ressortir les similarités et les différences entre la logique culturelle du monde informatisé et celle du Modernisme. Si les artistes, designers, architectes et réalisateurs du Modernisme ont inventé des nouvelles formes appropriées à la société industrielle, quelles sont alors les nouvelles formes appropriées à la société de l'information ? (Manovich & Reyes 2014)

Par exemple, des représentations graphiques populaires comme les « nuages de mots » exploitent les valeurs quantitatives du texte et les utilisent comme des paramètres pour modifier les propriétés visuelles (couleur, taille, position). La figure 03 montre les 30 mots les plus fréquents du texte intégral du *Dictionnaire*. Dans cet exemple la taille des mots est en rapport direct avec le nombre de répétitions dans l'œuvre, tandis que le

positionnement suit un ordre alphabétique. Ainsi, un outil comme Voyant<sup>35</sup> met à la disposition de l'utilisateur une quinzaine de types des visualisations exploitant les capacités graphiques des navigateurs, surtout celles des images vectorielles au format SVG (« *Scalable Vector Graphics* »). Il est intéressant de noter comment la dénomination de ces visualisations met en avant l'aspect iconographique du résultat, au détriment des noms des algorithmes ou des opérations informatiques derrière le traitement<sup>36</sup>. Ce constat est sans doute lié aux utilisateurs : il s'agit d'une invitation à interagir, cliquer et manipuler non seulement les boutons et menus déroulants de l'interface, mais aussi les images produites car elles-mêmes sont porteuses d'interactions (afficher ou masquer plus d'informations, recalculer, trier, supprimer, filtrer).

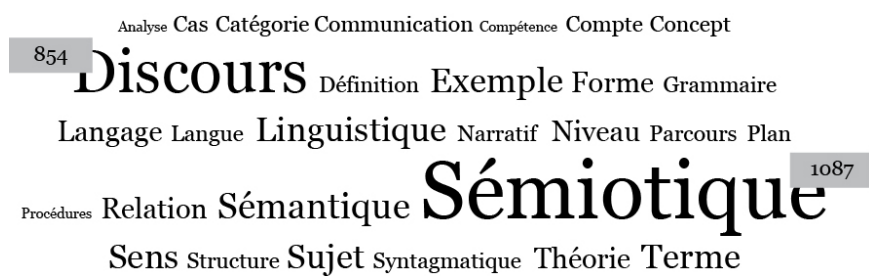


Figure 03. Nuage de mots du *Dictionnaire*

### Ré-instrumentalisation

Cette pratique est liée aux processus qui tendent vers la stabilité et le confort du système, tout en ouvrant des voies vers l'innovation. Au contraire des nouvelles formes de l'info-esthétique, nous parlons ici des « logiques des interfaces » qui émergent par convention d'usage ou par l'importation de modèles bien connus dans d'autres domaines. Les logiques d'interface combinent des configurations spatiales et visuelles à l'écran (panneaux, régions, contrôles et indices d'interactivité) et nous pouvons les caractériser par : retour d'information<sup>37</sup>, symbolisation et figurativisation d'actions, WIMP *responsive*, environnements de développement<sup>38</sup>, personnalisation, transformations successives, croisements de domaines, extensibilité programmatique, démystification du code, données dynamiques et en temps réel (Reyes 2017 : 144).

Sur cette ligne de pensée, nous avons créé une nouvelle représentation du *Dictionnaire* qui combine deux logiques : d'un côté l'ordre alphabétique et d'un autre côté l'affichage

<sup>35</sup> <http://voyant-tools.org/>, développé par Stéfan Sinclair et Geoffrey Rockwell.

<sup>36</sup> Par exemple, la visualisation « bubblelines » représente chaque mot comme une « bulle » (un rond colorié) positionnée sur une ligne droite représentant la largeur du texte.

<sup>37</sup> Ou « *feedback* ».

<sup>38</sup> Ou « *framework* »



des liens utilisés par les diagrammes de réseaux. Le résultat est un modèle d'interface qui n'existait pas auparavant et qui peut éventuellement être réutilisé pour d'autres systèmes de renvois. Outre les fonctionnalités interactives incluses dans le diagramme de réseau, nous avons placé les termes en colonnes, sous la lettre de l'abécédaire correspondant (figure 04).

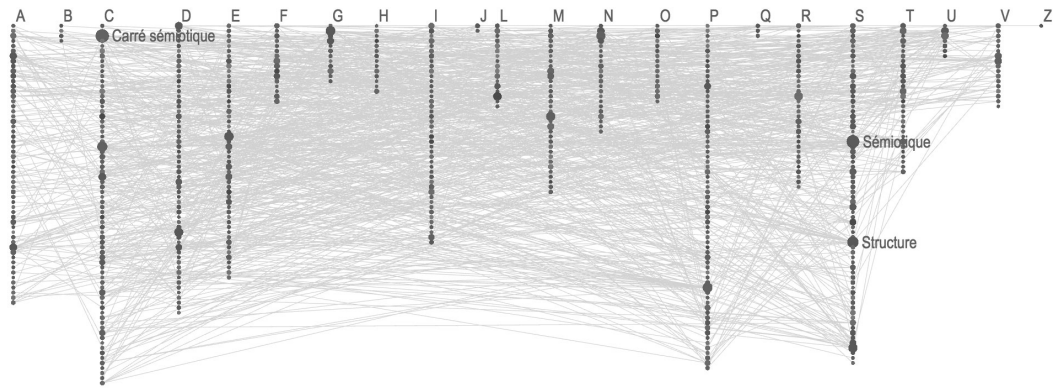


Figure 04. Réseau trié par ordre alphabétique du *Dictionnaire*<sup>39</sup>

### Régimes de la signification des interfaces

Les réflexions sur la conception et le développement des productions numériques sont regardées ici comme une responsabilité sociale et culturelle. Un point de départ consiste à renouveler l'idée que les outils numériques agissent comme des dispositifs qui modélisent les façons d'être (Winograd & Flores 1986 : ix). Les composants techniques des systèmes peuvent ainsi s'associer aux stratégies des modes de travail (comme le rappelle le théoricien des médias Matthew Fuller à propos du langage Java et la programmation orientée objet comme paradigme de développement des grands logiciels comme Microsoft Word) (Fuller 2003 : 137) ou à des régimes de signification selon la nomenclature proposée par le philosophe des médias Alexander Galloway (il observe les régimes dominants, privilégiés, tolérés et marginaux selon l'usage des aspects politiques et esthétiques des interfaces) (Galloway 2012 : 45).

Il est important d'indiquer ici que la plupart de ces réflexions sont accompagnées de réalisations numériques qui servent d'instrument théorico-pratique. Le chercheur des médias Ian Bogost propose, par exemple, la création d'outils ontographiques comme forme de représentation de la diversité de l'être (Bogost 2012 : 94), le chercheur en cinéma et médias numériques Warren Sack développe des animations sur le Web pour

<sup>39</sup> Une version interactive en ligne est disponible : <http://ereyes.net/dict/sigmajs/viz/filters-abc.html>

montrer les énormes variations arithmétiques des algorithmes<sup>40</sup> (qui restent néanmoins limitées idéologiquement car il suggère que les logiciels peuvent être conçus comme une littérature et la programmation informatique comme un type d'écriture) et, pour sa part, le groupe de recherche IRI du Centre Pompidou s'intéresse à des outils créant un Web herméneutique et contributif (Stiegler 2017 : 11).

## Conclusion

Dans cet article nous avons analysé la manière dont la sémiotique et les SIC peuvent faire l'objet de coopérations interdisciplinaires. Après une introduction succincte des rapports entre les SIC et le numérique, nous avons mis l'accent sur notre point d'entrée autour de la conception et du développement de réalisations numériques. Pour nous, les enseignements de la sémiotique structurale se matérialisent concrètement dans un modèle de description ancré dans le parcours génératif de l'expression. Un point en commun avec le parcours du contenu, qui mobilise des structures sémio-narratives, est que tous les deux s'organisent en termes de structures profondes (antérieures à la manifestation) et structures superficielles (sémiotique des objets et pratiques).

Nous avons montré comment une telle structuration peut aider dans la manipulation, l'intervention ou la construction de nouveaux objets techniques. Ces productions, nous les avons situées dans le contexte du Web comme espace distribué d'informations et comme plateforme de développement. Cependant, nos travaux futurs doivent prendre en compte l'expression des objets connectés, les structures de données dynamiques et de grande échelle comme les « big data » et le « machine learning », sans compter l'inclusion du *Dictionnaire 2*, la visualisation des champs conceptuels et l'affichage du texte intégral.

À l'heure actuelle, nous considérons que la sémiotique et les SIC peuvent proposer d'importantes contributions face aux transformations disciplinaires amenées par le numérique. SIC et sémiotique convergent, entre autres, au niveau de la « culturalisation des interfaces », c'est-à-dire dans l'étude de la transparence des processus profonds et de leur énonciation vis-à-vis des usagers des sciences humaines et sociales.

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<sup>40</sup> Disponible en ligne comme support de son livre *The Software Arts*, à paraître chez MIT Press : <https://people.ucsc.edu/~wsack/SoftwareArts/>

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## 3.2 Prologomènes à une approche numérique de la sémiotique picturale



**Figure 11.** Couverture de la revue *Semiotica : Journal of the International Association for Semiotic Studies*, Berlin/Boston, De Gruyter, 2019. ISSN : 0037-1998, et de l'article « New approaches to plastic language : prolegomena to a computer-aided approach to pictorial semiotics », pp. 71 – 96

### 3.2.1 Résumé en français de l'article

La sémiotique picturale -comprise comme l'étude générale des images en tant que signes- a constituée un pas en avant par rapport à l'intérêt marqué de l'histoire de l'art aux images individuelles. À ce propos, une importance particulière doit être faite à la division entre les niveaux iconiques et plastiques des images, proposée par Jean-Marie Floch et le Groupe  $\mu$ . Contrairement au Groupe  $\mu$ , qui mettait l'accent sur les opérations figuratives observables dans quelques images, Floch ciblait une analyse exhaustive des images qu'il étudiait. Néanmoins, Sonesson a détecté quelques faiblesses dans les analyses de Floch : premièrement, un modèle doit s'appliquer à l'identique à plusieurs occurrences du type modelé (dans notre cas des images en générale) ou, le cas échéant, à un certain genre des images. Mais Floch modifiait son modèle selon sa lecture intuitive des images changeait. Deuxièmement, il n'est pas du tout évident que toutes les images doivent s'organiser selon une division binaire. Troisièmement, l'utilisation des images figuratives pour dériver la signification des images non-figuratives doit supposer que la couche plastique soit complètement redondante en relation à la couche picturale. Si tel est le cas, la division des images en deux couches devient en réalité inutile.

La première partie de cet article résume une variété d'approches, distinguant entre les aspirations et les vrais accomplissements de la sémiotique picturale. Étant donné qu'aucun modèle explicite pour l'interprétation des images ait été présenté depuis le structuralisme, on maintient qu'une critique à ce modèle est toujours d'actualité. La deuxième partie offre des implémentations en cours conçues pour remédier les obstacles repérés. Ce qui est suggéré dans la deuxième partie peut être considéré comme un « *proof of concept* », le concept étant que les requis imposés par le structuralisme ne peuvent pas s'implémenter pleinement par un chercheur humain, mais qu'il devrait faire appel à l'aide de méthodologies informatiques. En même temps, on le verra, les programmes informatiques peuvent seulement accomplir les tâches commandées une fois qu'une phénoménologie adéquate de l'expérience humaine lui soit fournie.

### **3.2.2 Texte intégral de l'article, 25p.**

#### **1 Pictorial semiotics as the flickering light at the end of the art historical tunnel**

Semiotics is a discipline whose aim is to lay bare the rules and regularities which govern the use of signs and other meanings in human beings as well as in other species; as well as to discover the emergence of these meanings in evolution, child development, and socio-cultural history. Pictorial semiotics, as a subdomain of general semiotics, has to account for the similarities and differences between pictures and other signs and meanings, structurally as well as diachronically, in the threefold sense indicated above. Semiotics, then, is neither a method nor a model, but it makes use of different models and methods. One well-known model used by semiotics is the structuralist one, according to which everything is organized into binary oppositions, a particular variant of which is the Greimasian Square; and another familiar one is the hierarchy of trichotomies characterising the Peircean approach.

#### **1.1 The scope of pictorial semiotics**

It is thus the business of semiotics to ascertain general facts about objects endowed with meaning, in our case, about pictures, a task which includes both determining how pictorial meanings differ from other signs and significations, and what kinds of meanings are contained inside the limits of variability set by the texture of the pictorial sign. Semiotics, then, is a *nomothetic* science, a science directed at the elucidation of rules and regularities attendant on each and every case of signification.

In the present case, this is to say our object of study is the system underlying all extant pictures, as well as those about to be produced. In linguistics, the system is often understood at the lists of elementary units available and the rules for their combination, but this conception is, for obvious reasons, much less promising in the case of pictures. Rather, pictures and pictorial kinds may have to be conceived as rules of transformation applied to the visual world (Sonesson 1989a: 251-300; 2011). The essential point here, in any case, is that generalities, rather than individual characteristics, are our subject matter. No doubt, we cannot expect these generalities to be as general as in the case of linguistics, at least not on this early stage of study, for each single picture clearly involves a formidable number of meshed mechanisms of transformation, thus depending on its belongingness to a construction type, a means/ends category, and a channel division, in addition to the properties stemming from its motives, and the manner in which it has been apprehended. But at least as a distant goal, we are directed at generalities.

In the following, we will be particularly interested in the seminal work of Jean-Marie Floch, because nobody has gone further than he did in attempting to apply models and methods to the study of pictures, although, at the same time, paradoxically, he explicitly denies the pertinence of the quest for photographic specificity (Floch 1986a:11), and, more surreptitiously, also for the specificity of pictures generally.<sup>41</sup> On one hand, he claims as his task to account for the particularities of a given photograph, and on the other hand, he declares semiotics should define other categories which cross-cut such as are socially accepted, like *picture*, *art*, and *photography* (Floch 1984:11; 1986a:12). Both these opposed alternatives to a study of photography and other socially accepted pictorial kinds are explicitly present in Floch's work, but it is not at all clear how they could be reconciled. And while the first interpretation seems to make nonsense of semiotics as a science, at least of its pretensions to be something else than good old art history, the second appears to opt for a positivistic approach of the most gratuitous kind.

But, of course, the fundamental issue here is to find out what Floch is really doing in his token analyses, but this is not quite easy, for in actual fact, each one of Floch's studies appear to be somewhat different. Thus, in his analysis of the advertisement for the cigarette brand *News*, Floch (1984) claims to be using the same approach as employed beforehand when studying Kandinsky's semi-abstract painting *Composition IV*, and

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<sup>41</sup> The only other contribution coming close to being relevant for the present inquiry is that of the early Felix Thürleman (1982: 1990), but space won't allow us to engage with it in the present text. For a general overview of pictorial semiotics, see Sonesson (2010; 2014).

although there are in fact important differences between these two analyses, which we have noted elsewhere (Sonesson 1989a:150; Section 1.3), the basic operations pertaining to expression and content of the iconic and the plastic layers are indeed identical. Nevertheless, the categories resulting from these operations are of such a general nature, that they could hardly be said to delimit any peculiar kind of discourse, which cuts across the divisions of abstract painting and photography. In both cases, as in many others, Floch discovers a plastic organization in terms of binary contrasts, notably between continuity and discontinuity, expressed in the form of a proportionality which evokes Lévi-Strauss' analyses of myths. This seems a pre-ordained conclusion. It is possible for these categories to be properties of all discourses, but then they are incapable of defining new categories of discourses, simply because they are too abstract.

## 1.2 Four methods of semiotic study

Although our study is ultimately concerned with generalities, it may possibly begin from particulars. Indeed, we have distinguished elsewhere (Sonesson 1988; 1989b, using somewhat different terms) four different approaches to pictorial semiotics characterized by type analysis, token analysis, experiment, and token classification, which must be situated somewhere in between system analysis and text analysis.

*Type analysis* turns directly to the rules of the particular semiotic resources involved or, rather, the intuitions we have as users of this resource; and the most rigorous variant of this kind of analysis is what Husserl's calls imaginary variations, though in the case of social phenomena as those with which semiotics is mainly concerned, imagination may actually be less free, indeed bounded by the limits of structure (Sonesson 1989:15). The kind of reasoning employed by Umberto Eco (1976) to argue that iconic signs are arbitrary is of this kind, as are, in part, the arguments presented by Sonesson (1989a) to refute this idea. So is also the application of Peircean categories to pictures (Deledalle 1979; Jappy 2010), though imagination is here limited by the hierarchy of trichotomies. As we will see below, such an analysis may be computer-simulated, but since we are interested in understanding human picture perception, the properties which are varied have to be determined beforehand to be pertinent to human perception (Section 2.3)<sup>42</sup>.

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<sup>42</sup> Computer analysis may of course be applied to pictures with quite different purposes, which will require different properties to vary, but this does not make the latter properties any more *physical* than the former.

*Token analysis*, on the other hand, takes its point of departure in a meaningful token, that is to say, in a singular occurrence, such as a picture, and employs it to derive the rules of the system; but of course, in order to be in any sense reliable, such a method supposes the application of the procedure to a series of tokens, which, on account of other evidence (mostly from type analysis), may be supposed to have something in common, and in such a way that the results of the latter analyses are continuously projected back to the earlier ones to adjust the preliminary results. Put in other terms, such a procedure can only be valid if it is applied repeatedly to a series of instances, if the general principles are modified according as new instances yield to the analysis, and if the principles are reapplied to the instances earlier considered, in the light of the new insights resulting for the later analyses.

In his study of the Panzani publicity, Roland Barthes (1964) certainly claimed to go through the first part of this procedure; but he never tried out the analysis on other instances to verify the principles; and one may rightly doubt that, in the end, he had any model to apply in the first place (Floch 1978; Sonesson 1989a: 114-149). Later semioticians, such as Floch (1984; 1986a; 1990) and Thürleman (1982; 1990) have come closer to applying the same model to several instances of the object studied, but in fact they seem to modify the model in relation to each instance, without taking into account the changes taking place. Thus, for instance, Floch postulates that all pictures must be divided into two main areas, and most of the time he makes the division opposing the right to the left part (though not necessarily in the middle). However, there is at least one instance, the analysis of the *Nude* by Eduard Bourbat, where Floch (1984) makes the binary division in terms of a piece in the middle and its background, without commenting on this very different perceptual configuration. Different kinds of pictures may indeed require different models, on some level, but these differences should then be systematically correlated with different kinds of picture signs.

*Experiment*, again, supposes the construction of artificial tokens, the belongingness to the resource of which is determined by the judgments of native users of the resource; or else the creation of partial tokens, which are to be completed in accordance with the rules of the system by the native users of the resource. There were some examples of this kind of study in early pictorial semiotics, notably as realised by René Lindekens (1976) and by Martin Krampen (1983) and collaborators, but on the whole, this method has been little used. A few psychologists, with little notions of semiotics, notably Judy Deloache (2004, etc.) and collaborators, have studied children's notions of pictures.



Recently, Sonesson and his collaborators have been involved in some experimental studies, which investigate pictorial understanding in children and apes (e.g. Lenninger 2012; Zlatev et al. 2013; Hribar et al, 2014; Sonesson and Lenninger 2015).

*Token classification* is similar to type analysis in its developed form in that it is based on an intersection of two or more conceptual series, the compatibilities of which are tried out in the analysis. But these compatibilities are not tested on a purely conceptual basis, but by spotting actual examples, answering to that particular constellation of features defining each single case. The result of a token classification is thus a series of analyses of tokens, but unlike what occurs in real token analysis, there is no attempt to account completely for the given picture, which is characterized only to the extent that it realizes that particular constellation of features (Sonesson 1989b). Thus, in a drawing showing Captain Haddock with a bottle instead of a pupil in his eyes, Groupe  $\mu$  (1992), which introduced this method, would say that there is a presence of a bottle in an unexpected place, and this bottle appears as an integral part of (*conjoined with*) a body where a different part would be expected. The race then is opened to find illustrations for the three other combinations of the dimensions presence/absence and conjoined/disjoined.

### **1.3 The principle of binary division**

As we noted above (Section 1.2), Floch always begins his analysis by dividing a picture into two parts on the plastic level, each of which may then again be divided into two parts. This division is purely intuitive, as Floch admits. But then he starts looking for different plastic dimensions, whose opposite terms are realized in each of the binarily divided fields. One of the pictures analysed in this way by Floch (1984:48) is the photograph *Les Arènes de Valence*, photographed in 1933 by Henri Cartier-Bresson. In his analysis, Floch proceeds exactly as suggested above, proposing a division of the picture into a smaller part characterized by dark, blurry shapes and a bigger part containing light, distinct shapes.

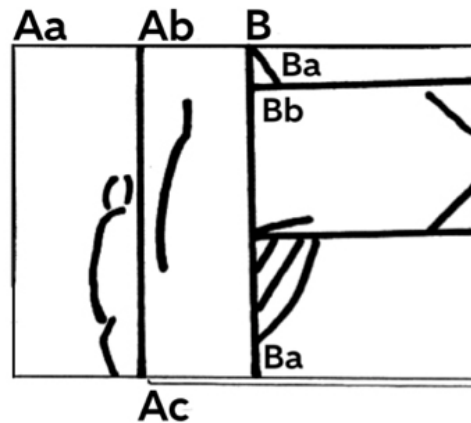


Figure 1. *Les Arènes de Valence* analysed by Sonesson (A vs B). Photo available at:  
<http://pro.magnumphotos.com/Asset/-2S5RYDI0Q9GT.html>

Nevertheless, this picture can also be divided binarily in at least two other ways, either, closer to the way Floch makes the division, into two more or less equivalent fields, or, more similar to the way Floch makes the division in other cases, such as the *Nude* by Eduard Bourbat, into prototypical shapes, that is, into a quasi-circle opposed to a quasi-rectangle (See Figure 1 and Sonesson 1989b:90). Although these divisions are just as *intuitive* as the division made by Floch, at least the second one can be supported by much more different dimensions, the opposite terms of which are manifested in the two fields, than Floch's original division. Thus, it seems that there are other intuitive divisions of the picture which may be at least as fully supported by the position of binary oppositions as the one proposed by Floch. A more fundamental question, however, is whether all pictures can be adequately divided by binary contrasts, in one way or another (Sonesson 1989a:132).

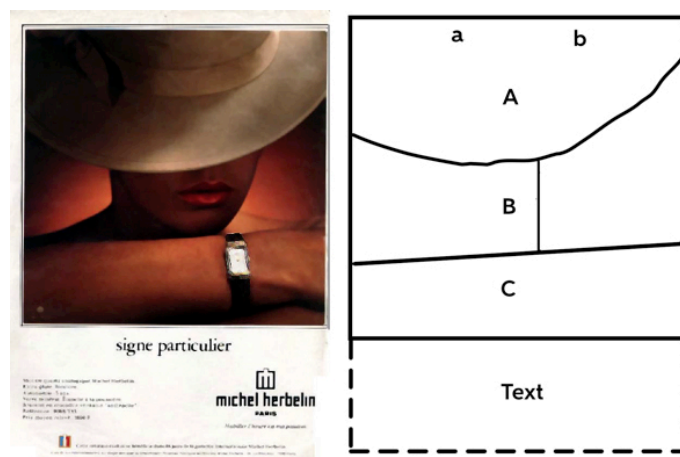


Figure 2. *The girl-with-a-hat-and-a-watch* as analysed in Sonesson (1988)

A more open-ended analytical procedure would be to take into account all imaginable divisions of a picture, whether they are binary, trinary or whatever, and to investigate which of these divisions can best be supported by a great quantity of plastic dimensions. Sonesson (1988: 114) carried out a plastic analysis of this type as applied to a publicity picture which he called *the girl-with-a-bat-and-a-watch* (Figure 2). We here adopted an analysis, similar to that employed by Floch (1984), but which started out from a trinary division of the picture, which, in this case, seem more intuitively justified, and then tried out all different possible combinations. The method contained four separate steps:

1) The picture was segmented into three horizontal bands, the middle one of which was also segmented further into two vertically demarcated portions, all of which could be correlated two-by-two, with the aid of attributes which dominate the attribute hierarchies of the respective areas.

2) Inside each correlation, we opposed one of the areas to the two others, in order to derive such contrastive pairs as characterize them; but on the background of these differences we also attended to similarities, as long as they could be read as continuities from one area to the other. We then also noted contrasts obtaining between two areas singly, and the deviations between the two sub-sub-areas of the middle band.

3) We ascribed properties derived from the different oppositions to the areas, inside which fall the poles of the oppositions; and we derived meanings for each one of the fields, relying on findings from psychological research and to some extent on personal intuitions.

4) Finally, we attended to the meanings generated by the textual block, also considered as a visual element; and we confronted the meanings derived iconically and plastically for the different areas.

We used A, B, and C, to refer to the different horizontal bands, and Ba and Bb to indicate the two sub-fields of field B. There is a colour correlation (beige vs yellowish brown) which opposes field A to B+C; and a shape correlation (rounded vs angular shapes), which accounts for the primary opposition between fields A+B, on the one hand, and field C, on the other; and a correlation of homogeneity differentiating field B from fields A+C. Features which are considered to serve as demarcative traits of the different fields are taken to dominate the respective feature hierarchies; also marked are

such features as are continuities (*isotopies*) from one field to another, again in opposition to the third field. For the full analysis, see Sonesson (1988: 114-146).

Now doubt this is too big a task for a human researcher once it is applied to a series of pictures, as token analysis requires. If we want to implement the tall task thus set up, we need to develop computer algorithms for the analysis of the plastic layer. Algorithms for recognizing faces are now part and parcel of ordinary computer interfaces. This is not surprising, since identifying faces is the first thing infants learn to do. But it involves what Floch called iconic language (our pictorial layer). The plastic layer may, however, be more fundamental to our experience of pictures, as different from ordinary perception. As has been shown by Sonesson (1988; 2014), many of the properties taken into account by Floch, Thürleman, and others, correspond to attributes isolated by psychologists, such as Sander & Volkelt, Werner & Kaplan, Arnheim, etc. Before we enter the discussion of computer methods in the second part of this paper, something has to be said about the distinction between the plastic and the pictorial layers of the picture.

#### **1.4 The specificity of the plastic layer**

An important result of pictorial semiotics, which seems to have been discovered independently by the Greimas school and by Groupe  $\mu$ , is the division of the standard pictorial signs into two layers: the iconic function, which is thought to be the feature by means of which the picture depicts one thing or another, normally corresponding to a fragment of a scene as perceived in real experience; and the plastic function, which is the meaning conveyed by the picture as a surface on which colour spots are disposed in a particular way, i.e. the picture considered as it if had been a piece of abstract art. As Floch points out, studying the plastic function of any picture amounts to treating figurative pictures as abstract art. Something that is, on one level, a sun or a flower, and even a human body huddled together, may on another level appear as a circle or another roundish shape.

It seems that for the Greimas school, as well as for Groupe  $\mu$ , iconicity is that aspect of the picture that creates the illusion of seeing a scene from the real world, as given in direct perception, while the plastic layer, whose expression is constituted by the flat surface of the picture, generally is taken to embody more abstract meanings. However, this is no more the iconicity in Peirce's sense, which serves to define a relationship between an expression and a content, and that can be applied to both the pictorial function, which creates the illusion of seeing the reality of perception, and to the plastic

function, whose contents are generic concepts, having the actual properties, not the illusory properties, of the flat surface as expression. While what is here called the iconic function connects relatively concrete expressions and contents corresponding to familiar objects within the individually perceptible world of our experience, plastic language, such as we just characterized it uses shapes whose properties are abstract, to convey to us meanings usually at even higher levels of abstraction (*roundness* for *nature*, etc.). In this sense, the latter may well be iconic, to the extent that they are synesthetic and/or physiognomic, which is part of the secret of abstract art. To avoid confusion, however, it is important not to use the same term for two notions which do not have to coincide: we will call the rendering of perceptual appearances the pictorial function and oppose it to the plastic function which has to do with the meanings of shapes and colours. The pictorial function is always iconic, but there are also other types of iconicity, some of which are characteristic of the plastic layer.

A further question is how we are supposed to be able to discover the meanings of the plastic layer. Floch (1981b) sets out to do this in his analysis of Kandinsky's *Composition IV*. According to Greimas and Courtés (1979), the criteria which are to be used in the segmentation of texts comprise the exchange of acting persons, transitions in time and place and changes of emotional atmosphere. Unfortunately, these criteria only seem applicable to verbal texts, or perhaps to texts extended in both space and time, and Floch rightly ignores them. That seems to leave him with intuition alone, but he does have a kind of regulative principle, as we saw above (Section 1.3.), the idea that all relevant properties must form binary contrasts, and that many of those will join to form bundles of similarities.

Even the principle of binary contrasts will not tell us how to find the first element of the pair, as we have pointed out (Sonesson 1989a:152): once we have A, we can find non-A, but that leaves us with the problem of finding A. This first phase must therefore remain intuitive. In order to gain *semiotic status*, as Floch says, the elements must be repeatable, like the units of linguistics, i.e. they must be susceptible of returning in identical form in many *texts*. That brings us to the second phase of the analysis: we must define a *corpus*, i.e. a collection of *texts*, which we suppose to derive from the same semiotic system, and in the analysis of which we will verify the identity and extension of the units proposed in the first analysis. In linguistics, the result of this procedure could very well be that what appeared to be one unit must now be dissolved in two or more, or

that the limits between the units must be placed elsewhere. In Floch's case, no such revisions take place. The corpus used is the collection of Kandinsky's works which are more or less contemporary with *Composition IV*. But this corpus is not really used to corroborate the units of expression of the plastic level already postulated; as we shall see, it is employed to discover their meaning.

Floch intends to find the meanings expressed in *Composition IV* scrutinizing other works of Kandinsky made more or less at the same time, where he deems the plastic layer to more or less similar to that of *Composition IV*, and which happens to be figurative paintings, that is, they come closer to represent objects of the real world, and they have titles saying something about their content. Sometimes, Floch goes beyond this principle to pay attention also to the particular context: the light area in the middle field of *Composition IV* should only be compared to other light fields also found below dark, bluish masses (1981b:145). Thus, while Floch is supposedly searching for the content plane of the plastic layer, he is actually all the time concerned with the content plane of, in his terms, the iconic language (our pictorial layer), because he presupposes, instead of demonstrating, that they must be identical. Sometimes, it is true, he also notes the emotional atmosphere common to particular contents, or rather, to the manner in which they are expressed, but also these seem to be derived from the contents.

But why should we bother to analyse the plastic language if what it tells us is anyhow the same thing that the iconic language tells us, and in fuller detail? While Floch is perhaps not aware of this problem, there seems to be at least one interpretation which makes this procedure worthwhile: perhaps different artists will correlate the plastic and the pictorial layers in different ways, so that the correlation itself becomes significant. For instance, using the same plastic shape for a captive princess, a person in a fight, a woman holding her chin, etc., Kandinsky tells us they have something in common, i.e. he creates a new category that no other artist would have used. Thus, he is segmenting the Lifeworld in a new way. Of course, on this interpretation, he does not tell us what he thinks they have in common. Thus, even if there is redundancy between plastic and iconic language in the case of each particular artist's work, the double analysis would not be vain.

Now, if we can attribute specific meanings to the figures on the plastic layer, the correlation between the plastic layer and the pictorial layer may tell us something worth considering about some pictures as opposed to others, for instance, about Kandinsky's

pictures, which would not be true of all other pictures. Elsewhere, we have tried to show that something like that holds true of the work of Rothko, relying on plastic meanings which are fairly well-established, such as those of roundness and angularity (Sonesson 1994; 2014). However, most plastic meanings are so far unknown, and have to be established by experiments, in the tradition of what has already been done by Gestalt psychologists, as well as by Lindekens and Krampen (Section 1.2). Prior to that, however, it will be useful to know what kinds of plastic expressions exist, or at least which are the most common.

## 2 Computing sparkles: digital methods for pictorial semiotics

In the first part of this paper, we studied the contributions of structural semiotics to modelling the meaning conveyed by pictures, and we have shown that, unlike traditional art history, and certainly unlike poststructural and postmodernist *visual studies*, these analyses have taught us a lot about the organization of pictorial meanings. At the same time, we have suggested that, given the way in which these analyses were performed, the gap remained huge between the ambitions implied by the models, and what they accomplished, in particular with respect to the possibility of generalizing the results. One of the barriers to fulfilling this goal involves manually implementing a model on numerous instances of pictures. In this respect, computing methods might come to rescue once an algorithmic procedure has been described into which the results of a thorough phenomenological analyses have been fed. We do not pretend, in the following, to show that computers are presently up to the task of resolving all the queries formulated in the first part of the paper. This section acts more like a proof of concept: some ideas for how we could go on from here.

### 2.1 Plastic expressions in digital images

In their seminal study on plastic signs, the classification proposed by Groupe  $\mu$  (1992) distinguished three main categories –colorememes, texturememe, and formememes–, each one of them containing more basic units (Table 1).

Table 1. Plastic categories according to Groupe  $\mu$

Category	Units
Formememes	Direction, Dimension, Position
Texturememe	Textural unit, Textural rule of repetition

Chromemes	Hue, Saturation, Brightness
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It will be necessary for our purposes to verify if the basic units can be described formally in terms of computing operations and translated into algorithmic procedures. We turn our attention now towards the field of visual computing, where *images*<sup>43</sup> are studied from different perspectives. For example, *image processing* is concerned with processes that are carried out once the image has been digitized and stored in a digital format. It comprises techniques such as image representation and description, image formation (quantization, sampling), image analysis (segmentation, feature extraction), image restoration, colour processing, image transformations (pixel processing, geometric transformations), and image compression. As for *computer vision*, it concentrates on gathering, describing, and analysing information as it is presented in perception. It also uses image analysis but strives to go from a syntactical description of objects and scenes to a semantic level, simulating the ability of human beings to organize perceptual experience (by means of clustering, learning, and recognizing shapes). Finally, *computer graphics* (CGI) deals with producing and synthetizing information. In relation to computer vision, it adopts an inverse procedure: it constructs and produces images based on a given computational model, most commonly based on polygons, surfaces, and volumes.

In contemporary everyday practices, the first aspect to take into account about the investigation of plastic expressions in the digital realm is that images exist only as simulations on screen (i.e. as versions, renderings, or interpretations). The complexity of material processes underlying the visualization of an image means that almost any instance is de facto an original, depending on variables such as the types of processor, application software, operating system, screen devices apart from numerous parameters that can be customized (Groys 2016). Second, if the image depicted on the screen is a momentary lapse of vision, the expression plane of an image has to be found at the deeper layer of file formats, which are the components that are stored and transmitted in computing devices. On the one hand, there are raster formats based on discrete units called pixels that will be mapped directly onto the amount of screen pixels available by the display device. Examples of such formats are JPG and PNG images. On the other hand, vector-graphics rely on geometrical properties of images, which are described

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<sup>43</sup> The term *image* will be used hereafter mainly to in relation to its technical specificity. When applying methods of digital images to pictorial semiotics, it is useful to distinguish images from pictures in the sense of everyday language.



either with ASCII characters or with binary digits. Examples are SVG and other XML-based formats. Given that human beings and computers have quite different *evolutionary histories*, and thus different etics (equivalent to the phonetic level in language), the basic problem facing us is how to arrive at a similar kind of emics (equivalent to phonemic level in language), notably as far as plastic categories such as colours and forms are concerned.

These two fundamental aspects of visual information, as given to the human eye and as it is normally fed into the computer, must be kept in mind when we proceed to create formal descriptions that will inform methods for the analysis of images.

## 2.2 Formal descriptions of the plastic layer

In terms of visual computing, an image is commonly analysed by quantifying its visual content. This method implies that input images are mainly in bitmap format, which consists of finite numerical values, called pixels, organized into a two-dimensional matrix. Thus, when an image is rendered on screen, a series of algorithms parse the values in the matrix to detect, extract, and organize visual and spatial data. At the lowest level, image-processing techniques are based on descriptions called features that will provide measurements of an image, or alternatively small regions of it. The type of existing content descriptors matches exactly the classification mentioned by Group  $\mu$ . In specialized literature, we find colour descriptors, shape descriptors, and texture descriptors.

Colour descriptors employ quantization techniques that help to map, reduce, or index the amount of colours available in a bitmap image to a different scale. These techniques can be appreciated in image acquisition (for example, when a scene of the natural world is captured through the camera lens, the colours have to be sampled for digital representation) or in image content-based search (for example, when a corpus of information can be searched or sorted by colour; Parker 2011:399). But essentially, the way in which chromatic values are stored and managed is based on a colour model, for example, HSB (that defines colour as a combination of hue, saturation, and brightness features) or the canonical RGB (or 24-bit, where images have three layers of 8-bit pixels each, resulting in 256 different values for each component, in this case, red, green, and blue).

Current methods for description shape and texture descriptors are also based on pixel values. These techniques commonly derive from feature detection and object recognition tasks. The algorithms designed for such routines analyse a digital space according to the entire image plane (the total area or surface) or local elements such as corners, edges, regions of interest (ROI), edges, lines, curves, or surfaces.

At this point, it is possible to formalize relationships between the basic descriptors. These are known as geometrical features and some of the most prominent algorithms have emerged from combinations of size measurements. Table 2 shows metrics determinations for shape descriptors adapted from (Russ 2011: 600).

Table 2. Shape descriptors

Shape descriptor	Formulae
Form factor (circularity)	$4 \pi * \text{Area} / \text{Perimeter}^2$
Roundness	$4 * \text{Area} / \pi * \text{Max Axis}^2$
Aspect Ratio	Max Axis / Minor Axis
Elongation	$1 - \text{Long Side Minimum Bounding Rectangle} / \text{Short Side Minimum Bounding Rectangle}$
Convexity	Convex Hull Perimeter / Perimeter
Compactness	$\sqrt{4 / \pi * \text{Area}} / \text{Major Axis}$

The notions of perimeter and area refer to the outer contour of an object (also called particle or blub) and they can be associated to the dimension category observed by the Group  $\mu$ . In respect to the other two eidetic categories, direction and position, we can determine spatial relationships (Del Bimbo 1999:27). On the one hand, once an orientation is established, the direction can be described as *from left to right* or *from top to bottom*. The metrics of directional relationships are typically the distance or angles between entities. On the other hand, topological relationships are described in terms of disjunction, adjacency, containment, overlapping. Usually they are formalized in natural language, but we can also use set operations as logical propositions.

Of course, these are not the only shape descriptors. Other models of measure can be designed with different methodologies. For example, fractal analysis summarizes the roughness of edges; spectral analysis corresponds to Fourier descriptors that define shapes mathematically; and topological analysis use descriptors that quantify the number of regions or holes between edges in an image (Gonzalez 2008).

We can use as many categories as necessary in a given project or we might even envision innovative relationships and create new algorithms. In the end, however, the final outcome of an image analysis gives a series of quantifiable values organized as a data table and, more interestingly, the same procedure can be applied to a collection of multiple images notably through batch processing. The following step, as it is practiced today in computing fields such as machine learning, would be to correlate high-level human-nameable semantics. We talk about classifiers: holistic descriptors (e.g. furry, shiny, etc.) and localized parts (e.g. has-legs, has-wheel (Chen 2017:50)) that assembled together can generate even broader classifiers, like *human*, *animal*, or *vehicle*.

In the following section we discuss a practical case in which we put in action the visual descriptors mentioned on a corpus of painting images by Mark Rothko.

### 2.3 An experimental implementation of pictorial digital methods

We constituted a corpus of analysis based on paintings by Rothko, inspired by a previous work by Sonesson (1994) in which he applies segmentation principles based on prototypical shapes and identifies correlations of plastic signs. For practical reasons, our corpus was created from the public archive [wikiart.org](http://wikiart.org)<sup>44</sup>. We obtained 201 compressed digital images, in JPG format, with the resolution of 72 dpi and in varied sizes (from 500 to 2000 pixels width).

The environment in which we implemented image-processing routines was ImageJ<sup>45</sup>. Our first task was to extract and organize colours for each image of our corpus. We relied on HSB and RGB colour models to describe our results. Two different scripts for colour extraction returned single values that summarize and weight the most frequent chromatic expressions in an image. Thus, we can obtain the mean, the median or the standard deviation (StDev) of hue, saturation, and brightness. In a similar manner for RGB, we obtain the same statistical metrics for each colour channel (red, green, blue). Table 3 shows a fragment of our data table.

Table 3. Fragment of colour quantization data

Image	Hue StDev	Saturation	Brightness	Red	Green	Blue
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<sup>44</sup> Obviously, a more robust study of the artist's work would involve scanning and digitizing the original pictures with our own methods and parameters.

<sup>45</sup> ImageJ is a scientific application distributed as open-source cross-platform software by the National Institute of Health, developed since 1987 by W. Rasband. <https://imagej.nih.gov/>

Id		StDev	StDev	StDev	StDev	StDev
186	15.2845	66.9679	60.6343	60.8013	58.9752	65.5233
199	41.5579	31.813	35.3704	34.799	33.5895	29.7562
36	27.7704	36.712	49.5433	49.5508	39.3557	20.6593
100	69.4059	45.5303	42.2035	50.5932	31.7156	20.2424
108	71.0471	45.9049	36.1251	36.7194	24.3674	17.3614

At this point, the analysis of the multiple instances of our corpus requires the passage to second-order organizations to observe variations and correlations of data. Typical examples could be charts, plots, and graphs. For our purpose, we generated a scatterplot matrix (SPLOM) where each mosaic shows a different correlation between chromatic values, for example hue vs. saturation, hue vs. brightness, hue vs. red, hue vs. green, hue vs. blue, etc. (Figure 3). The usefulness of this representation is to contemplate the totality of combinations in order to start identifying patterns and clusters where we can focus in more detail.

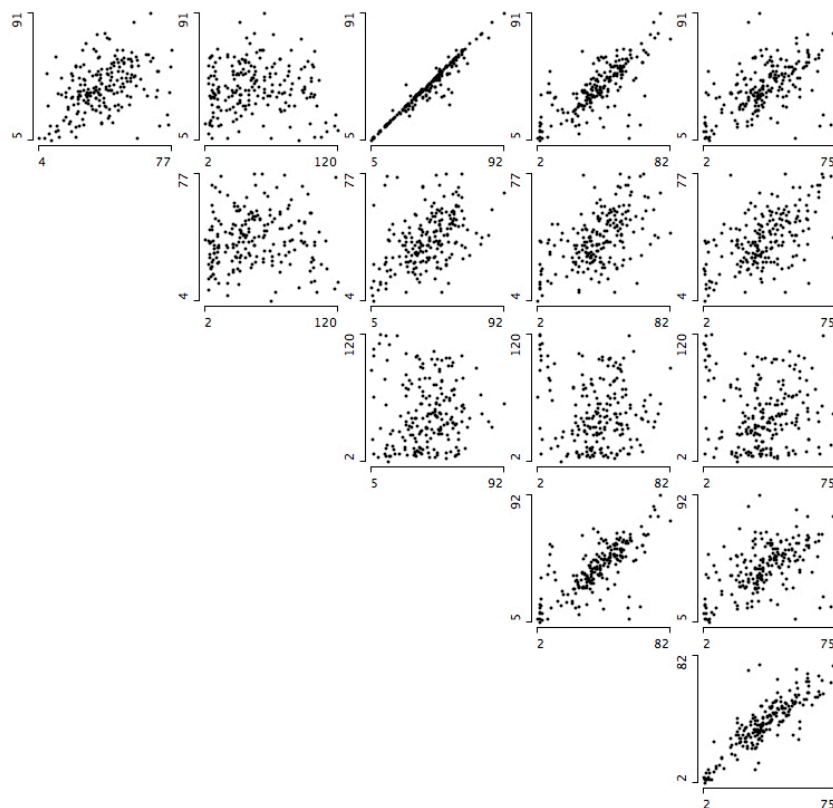


Figure 3. Scatterplot matrix (SPLOM) of HSB and RGB standard deviation values

Another graphical representation of the same data takes into account the theoretical form of colour models. For example, the RGB model specifies a cube, whose vertices map the relationships between red, green, and blue (and forming magenta, cyan, yellow, black, and white). The other model, HSB/HSV, is plotted with a cylindrical form where the top part corresponds to the 360 degrees of the hue values, the height to the brightness/value, and the distance from the centroid to the saturation (Figure 4).

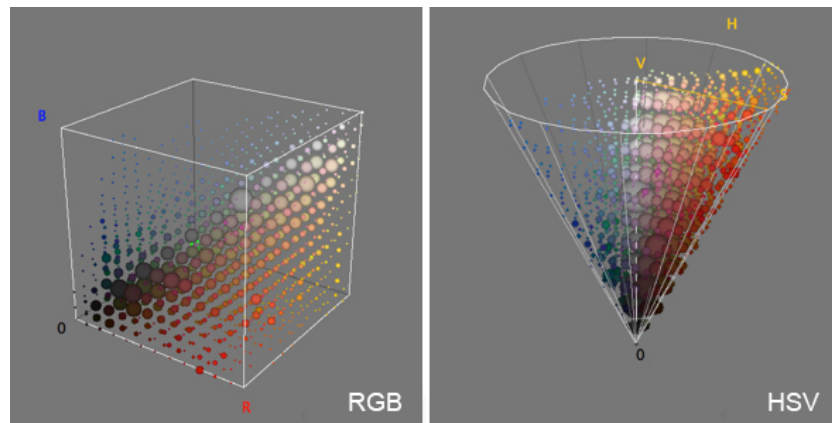


Figure 4. Colour quantization of our corpus of images

Through these figures it is possible to gain insight about the colour signature specific to Rothko. Accordingly, it would be feasible to create similar representations to make comparisons of colour palettes for other artists, for entire periods, and even for types of pictures. For now, however, it is out of the scope to orientate our efforts in that direction and we will rather explore shape measures of our corpus.

Following the procedure for segmenting and correlating plastic dimensions that we listed in Section 1.3, we adapted a general routine based on the shape descriptors defined by Russ (Section 2.2) and implemented as an ImageJ script by G. Chinga<sup>46</sup>. The method implies first to transform true-colour images to 8-bit format; it then expects to delimit a chromatic threshold of the image that will highlight the most important regions to be measured. Predefined functions such as edge detection can be invoked to satisfy these requirements, or we can also parameterize our own settings. Furthermore, it is possible to obtain all the specific data in each region or to calculate the mean of the whole values into one single footprint. To exemplify with an image previously analysed by Sonesson (1994), Table 4 shows a fragment of data for the biggest regions in Figure 5.

<sup>46</sup> Available online: <https://imagej.nih.gov/ij/plugins/descriptors.html>

Table 4. Shape measure of Figure 5

Area	Perim	Width	Height	Angle	Circ.	Skew	Aspect Ratio	Round	Solidity
1153	810.10	324	22	0.13	0.02	0.86	26.58	0.04	0.23
705	440.43	179	25	174.65	0.05	1.27	22.11	0.05	0.31
660	513.71	108	34	173.79	0.03	1.01	6.10	0.16	0.29
443	244.25	61	19	176.59	0.09	0.76	4.21	0.24	0.52
431	285.97	118	12	1.20	0.07	0.94	12.55	0.08	0.40

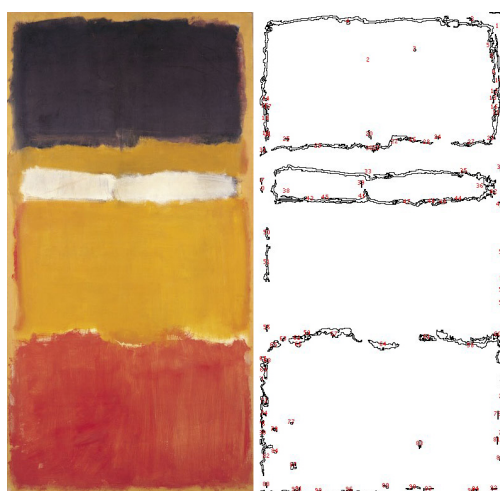


Figure 5. Regions and measures from Untitled, 1951

Such measures can be seen in relation to the prototypical shapes observed by Sonesson. The implicit circularity of shapes, for example, is given by a value between 0.0 and 1.0 where the highest tends to a circle and the lowest to a rectangle. While the results are approximate and may vary depending on the selected parameters, they are useful in combination with colour data to generate visualizations of similarity between pictures.

In sum, our data table was now completed with chromatic values and shape measures, besides categorical metadata such as title of the work and year of creation. In its current state, the table has 30 low-level descriptors per image that we exploit in two manners. First, in form of a plot of images that will help us identify similarities and patterns among the images. Second, from those observations we can test if the analysed correlations can inform an approach to image generation for experimental purposes.

For our first experiment, the plot of images, we employed the PCA (Principal Component Analysis) method in order to deal with our 30 low-level variables. PCA is

widely used for reduction dimension of multivariate data sets of more than 10 columns. Overall, the technique consists in transforming the original data and producing new columns (also named principal components) based on the maximum variances of data. Moreover, the results are ordered by significance, which is of particular interest to map the most significant trends in the visualization process (Müller 2006).

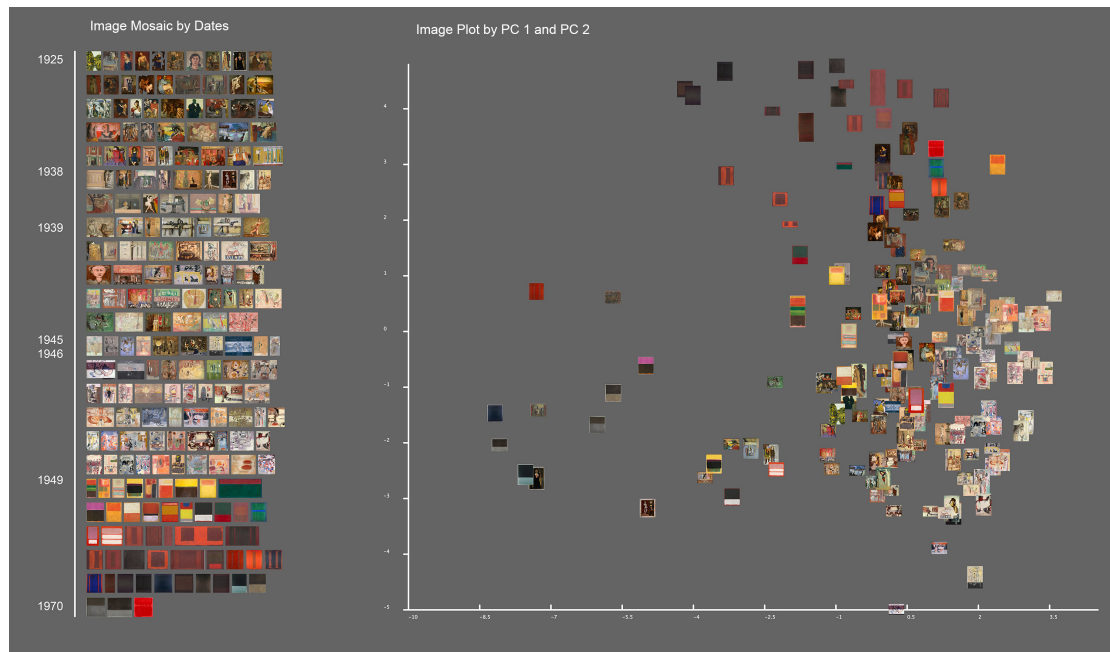


Figure 6. Image mosaic and image plot representation

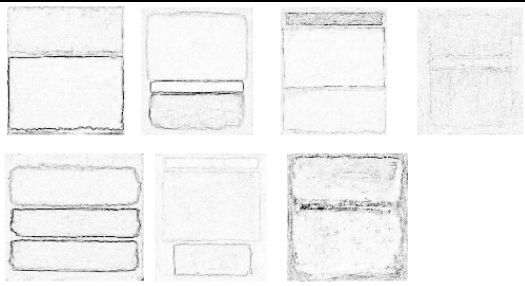
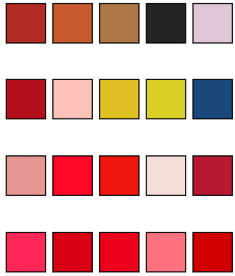
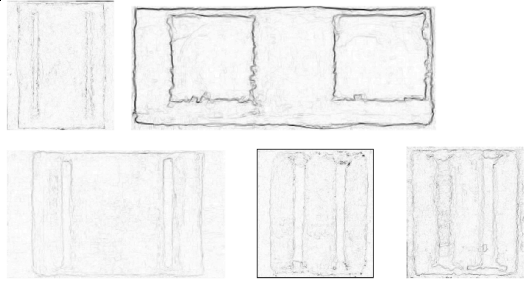
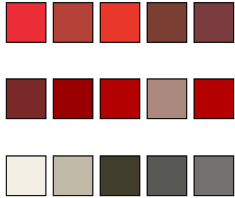
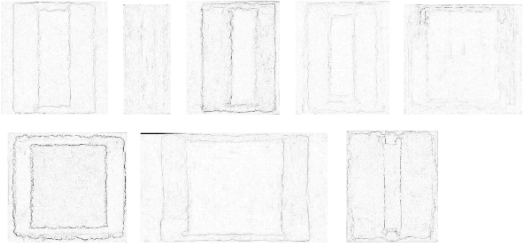
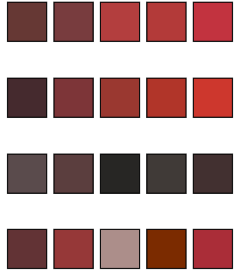
In Figure 6 we can see two representations. To the left, we organized the 201 images as a chronological mosaic. We only highlighted with text annotations those year spans where variations in style are clearly visible. To the right, we plot the same images according to the first two principal components (PC1 and PC2). The technique of depicting actual images instead of simple dots is called *direct visualization* or *media visualization* (Manovich 2011)<sup>47</sup>. This figure serves as an analytical map for visual enquiries where different sorts of similarity emerge. For example, images appear grouped into spatial clusters that share colours, shapes, or a combination of both. Although some images are superimposed and may be difficult to spot as individual instances, the plot offers a record of overall trends and patterns. Consider the bottom-right part of the plot, which shows brighter colours with complex shapes in contrast to the top-centre and the left part, which corresponds to darker tones with simple shapes. In the case of Rothko,

<sup>47</sup> We used the ImagePlot script for ImageJ, created by the Cultural Analytics Lab. Available online: <http://lab.softwarestudies.com/p/imageplot.html>



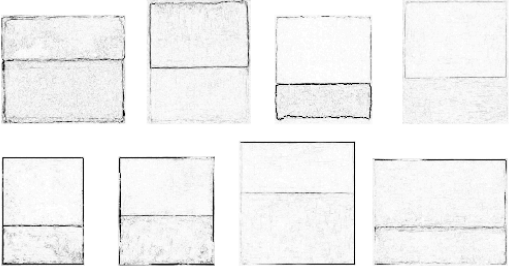

we can relate these tendencies to periods of a determinate style. Works mainly from his earlier figurative time (roughly from 1925 to the mid 40s), include a more diversified colour palette, while his later period (from late 40s until 1970) embraces more accentuated contrasts with more basic forms.

For our second data exploration, concerning image analysis and synthesis, we concentrated on the last 37 images of our collection, pertaining to the Rothko's later carer, from 1955 to 1970. In this sub-corpus, the relation between prototypical rectangles presents at least six variations: single, double, triple, quadruple, quintuple, and pair of vertical zones. Interestingly, each variation can be associated to a range of time and to a distinctive palette with traits like: dark saturated, bright unsaturated, analogous tonalities in combination with high contrast, and colours delimited to a determinate shape. Table 5 depicts, in chronological order, contour detection and the most frequent colours per image.

Table 5. Correlations between shape organizations and colours

Years	Shapes	Colours
1955 - 1957		
1958-1962		
1959		



1964 -1968		
1969-1970		

We relied on Table 5 as a visual guide to formalize correlations in computer code. Inspired by the work of Kirsch & Kirsch (1988), we put our descriptions to test by means of image synthesis. With the intention to prepare supporting materials for empirical verification and to gather experimental data, we created image generators that furnish novel and potentially infinite instances of Rothko styles each time the user clicks on a button. Figure 7 shows several images dynamically generated. For this implementation, we opted to use Web languages, making it available as a public URL<sup>48</sup>. Indeed, as a graphical language, CSS currently allows us to formulate many of our correlations (shape and colour descriptors) in terms of style sheet rules that can be manipulated in real time with JavaScript. If synthetic images manage to mislead a viewer, when confronted with our interface, into believing she is seeing a new Rothko-like image, that means the rules defined by our generator prove to be effective. If so, the images generated are instances of configurations that may be characteristic, in this case, of Rotho's style, which may be usefully validated by other methods. At present, the experimental tests remain an on-going project that needs to be defined in collaboration with colleagues in psychology and cognitive semiotics.

<sup>48</sup> This and other representations are available online: <http://ereyes.net/rothkoviz/>

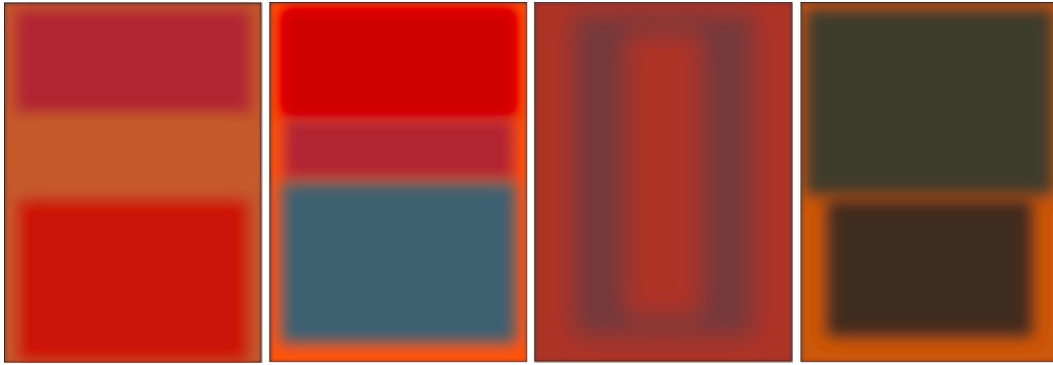


Figure 7. Rothko-style dynamically generated images

### 3 Conclusion

In this paper, we have rehearsed some of the critiques which may be addressed to the methods used so far in pictorial semiotics, explaining, in our first part why, in spite of being an immense advancement in relation to art historical analysis, these methods remain problematic. The main issue of structuralism, as well as current pictorial semiotics is the lack of application of one model to numerous instances of pictures. We pondered, in the second part of the paper, whether some help can be gained from computer technologies. The application of computer algorithms to images is already very advanced, but the adaptation of these technologies to the tasks set by pictorial semiotics is only at its beginnings. Therefore, we offered a preliminary approach to such an adaptation. As observed, this endeavour can at present only be considered a *proof of concept*. Indeed, the main obstacle before developing a full computer-aided analysis of pictures may not be technological, but rather phenomenological. We need to understand the nature of those holistic, topological, and physiognomic properties of perception on which human beings focus in order to make sense of pictures from a plastic point of view.

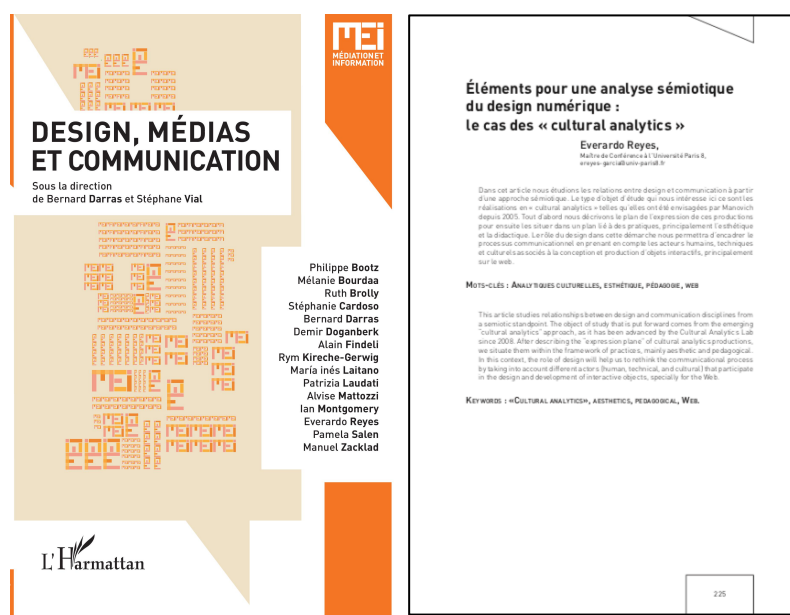
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### 3.3 Esthétique et didactique du design numérique



**Figure 12.** Couverture de la revue *MEI : Médiation et information*, No. 41 « *Design et communication* », sous la direction de Bernard DARRAS et Stéphane VIAL. Paris : L’Harmattan, 2017, ISBN : 978-2-343-12498-8, et de l’article « *Éléments pour une analyse sémiotique du design numérique : le cas des cultural analytics* », pp. 225-236

#### 3.3.1 Texte intégral de l’article, pp. 225- 236

##### Résumé

Dans cet article nous étudions les relations entre design et communication à partir d’une approche sémiotique. Le type d’objet d’étude qui nous intéresse ici ce sont les réalisations en « cultural analytics » telles qu’elles ont été envisagées par Manovich depuis 2005. Tout d’abord nous décrivons le plan de l’expression de ces productions pour ensuite les situer dans un plan lié à des pratiques, principalement l’esthétique et la didactique. Le rôle du design dans cette démarche nous permettra d’encadrer le processus communicationnel en prenant en compte les acteurs humains, techniques et culturels associés à la conception et production d’objets interactifs, principalement sur le web.

##### Le domaine de « cultural analytics »

L’expression « cultural analytics » a été conçue par Lev Manovich en 2005. Chercheur essentiellement pluridisciplinaire avec un bagage en histoire de l’art, théorie du film, littérature, programmation par ordinateur et animation 3D, Manovich a apporté des

contributions dans plusieurs disciplines telles que les « media studies », l'art numérique, les humanités numériques, la visualisation de données, et les « software studies », ce terme ayant été introduit également par lui en 2001 (Manovich, 2001 : 48). Actuellement, 11 ans après, la recherche en « cultural analytics » se profile plutôt comme une discipline, avec une revue dédiée<sup>49</sup>, une équipe de recherche internationale<sup>50</sup>, des programmes académiques<sup>51</sup>, des projets et réalisations interactives<sup>52</sup>, des conférences, journées d'études<sup>53</sup>, expositions de projets<sup>54</sup> et un livre à paraître prochainement<sup>55</sup>.

Pour expliquer le domaine des cultural analytics, la proposition fondamentale a été, dès le début, celle de « penser la culture comme des données pouvant être explorées et visualisées, y compris les contenus des médias et les activités créatives et sociales des personnes autour de ces contenus » (Manovich 2007 : 3). À fin d'esquisser les principaux traits du programme, nous résumons :

Sensibilisation à l'augmentation massive de données. Ce constat s'observe non seulement au niveau de la numérisation des médias, mais aussi de la quantité d'informations créées directement en format numérique : photographies prises avec des téléphones portables, vidéos postées sur YouTube, images, liens et commentaires échangées sur Flickr, Pinterest, Facebook, Twitter, Instagram et bien d'autres réseaux sociaux sur Internet, etc.

Introduction et adoption des méthodes informatiques, mathématiques et statistiques dans les sciences humaines et sociales. Par exemple, en ce qui concerne le traitement numérique d'images, les représentations graphiques exploitant exclusivement les méta-données des images peuvent être amplifiées en considérant leurs propriétés visuelles intrinsèques : couleurs, formes, textures.

Observation de plusieurs types d'images et types de producteurs. Ceci implique d'utiliser, adapter et repenser les techniques en cultural analytics non seulement à l'étude

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<sup>49</sup> « *Journal of Cultural Analytics* ». <http://culturalanalytics.org/>

<sup>50</sup> « *Software Studies Initiative* ». <http://softwarestudies.com/>

<sup>51</sup> Comme le programme de longue durée « *Culture Analytics* » à l'University of California à Los Angeles, de mars à juin 2016. <https://www.ipam.ucla.edu/programs/long-programs/culture-analytics/>

<sup>52</sup> OnBroadway (<http://on-broadway.nyc/>), Phototrails (<http://phototrails.net/>), Selfiecity (<http://selfiecity.net>), 144 hours in Kiev (<http://www.the-everyday.net>).

<sup>53</sup> Comme la journée « Cultural analytics et pratiques patrimoniales », organisé par Nicolas Thély et Clarisse Bardiot à la MESHS, Lille. [https://www.meshs.fr/page/cultural\\_analytics\\_et\\_pratiques\\_patrimoniales](https://www.meshs.fr/page/cultural_analytics_et_pratiques_patrimoniales)

<sup>54</sup> Comme le festival « *Data Drift* », à Riga, du 10 octobre au 22 novembre 2015. <http://rixc.org/en/festival/DATA%20DRIFT/>

<sup>55</sup> « *Cultural analytics* » de Lev Manovich, à paraître chez The MIT Press.

d'œuvres et de manifestations canoniques, exemplaires ou professionnels, mais aussi à des images créées par des amateurs, non-professionnels et par le public en général.

Les premiers exemples concrets en cultural analytics ont été réalisés à partir de corpus d'images : peintures, vidéos, photos, BD, jeux vidéos. Aujourd'hui nous dirons que les objectifs se sont élargis et, en réalité, c'est la description des phénomènes culturels qui conduit souvent à la création de corpus hétérogènes : images, données géographiques, données textuelles (discussions, romans, journaux, textes académiques et historiques) et données générées par les logiciels et les objets connectés (types de session, durées de connexion, actions effectuées).

Mais si les premiers résultats ont été présentés dans un espace technologique spécialisé<sup>56</sup>, les développements récents prennent en compte la variété de types d'écran et les développements informatiques disponibles de nos jours (par exemple les API et services web). De fait, les projets en cultural analytics ne sont pas astreints à un matériel donné car, au contraire, ce sont les objectifs de recherche qui régissent l'élaboration de nouveaux concepts, théories, méthodes, technologies et techniques informatiques (des nouveaux logiciels, algorithmes et interfaces graphiques).

Au sens large, cultural analytics s'intéresse à la représentation et à la description de la complexité, de la diversité, de la variabilité et des propriétés des processus culturels contemporains. À ce titre, l'expérimentation d'outils par les communautés des chercheurs en sciences humaines et sociales informe davantage sur les pratiques de description de phénomènes sociaux et communicationnels. La question centrale est celle de l'inclusion, par le biais d'outils et des méthodes, d'une grande variété d'interprétations tout en considérant des changements d'échelle qui s'y rapportent : allant du global au local (des villages aux continents, par exemple) ou d'une courte à une longue durée dans le temps (des secondes à des années).

### **Plan de signification et description des images numériques**

Nos contributions dans le domaine des cultural analytics portent essentiellement sur trois axes : 1) l'étude de l'image numérique en tant qu'objet technique et sémiotique ; 2) les relations entre les propriétés techniques des images et leur manipulation à travers des

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<sup>56</sup> Comme le HIPerSpace au CalTech, comprenant 9,7 x 3,2 mètres pour afficher 35 mille x 8 mille pixels.

interfaces graphiques sur le web ; 3) les effets esthétiques et didactiques des réalisations et des méthodes des cultural analytics.

Concernant les images numériques, nous avons déjà rappelé qu'elles étaient le type de média favorisé au début des démarches en cultural analytics. L'introduction des techniques en traitement d'images a facilité la quantification et la description des propriétés visuelles. Ces techniques, utilisées notamment dans les domaines scientifiques comme la biologie, la médecine et la physique, peuvent également servir à analyser un corpus d'images culturelles. Il est intéressant de noter que, comme toute description et représentation, le résultat est une formalisation des valeurs quantitatives (par exemple, la description des couleurs RVB comprend des valeurs du 0 à 255, mais la description de dominantes chromatiques en HSL va de 0 à 360). De plus, les descriptions résultent du travail des communautés de spécialistes et déterminent en grande mesure la couche visible d'un logiciel ou langage de programmation : nous pensons à la manière dont on peut accéder et manipuler les valeurs, souvent utilisant différentes terminologies ou interfaces utilisateur.

La sémiotique structurale offre ici un cadre théorique pour comprendre les niveaux d'articulation d'éléments de signification. À proprement parler, c'est le développement des travaux du linguiste Louis Hjelmslev qui, en amplifiant les catégories du signifiant et signifié proposées par Ferdinand de Saussure, a distingué le plan de l'expression et le plan du contenu, respectivement. D'une part, le plan de contenu a constitué l'un de sujets majeurs du fondateur de l'école française de sémiotique, Algirdas Julien Greimas, néanmoins le plan de l'expression avait manqué sa description rigoureuse. Ce n'est que depuis récemment que nous disposons d'une articulation élaborée pour le plan de l'expression, à travers les travaux de Jacques Fontanille (Fontanille, 2008) et que nous pouvons également aborder à des recherches en sémiotique visuelle, notamment la sémiotique plastique (Groupe Mu, 1992).

Le plan de l'expression représente l'aspect matériel d'un phénomène de signification. Sous forme de parcours génératif, ce plan distingue des niveaux de pertinence (signes, textes, objets, pratiques, stratégies, et formes de vie) où chacun de ces niveaux contient théoriquement deux faces : l'une qui est formelle car constitue les règles et formalisations dont l'autre face, qui est matérielle ou substantielle, retrouve sa manifestation ou énonciation. Nous avons discuté ailleurs l'adaptation du parcours à un objet d'étude comme les images numériques et nous résumons les résultats dans la figure 1 (Dondero & Reyes, 2016).



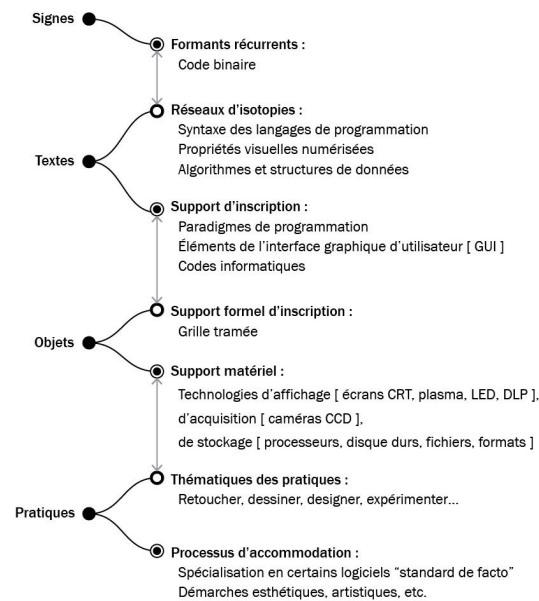


Figure 1. Fragment du parcours du plan de l'expression appliqué aux images numériques

À travers ce schéma, notre objectif est de contribuer à une clarification des niveaux imbriqués sous-jacents à la restitution et manipulation des images à l'écran. Ainsi, nous localisons les différentes formes de quantification de propriétés visuelles dans un niveau profond mais qui vont déterminer l'existence des niveaux supérieurs. Un algorithme, par exemple, est souvent conçu en prenant en compte la manière dont l'information est formalisée : si les propriétés visuelles sont décrites sous forme de données, nous parlons des valeurs de pixels qui s'organisent la plupart du temps dans une structure informatique connue comme tableau (ou « array ») permettant des opérations et manipulations. L'algorithme est donc accessible par l'interface graphique, ou le langage de programmation, afin d'exécuter les opérations qu'il est censé réaliser. De cette manière, la retouche de couleurs, le redimensionnement, la rotation, la séparation de couches RVB ou la compression d'images sont les noms que l'on donne à la suite des étapes d'un algorithme (ou plusieurs algorithmes) sur une structure de données.

À ce stade nous retrouvons un point en commun avec la sémiotique visuelle. En termes de sémiotique plastique, le Groupe Mu a apporté une classification d'unités basiques de signification au sein des images. On distingue trois catégories : 1) chromatiques (la tinte ou dominante chromatique, la saturation et la luminosité) ; 2) eidétiques (les configurations spatiales par direction, dimension et position) ; 3) textures

(les unités et règles de répétition des *patterns*). Les analyses en sémiotique visuelle emploient ces catégories afin de décrire les aspects plastiques des images, une situation qui a prouvé son utilité surtout lorsqu'on s'intéresse à des manifestations ayant une pictorialité faible, comme l'art abstrait ou même les images scientifiques. Souvent aussi, afin de trouver d'autres éléments de signification, le parcours de l'expression rappelle qu'on peut les chercher à des niveaux inférieurs ou supérieurs, c'est-à-dire en allant des « objets » aux « textes » ou des « objets » aux « pratiques ».

Toutefois, en termes de cultural analytics les catégories plastiques s'associent à des propriétés visuelles. Étant donné qu'il s'agit d'informations quantitatives, il est possible d'effectuer des opérations statistiques, par exemple : moyenne de la luminosité, déviation standard des couleurs, tri par densité de formes dans une image, graphiques de valeurs de saturation en barres ou en secteurs, etc. Mais l'intérêt pour les cultural analytics porte à extraire les attributs visuels pour les représenter dans une nouvelle totalité signifiante. De ce point de vue, il est déterminant que la visualisation d'informations visuelles soit également sous forme graphique. Cette méthode a été nommée « média visualisation ». En s'inspirant de travaux en art et design numérique, les nouveaux types de totalités incluent : moyenne d'images (« *image averaging* »), mosaïque d'images (« *image mosaicing* »), découpage d'image (« *image slicing* ») et graphe d'images (« *image plotting* ») (Reyes, 2015). Nous parlons de « totalités » car ces techniques résument dans une seule image les traits visuels d'une multiplicité ou collection d'images. Le principal changement qui s'opère est au niveau de l'échelle : alors qu'en sémiotique visuelle nous sommes habitués à analyser ou comparer peu d'images, en média visualisation nous sommes devant une image non-figurative mais avec une indexicalité élevée car les *patterns* qui se distinguent renvoient aux propriétés visuelles quantifiées.

### **Pratiques d'appropriation**

Revenons à la figure 1. Le passage des objets à des pratiques met en relation la face substantielle du support matériel avec la face formelle des thématiques des pratiques. Nous avons listé dans le schéma « retoucher, dessiner, designer, expérimenter », mais nous pouvons compléter avec « enseigner, former, manipuler, explorer ». Cette face répertorie théoriquement les activités des différents types d'utilisateurs. Ensuite, les thématiques de pratiques retrouvent leur face substantielle dans des processus d'accommodation qui peuvent découler, par exemple, en pratiques à des buts précis. Dans le cas des images numériques nous pouvons identifier des objectifs courants :

obtenir un diplôme (au travers une Licence ou un Master en design, communication, etc. qui systématise les pratiques) ; une certification (comme celles délivrées par Adobe, Autodesk et autres compagnies de logiciels qui forment à l'usage d'un environnement donné) ; ou bien entamer une démarche plus personnelle (artistique, auto-didactique, activiste, « hacktiviste », etc.).

Dans un cadre didactique et pédagogique, les réalisations et productions en cultural analytics exigent une posture expérimentale. En effet, les étudiants expriment un degré de satisfaction et stimulation lorsqu'ils sont capables d'arriver à des résultats visibles par eux-mêmes et avec leurs propres corpus de données. Notre approche pour introduire des techniques en cultural analytics se réalise idéalement sur plusieurs années d'études, en commençant par la découverte d'outils et la réplique de techniques de base (Reyes, 2014a). Dans ce premier niveau, le type d'interface graphique préconisé pour les manipulations et visualisations doit offrir peu des choix et de paramètres de personnalisation afin de favoriser la simplicité. Dans un second temps, les étudiants doivent proposer des nouvelles configurations interactives et c'est ici que la pratique de design devient centrale.

Nous pensons le design comme une posture critique qui permet de questionner nos objets et interfaces graphiques quotidiennes. À travers la pratique du design, on peut proposer de nouvelles manières d'agir et de se questionner soi-même. Il s'agit essentiellement de construire et confectionner non seulement des outils, mais aussi des visions, des expériences, des espaces et des moments. Pour nous, les méthodes des cultural analytics telles que la quantification d'informations visuelles, leur description dans un langage adapté au web (comme JSON, XML, CSV, HTML) et la création de nouvelles totalités, permettent de revoir les conventions et modèles de communication que nous menons avec les objets techniques (images numériques, navigateurs web, conventions d'interface homme-machine). De plus, en construisant des prototypes d'outils, ces artefacts servent aussi d'objet de réflexion ou de théorisation (Bogost, 2012). Par exemple, comment repenser la manière d'agir d'un bouton ? Ou comment le scrolling d'une page web peut-il devenir un élément d'interface lui-même ?

À titre d'exemple, la figure 2 montre deux images qui constituent la représentation d'une collection de 2000 images différentes. À gauche, la technique de mosaïque est utilisée pour visualiser les images et pour ensuite les trier par dominante chromatique (selon le modèle HSL). À droite, les mêmes images sont réorganisées selon deux

paramètres : 1) la réduction de couleurs (en résumant en une seule tonalité toutes les couleurs d'une image), et 2) l'organisation polaire (une transformation cartésienne à 360 degrés). La figure 3, pour sa part, montre le résultat d'un devoir simple fait dans un cadre pédagogique. Les étudiants répliquent l'extraction et la quantification de propriétés visuelles mais ils conçoivent une nouvelle organisation selon les possibilités de l'espace web. L'image résume 600 couvertures de bandes dessinées. Tout comme la figure 2, les cartes de couleur sont des indices des images mais dans la figure 3 nous voyons également un résumé dans le temps, trié par saisons (printemps, été, automne, hiver). En outre, la version en ligne de la figure 3 est interactive en ce qu'elle permet d'interagir avec les barres de couleurs, copier le code couleur (en format hexadécimal) et se déplacer pour découvrir les dix tonalités les plus utilisées. Notons en passant que la figure 3 essaie de ne pas utiliser les conventions classiques d'interface web, c'est-à-dire que les fonctions des boutons sont substituées par les touches de clavier (au lieu de cliquer, on appuie sur les flèches du clavier).

Nous pouvons dire que, dans le design, les nouvelles totalités émergentes possèdent une signification encore instable, manquant des conventions de lecture. Si le risque est alors la non-signification, nous croyons que ces productions engendrent leur validité à un autre niveau. Si une réalisation est uniquement compréhensible par le concepteur lui-même, cela pourrait, si c'est l'intention finale, reconduire à la boucle du design cherchant une stabilité de signification (en faisant des tests d'« usabilité », en permettant à d'autres individus sa réception et son utilisation, en ajoutant des annotations ou instructions pour ancrer le sens). Par ailleurs, sous un angle de vue distinct, nous employons la notion d'« esthétique du logiciel » pour faire référence à la capacité d'exprimer un sentiment complexe et abstrait à travers un code informatique ou une interface graphique, et aussi à l'expérience d'acquérir une nouvelle connaissance et d'aller au-delà de la simple compréhension de l'interface en parcourant vers le haut ou vers le bas le plan de l'expression de la signification (Reyes, 2014b).

Pour finaliser, soulevons l'observation de Roman Jakobson à propos des échanges entre les langues qui peuvent être de nature « interlinguistique » (quand on traduit un texte ou quand on inclut une partie d'un texte dans un autre comme les citations, les métatextes, les intertextes) ou bien « intralinguistique » (quand on substitue un mot par un autre dans une même phrase ou paragraphe).

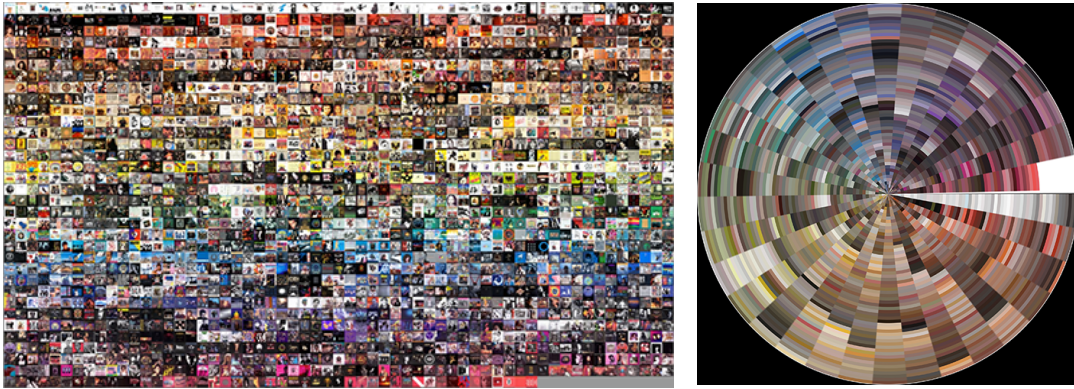


Figure 2. Deux représentations graphiques à partir de 2000 pochettes de disques. Faites par E. Reyes, 2014, afin d'explorer des organisations visuelles. <http://ereyes.net/rockViz/>

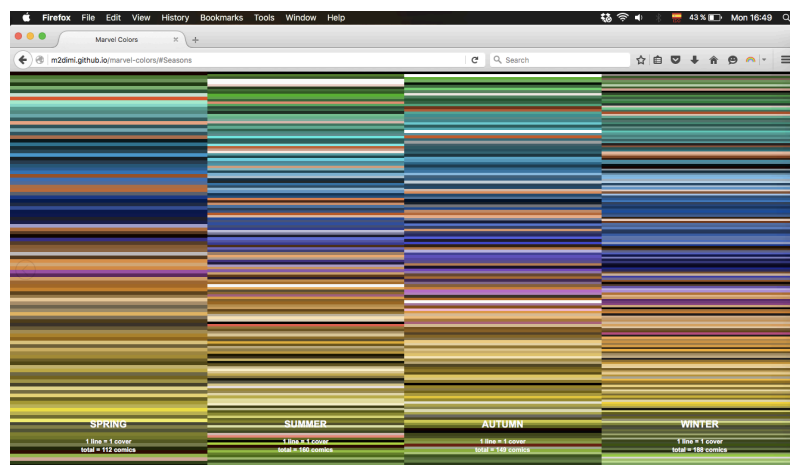


Figure 3. Interface d'exploration de 609 couvertures des BD de Marvel. Faite par Claire Blumenfeld, Claire Mauchin et Ingrid Lenoir, 2015, dans un cadre pédagogique sous la supervision de D. Guido et E. Reyes. <http://m2dimi.github.io/marvel-colors/#Home>

De manière similaire, Göran Sonesson a noté que les échanges entre les images peuvent suivre un schéma semblable. On pourrait parler d'échange « inter-pictorial » quand une image appartenant à un certain genre ou style en remplace une autre (comme les collages ou les photo-romans), ou d'« inter-pictorial » : quand une image prend la place d'une autre à l'intérieur du même discours visuel (Sonesson, 2012). Ainsi nous pouvons proposer la locution échanges « inter-interfaciques » pour les situations où un objet ou une forme d'interaction bien connue dans un domaine vient remplacer un élément d'interface graphique d'un autre domaine (ce serait le cas de conversions de logiciels scientifiques vers des logiciels culturels). Et les relations « intra-interfaciques » poseraient la question de la pertinence des choix entre les éléments appartenant au même répertoire

des possibles : les conventions IHM spécifiques à un support donné ou les éléments d'interaction inclus dans un logiciel ou langage de programmation.

Le territoire des pratiques, s'approchant de niveaux plus vastes comme les stratégies et les formes de vies (vers le haut du parcours du plan de l'expression), demanderaient une révision des cultures et interprétations que celles-ci confèrent aux objets techniques numériques. Dans ce sens, la communication médiée par les interfaces pourrait distinguer des messages provenant des cultures (ou des domaines disciplinaires) jouant le rôle de destinataires, tandis que d'autres seraient dans le rôle de destinateurs. Ces aspects relancent le débat sur les métaphores des interfaces comme des objets éthiques et politiques (Galloway, 2012), un sujet qui mérite une discussion plus ample dans le programme des cultural analytics.

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## Conclusion générale

Dans ce volume, j'ai exposé une sélection des travaux qui m'aident à définir une approche sémio-technique des objets hypermédias. Ayant eu l'occasion de présenter et discuter ma recherche dans plusieurs contextes, nationaux et internationaux, ces textes ont la particularité d'être parus dans des revues et actes de conférence avec des publics divers. C'est-à-dire qu'il n'est pas commun de rencontrer les collègues d'une communauté dans les manifestations scientifiques d'une autre. Certes, cela est dû principalement aux événements auxquels je participe et cela est différent pour d'autres chercheurs en sciences humaines et sociales. De toutes manières, je pense que le point de convergence est précisément l'ouverture et variété de méthodes des sciences de l'information et de la communication.

Ce travail de compilation apporte une vue d'ensemble de ma trajectoire. À présent j'envisage d'élargir mes collaborations et de proposer des prototypes hypermédiatiques dans des contextes sociaux. Je compte également m'investir dans les initiatives où l'intégration du numérique est au service de l'amélioration de la qualité de vie (dans la ville, le travail, l'école, la maison, l'environnement). Les types de projets à venir seront plus ambitieux en termes de temps (en pensant à une stratégie à suivre pendant quelques années) et d'espace (territoires, réseaux, cultures). Pour cela, les dialogues entre disciplines, collègues, institutions, instruments et dispositifs sont primordiaux ; et la communication est bien placée pour faciliter ces échanges, pour préserver et vivre ensemble.

## Indexe des publications et images des couvertures

**Figure 1.** Couverture de l'ouvrage *The Image-Interface : graphical supports for visual information*. Londres : Wiley-ISTE, 2017. ISBN : 978-1-78630-062-1

**Figure 2.** Couverture de l'ouvrage *Design de systèmes hypermédia interactifs*. Londres : ISTE, 2017. ISBN : 978-1-78405-264-5. Traduit à l'anglais par ISTE Éditions. Co-édité avec Nasreddine Bouhaï. Contributions de: Orélie Desfriches-Doria, Stéphane Crozat, María Inés Laitano, Leslie Matté Ganet, Dominique Cunin, Donato Ricci, Robin De Mourat, Christophe Leclercq et Bruno Latour.

**Figure 3.** Couverture de l'ouvrage *Handbook of Research on Digital Media and Creative Technologies*. Edité par Dew Harrison. Hershey, PA: IGI Global, 2015. ISBN : 978-1-4666-8205-4 et de la couverture du chapitre 10 « Designing Pervasive Virtual Worlds », pp. 224-247

**Figure 4.** Couverture de l'ouvrage *Computer Art & Design for All Proceedings of the 4th Computer Art Congress*. Edité par Guto Nóbrega, Khaldoun Zreik, Maria Luiza Fragoso & Tania Fraga. Rio de Janeiro : RIO Books, 2014. ISBN : 978-85-61556-64-8 et de l'article « On Media Art Software », pp. 39-48.

**Figure 5.** Couverture de la *Revue Documentaliste - Sciences de l'Information*. Dossier « Datavisualisation : des données à la connaissance » coordonnée par Béa Arruabarrena. Paris : ADBS, 2015. ISSN : 2428-2111 et de l'article « La data visualisation comme image-interface », pp. 38-40

**Figure 6.** Couverture de la revue *Metaverse Creativity*, Vol. 4. No. 2. sous la direction de E. Ayiter & Y. Sharir. Londres : Intellect, 2014. ISSN : 2040-3550 et de l'article « Aesthetics of temporal and spatial transformations in virtual environments », pp. 151 – 165

**Figure 7.** Couverture de l'ouvrage *La construcción de la realidad en los medios audiovisuales*, édité par Roberto Aparici. Madrid: UNED, 2010. ISBN: 978-84-362-6142-4 et du chapitre « Interrelaciones mediáticas entre cine e hipermedios », pp. 211-232



**Figure 8.** Couverture de la revue *Leonardo*. Ce numéro spécial inclut les *Long Art Papers* de SIGGRAPH 2019, édité par Everardo Reyes. Cambridge, MA : MIT Press, 2019. ISSN: 1071-4391, pp. 347-348.

**Figure 9.** Couverture de la nouvelle revue *SIGGRAPH Short Papers Proceedings*. Vol. 1, No. 1. Juillet 2019. Cette publication a été initiée par E. Reyes et inclut les *Short Art Papers*. New York : ACM Press, 2019. ISSN: 978-1-4503

**Figure 10.** Couverture de la revue *Langages*. « *Le dialogue entre la sémiotique structurale et les sciences : hommage à Algirdas Greimas* », sous la direction de J. FONTANILLE et A. ZINNA. Paris, Armand Colin, 2019, ISSN : 1958-9549, et de l'article « *Sémiotique, structure et médias numériques* », pp. 119 - 135

**Figure 11.** Couverture de la revue *Semiotica : Journal of the International Association for Semiotic Studies*, Berlin/Boston, De Gruyter, 2019. ISSN : 0037-1998, et de l'article « *New approaches to plastic language : prolegomena to a computer-aided approach to pictorial semiotics* », 25p.

**Figure 12.** Couverture de la revue *MEI : Médiation et information*. No. 41 « *Design et communication* », sous la direction de Bernard DARRAS et Stéphane VIAL. Paris : L'Harmattan, 2017, ISBN : 978-2-343-12498-8, et de l'article « *Éléments pour une analyse sémiotique du design numérique : le cas des cultural analytics* », pp. 225-236

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